Third Report on Nutrition Monitoring in the United States

Volume 1

Prepared by the Life Sciences Research Office,
Federation of American Societies for Experimental Biology

Interagency Board for Nutrition Monitoring and Related Research

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Foreword

This report is the third in a series on nutrition monitoring in the United States. The first report, *Nutrition Monitoring in the United States: A Progress Report from the Joint Nutrition Monitoring Evaluation Committee*, was published in 1986. The second, *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring*, was published in 1989. The third report reviews the dietary and nutritional status of the U.S. population, as well as the factors that determine status, based on the data available through the National Nutrition Monitoring and Related Research Program (NNMRRP) by June 1994.

The NNMRRP includes surveys, surveillance systems, and other monitoring activities that provide information about the dietary, nutritional, and nutrition-related health status of Americans; the relationship between diet and health; and the factors that influence dietary and nutritional status. The program was established by the U.S. Congress in the National Nutrition Monitoring and Related Research Act of 1990 (Public Law 101-445). The act specified that the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA) jointly implement and coordinate the activities of the NNMRRP. The legislation further specified that the agencies "contract with a scientific body, such as the National Academy of Sciences or the Federation of American Societies for Experimental Biology, to interpret available data analyses, and publish . . . a report on the dietary, nutritional, and health-related status of the people of the United States and the nutritional quality (including the nutritive and nonnutritive content) of food consumed in the United States . . . at least once every five years."

The third report on nutrition monitoring was developed at the request of USDA and HHS in accordance with the provisions of a joint contract, No. USDA 53-3K06-5-020, with the Federation of American Societies for Experimental Biology (FASEB). The report was prepared by the Federation's Life Sciences Research Office (LSRO). The report was drafted and edited by Sue Ann Anderson, Ph.D., R.D., Associate Director, and Janet H. Waters, M.S., R.D., Staff Scientist, LSRO, FASEB, with the assistance of Expert Consultants, scientists who were chosen by FASEB for their qualifications, experience, and judgment, with due consideration for balance and breadth in appropriate disciplines. The Expert Consultants examined and reviewed data, suggested interpretations, and reviewed and edited drafts of the report during its preparation. LSRO extends its appreciation to the Expert Consultants, whose expertise, insights, and encouragement were invaluable in the preparation of this report.

The LSRO staff and Co-Project Officers met with the Expert Consultants between December 1993 and March 1995 to obtain background information on the NNMRRP, to review analyses of NNMRRP data prepared for this report, and to review drafts of the report. The Expert Consultants reviewed each draft of the report and provided additional documentation of conclusions and viewpoints to incorporate into the report; however, the participation of these individuals in the project does not imply that each Expert Consultant specifically endorses all statements in the report.

The efforts of the Expert Consultants were augmented by contributions from two Special Consultants—George H. Beaton, Ph.D., University of Toronto, Toronto, Ontario, Canada and Barbara A. Underwood, Ph.D., World Health Organization, Geneva, Switzerland. LSRO also thanks these individuals for their assistance. Similarly, listing of individuals as Special Consultants does not imply that they necessarily agree with interpretations and conclusions in the report.

The contractual activities were overseen and assistance was provided to LSRO and its Expert Consultants by a Steering Committee, consisting of representatives of Federal agencies submitting data for this report. The Committee provided oversight for the report on behalf of the Interagency Board for Nutrition Monitoring and Related Research (IBNMRR). Members of the IBNMRR and the Steering Committee reviewed drafts of the report for technical accuracy. Members of the National Nutrition Monitoring Advisory Council provided input to the format and also reviewed selected drafts. The cooperation and the careful, conscientious reviews provided by these groups were essential to the successful completion of this project. LSRO accepts responsibility for the study conclusions and the accuracy of the report.

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The final report was reviewed and approved by the LSRO Advisory Committee (which consists of representatives of each constituent society of FASEB) under authority delegated by the Executive Committee of the Federation Board. Upon completion of these review procedures, the report was approved and transmitted to USDA and HHS by the Executive Director, FASEB.

Although this is a report of the Federation of American Societies for Experimental Biology, it does not necessarily reflect the opinion of each individual member of the FASEB constituent Societies.

July 31, 1995
(Date)

Marvin Snyder
Marvin Snyder, Ph.D.
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How to Use the *Third Report on Nutrition Monitoring*

This report is divided into two volumes. The first volume contains the executive summary, 10 text chapters, and four appendices (the glossary (app. I), 1989 Recommended Dietary Allowances tables (app. II), statistical and reporting guidelines for the TRONM (app. III), and survey-response-rate tables (app. IV)). The National Nutrition Monitoring and Related Research Program (NNMRRP) data are summarized in the text tables and figures and are discussed in the text in the first volume. The second volume is appendix V, which contains the detailed data for the text tables and figures, including sample sizes and standard errors. Appendix tables are not provided for published data or in cases in which the text tables include the comprehensive data. Table notes for all the surveys and acknowledgements of government contributors are also included in appendix V.

Appendix V tables and figures are organized by text chapter. They are presented in the order in which the text tables and figures appear in each chapter of the first volume and are numbered accordingly. For example, the four appendix V tables that include detailed data for the second table in chapter 6 (table 6-2) are tables A.T6-2a through A.T6-2d. The data that support figure 6-2 are in table A.F6-2. There is not a one-to-one correspondence between numbers for text tables and figures and appendix V tables and figures. In many instances, the detailed data supporting the information presented in a single text table or figure are presented in multiple appendix V tables and/or figures, and vice versa. Notes at the end of each text table and figure specify the appendix V table(s) and figure(s) that contain data pertaining to that text table or figure. In some instances, appendix V tables and figures are cited only in the text. These are grouped at the end of the list of tables and figures for each chapter in appendix V. For example, data from tables A.6a through A.6z were not used to create any text tables or figures, but those appendix tables are cited in the text.

In the text, the "SOURCE" cited at the end of all tables and figures is usually a survey or surveillance system (e.g., "USDA, CSFII, 1989-91"). When a published reference is cited (e.g., "Gerrior and Zizza (1994)"), the full reference is included in the reference list at the end of the chapter. Unpublished material is cited this way: "LSRO, 1995."

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Preface

The U.S. Congress has defined nutrition monitoring and related research as "the set of activities necessary to provide timely information about the role and status of factors that bear on the contribution that nutrition makes to the health of the people of the United States." The National Nutrition Monitoring and Related Research Program (NNMRRP) was established by Congress in the National Nutrition Monitoring and Related Research Act of 1990 (Public Law 101-445). In that legislation, Congress directed the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA) to share responsibility for implementing the program and to "contract with a scientific body, such as the National Academy of Sciences or the Federation of American Societies for Experimental Biology, to interpret available data analyses, and publish . . . a report on the dietary, nutritional, and health-related status of the people of the United States and the nutritional quality (including the nutritive and nonnutritive content) of food consumed in the United States . . . at least once every five years."

This *Third Report on Nutrition Monitoring in the United States* (TRONM) was prepared by the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology (FASEB) under contract with USDA and under the joint leadership of HHS and USDA. The first report, *Nutrition Monitoring in the United States: A Progress Report from the Joint Nutrition Monitoring Evaluation Committee,* written by HHS and USDA in 1986, and the second report, *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring,* prepared by LSRO in 1989, summarized nutrition monitoring information from the National Nutrition Monitoring System, the NNMRRP's predecessor. Between publication of the second and third reports on nutrition monitoring, the Interagency Board for Nutrition Monitoring and Related Research (IBNMRR) published *Chartbook I: Selected Findings from the National Nutrition Monitoring and Related Research Program.*

LSRO prepared the TRONM with the assistance of Expert Consultants with specialties in dietary intake and food consumption patterns, food composition and analysis, public health nutrition, community nutrition, clinical nutrition, nutrition monitoring and surveillance research, behavioral aspects of the interrelationships of nutrition and health, agricultural economics, and statistics and biostatistics. The data for the TRONM came from surveys and surveillance systems in the interconnected Federal and State activities that are part of the NNMRRP. A description of each NNMRRP survey and surveillance system can be found in *Nutrition Monitoring in the United States: The Directory of Federal and State Nutrition Monitoring Activities,* a 1992 report by the IBNMRR. Major components of the NNMRRP discussed in the TRONM include

- nutritional status and nutrition-related health measurements;
- food and nutrient consumption;
- knowledge, attitudes, and behavior assessments;
- food composition and nutrient data bases; and
- food-supply determinations.

Food components are evaluated and classified as current public health issues, potential public health issues for which further study is required, or not current public health issues. Finally, the report summarizes the recommendations made by the Expert Consultants and LSRO for strengthening the NNMRRP, based on their experiences with analyzing and interpreting the data as they prepared the TRONM.

Third Report on Nutrition Monitoring in the United States (1995)[1]
Overview of Findings

What is the nutrition-related health status of the U.S. population?

Nutritional status is associated with conditions such as overweight, high serum cholesterol levels, hypertension, and osteoporosis (decreased bone mass). These diet-related conditions increase the risk of certain chronic disease outcomes, including coronary heart disease, stroke, and bone fracture.

- Markedly higher percentages of Americans are overweight now than in the late 1970s. Many adults also report sedentary life-styles. Because overweight is associated with many chronic diseases and adverse health outcomes, the increased prevalence of overweight is a cause for public health concern.
- Although the proportion of adults who have desirable serum total cholesterol levels is increasing steadily, many people still have high levels. High serum cholesterol is a major risk factor for coronary heart disease.
- Hypertension remains a major public health problem in middle-aged and elderly people. Non-Hispanic blacks have a higher age-adjusted prevalence of hypertension than non-Hispanic whites and Mexican Americans. Hypertension is the most important risk factor for stroke and a major risk factor for coronary heart disease.
- Femoral osteoporosis in females 50 years of age and older in the United States occurs in 21% of non-Hispanic whites, 10% of non-Hispanic blacks, and 16% of Mexican Americans. Low calcium intake and lack of weight-bearing exercise, among other factors, contribute to bone loss.

What is the nutritional quality of the U.S. diet?

Americans are slowly changing their eating patterns toward more healthful diets. A considerable gap remains, however, between public health recommendations and consumers' practices. In particular, intakes of foods that should be changing—according to the recommendations in the Healthy People 2000 objectives, the Food Guide Pyramid, and the 1990 *Dietary Guidelines for Americans*—have not yet reached the targeted goals.

- The increase in the prevalence of overweight in the U.S. population since the 1970s indicates that energy balance remains a problem for many Americans. About one-third of adults and one-fifth of adolescents in the United States are overweight, suggesting that they have higher energy intakes than expenditures.
- Although the intakes of total fat, saturated fatty acids, and cholesterol have decreased, they remain above recommended levels for a large proportion of the population.
- Median sodium intakes from food are higher than recommended values for most Americans 6 years of age and older. (These intakes excluded salt added at the table.)
- Median calcium intakes from food are below recommended values, particularly for adolescents, adult females, elderly people, and non-Hispanic black males. Many Americans are not getting the calcium they need to maintain optimal bone health and prevent age-related bone loss.
- Median iron intakes from food are below recommended values for children 1-2 years of age, female adolescents 12-19 years of age, and females 20-59 years of age. The prevalence of anemia is generally higher in these groups than in other age-sex groups.
- Average daily intake of fruits and vegetables for the general population is about 4 servings. Fewer than one-third of American adults meet the recommendation to consume 5 or more servings of fruits and vegetables per day.
- Some Americans are not always getting enough to eat, although the availability of food and nutrients in the U.S. food supply, on a per capita basis, is generally adequate to prevent undernutrition and deficiency-related diseases. About 9-13% of people living in low-income households or families experience some degree of food insufficiency.

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[1]Data for this report were provided by the National Nutrition Monitoring and Related Research Program.

Executive Summary

Introduction

The United States has the most sophisticated national nutrition monitoring system in the world. The system can be used to examine food and nutrition issues that are important to the health of Americans (fig. ES-1). This executive summary highlights the major themes and findings of the latest comprehensive report of information from the monitoring system—the *Third Report on Nutrition Monitoring in the United States* (TRONM) (see preface). The report is based on data gathered by the National Nutrition Monitoring and Related Research Program (NNMRRP) since the second nutrition monitoring report was completed, giving special emphasis to low-income and high-risk population subgroups. Focusing on nutrients of public health concern, the report provides an update on the dietary, nutritional, and nutrition-related health status of Americans; the relationships between diet and health; and the factors that influence dietary and nutritional status. Readers are referred to the main report for a detailed presentation of NNMRRP data.

Major themes and findings

The TRONM's major themes and findings are grouped below into three categories: nutrition-related health status, dietary status, and concerns for low-income, high-risk populations.

Nutrition-related health status

Data collected in the NNMRRP surveys and surveillance systems provide information about the nutrition-related health status of the U.S. population. Nutritional status is associated with conditions such as overweight, high blood pressure, elevated serum cholesterol levels, and osteoporosis (decreased bone mass). These diet-related conditions increase the risk of certain chronic diseases and health outcomes, such as coronary heart disease, some types of cancer, stroke, gallbladder disease, non-insulin-dependent diabetes, and bone fracture.

The assessment of nutritional status includes taking anthropometric body measurements, collecting results of hematological and biochemical tests, monitoring clinical signs of nutritional deficiency or excess, and assessing dietary intake. Anthropometric body measurements are used to assess low birth weight and growth parameters in children as well as overweight in the general population. Biochemical and hematological measures, such as concentrations of hemoglobin and serum vitamin A, are used in conjunction with dietary intake data to assess conditions such as iron-deficiency anemia and vitamin A status in the population and in high-risk subgroups, such as young children and pregnant women. Major findings on nutrition-related health status are highlighted below.

Lipids and health

Americans are decreasing their high serum cholesterol levels. High serum cholesterol is a major risk factor for coronary heart disease. Lower dietary intakes of total fat and cholesterol contribute to reduced serum cholesterol levels.

- Between 1960 and 1991, the proportion of adults aged 20-74 years who had high serum total cholesterol levels decreased steadily. Likewise, the proportion of adults who had desirable serum total cholesterol levels increased (figs. ES-2 and ES-3).
- Over the same time period, the proportion of black and white females 20-74 years of age with high serum total cholesterol was higher than that of their male counterparts.

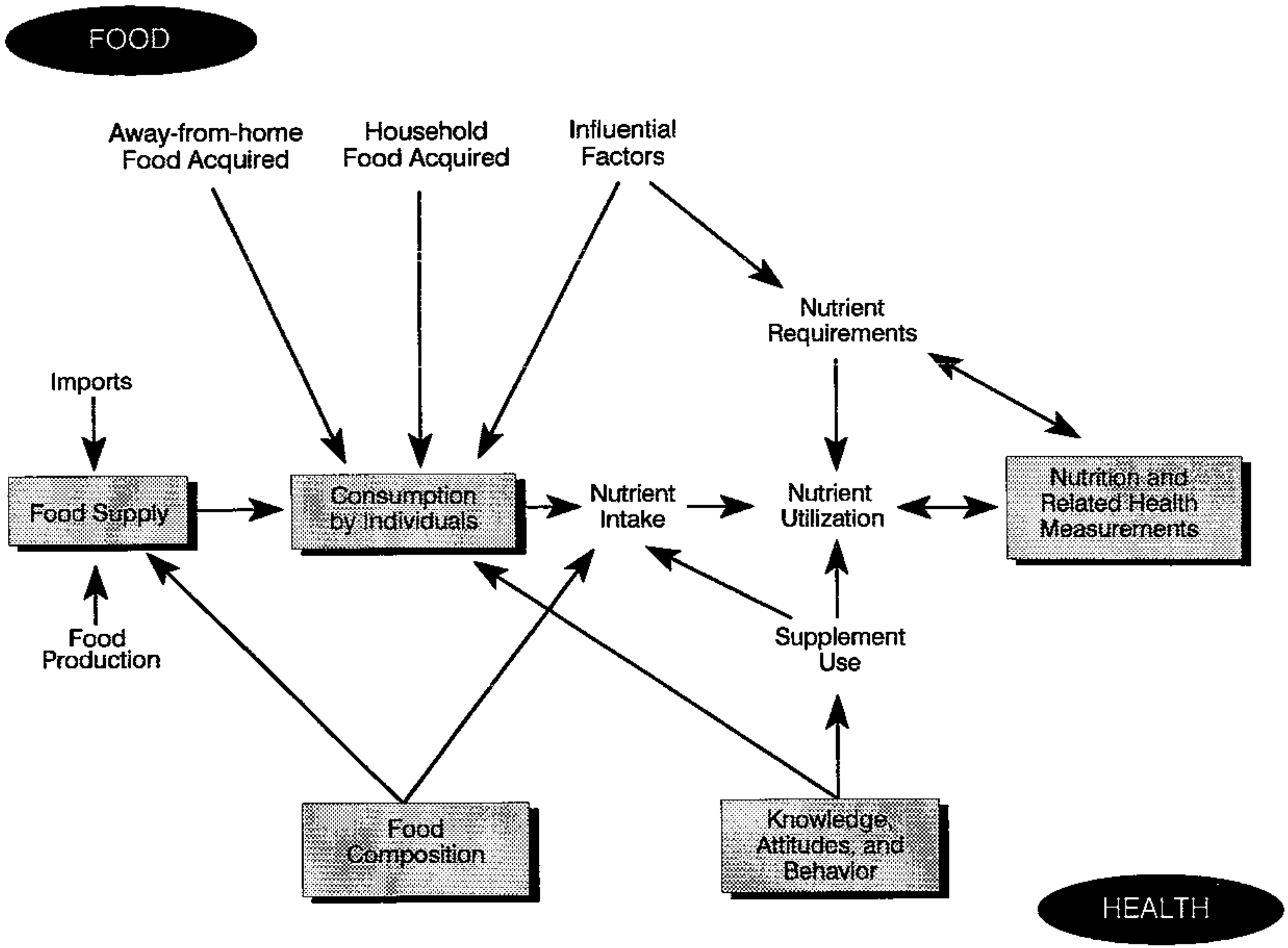

Figure ES-1. Relationship of food to health, highlighting the NNMRRP's major components

SOURCE: HHS and USDA (1993).

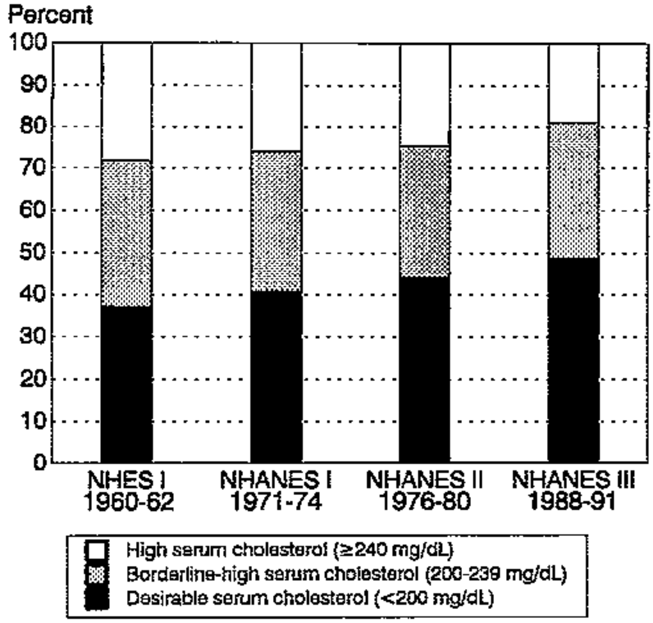

Figure ES-2. Age-adjusted percentage of males 20-74 years of age with desirable, borderline-high-risk, and high serum total cholesterol levels, 1960-62, 1971-74, 1976-80, and 1988-91

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

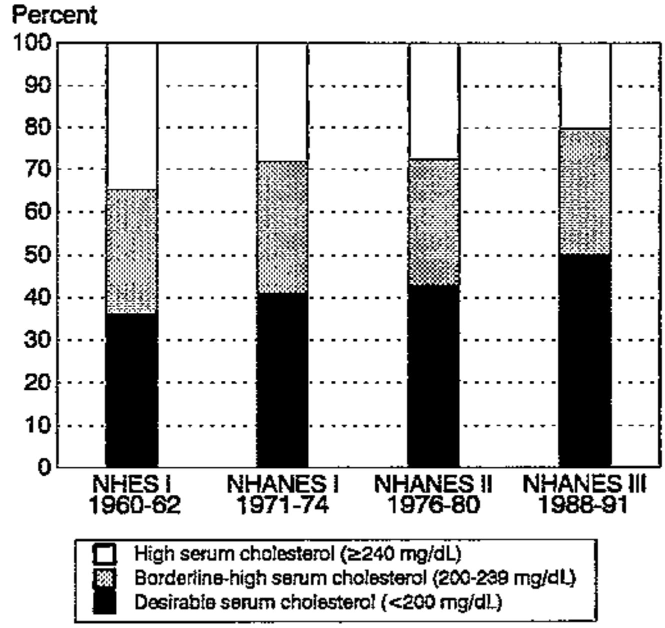

Figure ES-3. Age-adjusted percentage of females 20-74 years of age with desirable, borderline-high-risk, and high serum total cholesterol levels, 1960-62, 1971-74, 1976-80, and 1988-91

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

- Concurrently, intakes of total fat have decreased slightly for adults and intakes of saturated fatty acids have stayed about the same or decreased slightly. In 1988-91, median total fat intake as a percentage of calories was about 34%, down from about 36% in 1976-80. In 1988-91, median saturated fatty acid intake as a percentage of calories was 12-13%, compared with the 13% found in 1976-80.

Intakes of total fat and saturated fatty acids remain above recommended levels for a large proportion of the population.

- Fewer than 20% of children 6-11 years of age and of adolescents and only 21% of adult males and 25% of adult females consumed diets containing recommended levels of total fat (≤30% of calories) in 1989-91 (table ES-1).

- Median intakes of total fat and saturated fatty acids (as percentages of calories) were similar for males and females of different racial/ethnic groups but tended to be somewhat lower in older than younger adults.

- Median cholesterol intakes were generally within the recommended range (<300 mg/d), except among non-Hispanic black and Mexican-American males 16-59 years of age.

Most people who were told that their serum cholesterol level was high report that they are following a health professional's advice to lower it. However, only about one-half of U.S. adults in 1988-91 reported that they had ever had their serum cholesterol level checked.

- Of those who were told that their serum cholesterol level was high, 85% were told by a physician or other health professional to change their diet, 54% were told to exercise, 47% were told to lose weight, and 20% were told to take medications to lower their high serum cholesterol level.

- Of people who were told to change their diet, 89% said that they were currently following the advice; of people told to lose weight, exercise, and/or take medications, more than 70% said that they were currently following the advice given.

Table ES-1. Percentage of people with total fat intake ≤30% of calories, >30% and ≤40% of calories, and >40% of calories during 3 days, by age, race, income level, Food Stamp Program (FSP) participation, and sex, 1989-91 (%)

	≤30%[1]		>30% and ≤40%		>40%	
Age in years, race, income level, and FSP participation	Male	Female	Male	Female	Male	Female
Age						
6-11	18.2	17.7	64.2	66.9	17.6	15.4
12-19	14.0	17.9	67.5	61.1	18.6	21.0
≥20	20.9	25.2	53.8	53.6	25.3	21.1
Race, ≥20 years						
White	20.6	25.3	53.1	53.7	26.3	21.0
Black	17.0	21.3	62.5	55.5	20.5	23.3
Income level, ≥20 years						
<131% poverty	21.7	25.9	50.9	53.0	27.4	21.2
131-350% poverty	18.2	26.0	56.0	54.7	25.8	19.3
>350% poverty	22.3	23.6	52.0	53.4	25.7	23.0
FSP participation, ≥20 years						
Participant	21.5	23.5	48.6	52.7	30.0	23.8
Nonparticipant	21.8	26.9	51.5	53.1	26.7	20.0

[1]Recommended intake.

SOURCE: USDA, CSFII, 1989-91.

Despite widespread nutrition education efforts, many consumers still do not know enough about dietary fats and cholesterol to make food choices that are consistent with dietary recommendations.

- Only 26% of U.S. adults in 1990 knew that "saturated fats" and "polyunsaturated fats" were similar in their caloric values or that fats and oils become more saturated when they are hydrogenated, 36% knew that "polyunsaturated fats" were more likely to be liquid than solid, and 54% knew that cholesterol was not the same thing as "saturated fats" or "polyunsaturated fats." (Quotation marks denote actual terms used in questionnaires.)

- Only 32% knew that cholesterol is found only in animal products, and 69% knew that "saturated fats" are usually found in animal products.

- About 60% were aware that "saturated fats" are more likely to raise "blood" cholesterol levels than are "polyunsaturated fats."

More people are aware of the relationship between dietary cholesterol and health than of the relationship between dietary "fat" and "saturated fat" and health.

- Eighty-seven percent of female main meal planners and preparers said that they were aware of health problems related to cholesterol intake, 80% said that they were aware of health problems related to "fat" intake, and 65% said that they were aware of health problems related to "saturated fat" intake.

- In general, female main meal planners and preparers who were white, middle-aged, more educated, and from higher income levels were more aware of relationships between health and intake of "fat," "saturated fat," and cholesterol than were those who were black, less than 40 years of age or 60 years of age and older, less educated, and from lower income levels.

Data from the NNMRRP have made it possible to track the progress toward achieving the U.S. Department of Health and Human Services' (HHS's) Healthy People 2000 objectives for dietary "fat and saturated fat" intake. Although the percentages of calories from total fat and saturated fatty acids have decreased slightly over time, additional progress is needed to meet population targets set in Healthy People 2000 Objective 2.5: to reduce dietary fat intake to an average of 30% of calories or less and average saturated fatty acid intake to less than 10% of calories.

Overweight

Markedly higher percentages of American adults, adolescents, and children are overweight now than in 1976-80. Because overweight is associated with many chronic diseases and adverse health outcomes, the increased prevalence of overweight is a cause for public health concern.

- The age-adjusted prevalence of overweight for adult males and white females increased from about 25% between 1960 and 1980 to 33% in 1988-91. The major portion of the change appeared to occur between 1976-80 and 1988-91. Over the entire time span, the prevalence of overweight was higher for black adult females (42-44% between 1960 and 1980 and 49% in 1988-91) than for any other group (fig. ES-4).

- The prevalence of overweight also increased in children and adolescents between 1971 and 1991, regardless of the criteria used to define overweight. In two analyses of data from the third National Health and Nutrition Examination Survey (NHANES III 1988-91), body mass index (BMI) above certain age- and sex-specific percentiles was used to define overweight. (BMI is a ratio relating body weight to height. It is calculated by dividing weight in kilograms by the square of height in meters.) On the basis of cutoff values associated with the 95th percentiles in the first NHANES (NHANES I 1971-74), the prevalence of overweight was 9% for males and 13% for females 6-11 years of age, and about 10% for adolescent males and 9% for adolescent females 12-19 years of age (fig. ES-5). When the BMI cutoff values corresponding to the 85th percentiles from the second NHANES (NHANES II 1976-80) were used, the prevalence of overweight in 1988-91 was 20% for adolescent males and 22% for adolescent females 12-19 years of age. In 1976-80, 15% of adolescents were overweight. This definition was used for tracking Healthy People 2000 Objective 2.3, which specifies that the prevalence of

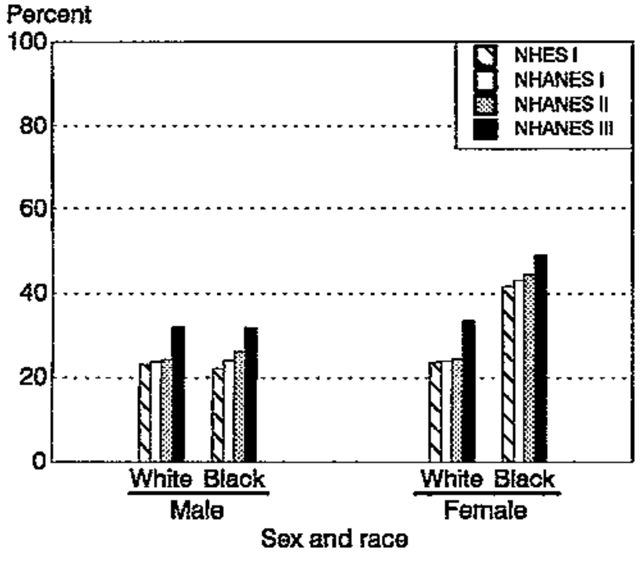

Figure ES-4. Age-adjusted percentage of people 20-74 years of age who are overweight (high BMI), by sex and race, 1960-62, 1971-74, 1976-80, and 1988-91

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

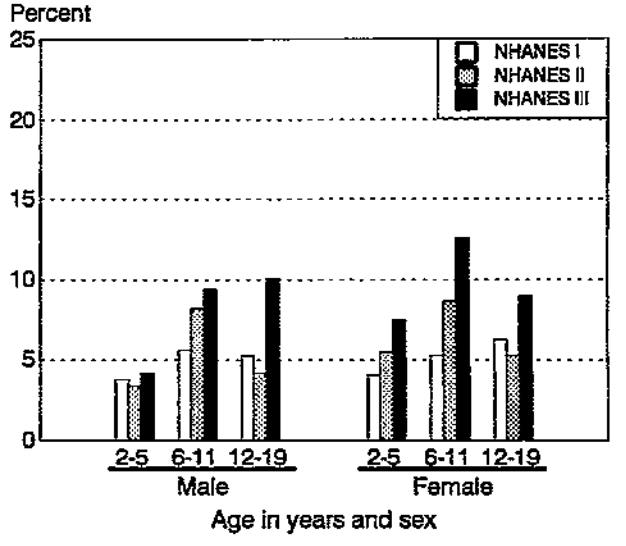

Figure ES-5. Percentage of children and adolescents 2-19 years of age who have high weight for height (2-5 years of age) or are overweight (6-19 years of age), by age and sex, 1971-74, 1976-80, and 1988-91

SOURCE: HHS, NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

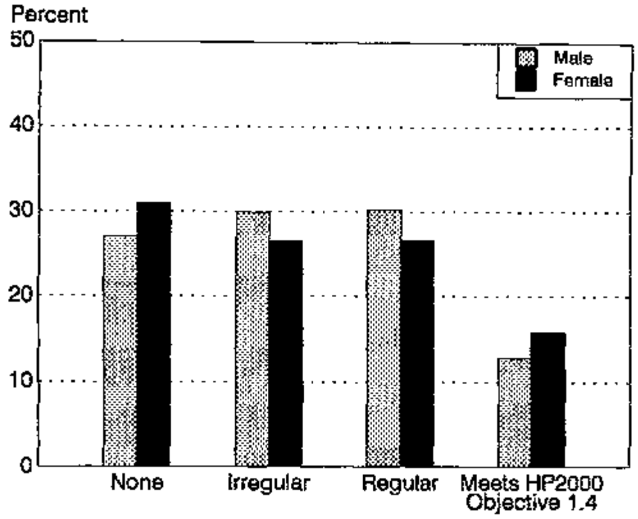

Figure ES-6. Prevalence of physical activity among people 20 years of age and older and percentage meeting the Healthy People 2000 (HP2000) objective for vigorous physical activity, by sex, 1992

SOURCE: HHS, BRFSS, 1992.

overweight in adolescents 12-19 years of age be no more than 15%. (See also "Maternal and Child Health and Nutrition" and "Concerns for Low-Income, High-Risk Populations," below.)

- The prevalence of overweight has increased considerably despite only small changes in reported food energy intakes. However, reported food energy intakes were not above recommended values. Overweight is caused by energy imbalance (food energy intake in excess of energy expenditure). More than half of adults have a sedentary life-style. Fewer than one-third participate in regular physical activity (fig. ES-6). These observations, along with data from experimental and clinical studies and other surveys, suggest that 1) recommended food energy intakes are too high in relation to physical activity, 2) underreporting occurs when some people report their food consumption, and/or 3) levels of physical activity are low.

- Among students in grades 9-12 in 1990, non-Hispanic white and Hispanic males were more likely than non-Hispanic black males and males of other races/ethnicities (non-Hispanic) to report that they did not participate in any vigorous physical activity in the past 14 days (fig. ES-7). Nearly 40% of non-Hispanic black females, 29% of Hispanic females, 22% of non-Hispanic white females, and nearly 40% of females of other races/ethnicities (non-Hispanic) reported no vigorous physical activity in the past 14 days.

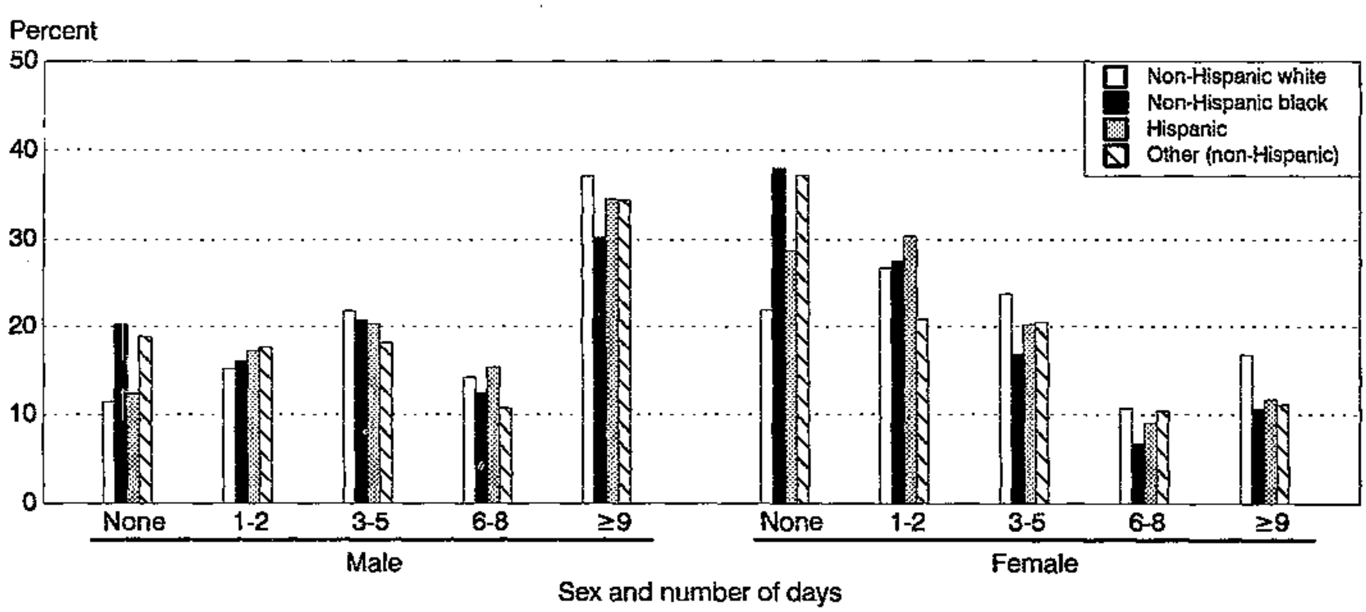

Figure ES-7. Frequency of participation in vigorous physical activity over the past 14 days among high school students, by sex and race/ethnicity, 1990

SOURCE: HHS, YRBS, 1990.

Disturbingly lower levels of vigorous activity were noted with each subsequent year of high school, especially in females.

- People often did not perceive their body weight status correctly (figs. ES-8 and ES-9). Regardless of weight status, the proportion of non-Hispanic white females 20 years of age and older who considered themselves overweight was higher than that of females in other racial/ethnic groups in 1988-91. Body weight was less of a concern for non-Hispanic black adolescent females than it was for female adolescents of other racial/ethnic backgrounds. Among a military population of enlisted female trainees surveyed in 1993, a fairly high percentage (29%) of relatively lean women perceived themselves as overweight.

- On average, 30% of males and 53% of females in 1988-91 reported that they had tried to lose weight in the past 12 months (fig. ES-10). Dieting and exercise were the weight-loss practices most frequently reported by people 18 years of age and older. Women were more likely than men to cite use of vitamins, meal replacements, or over-the-counter products for weight loss and to participate in organized weight-loss programs.

The reasons for the sharp increase in the prevalence of overweight since 1976-80 are not clear. Age-adjusted prevalence of overweight for adults was 33% in 1988-91. Evidence from several NNMRRP surveys collected during this time period suggests that energy intakes exceed energy expenditures, probably because of low levels of physical activity.

The goal of Healthy People 2000 Objective 1.4 is to increase to at least 20% the proportion of people aged 18 years and older—and to at least 75% the proportion of children and adolescents aged 6-17 years—who engage in vigorous physical activity that promotes the development and maintenance of cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion. In 1992, only 13% of male and 16% of female adults reported physical activities or exercise vigorous enough to meet this objective (fig. ES-6). In 1990, 36% of male and 15% of female high school students, on average, reported that they exercised vigorously for 20 or more minutes on 9 or more days in the past 14 days.

The goal of Healthy People 2000 Objective 1.5 is to reduce to no more than 15% the proportion of people 6 years of age and older who engage in no leisure-time physical activity. In 1992, 27% of male and 31% of female adults surveyed said that they did not

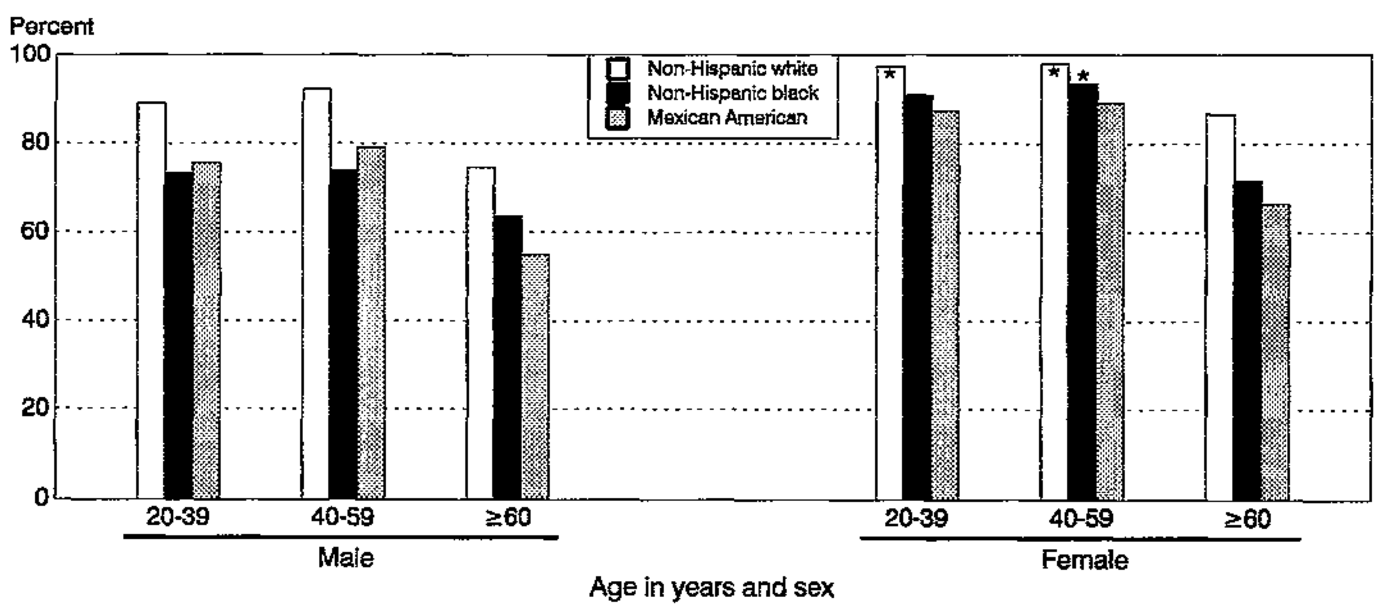

Figure ES-8. Self-perceived overweight: percentage of overweight people 20 years of age and older who think they are overweight, by age, sex, and race/ethnicity, 1988-91

SOURCE: HHS, NHANES III, 1988-91.

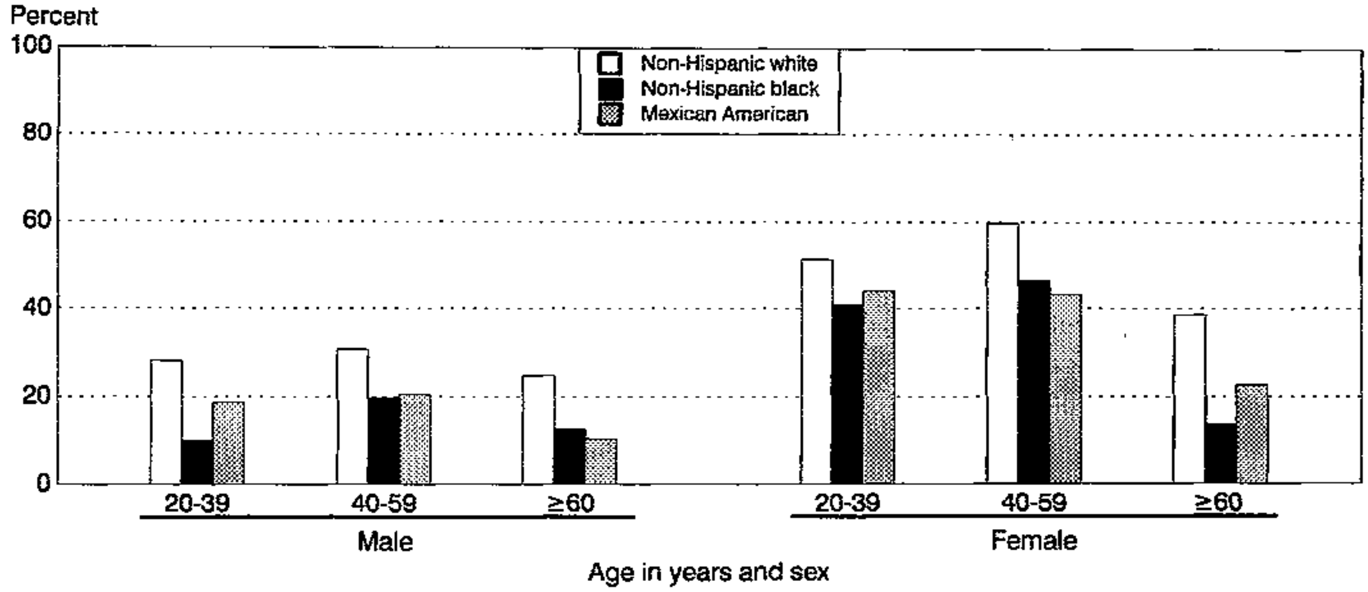

Figure ES-9. Self-perceived overweight: percentage of people 20 years of age and older who think they are overweight but are not overweight, by age, sex, and race/ethnicity, 1988-91

SOURCE: HHS, NHANES III, 1988-91.

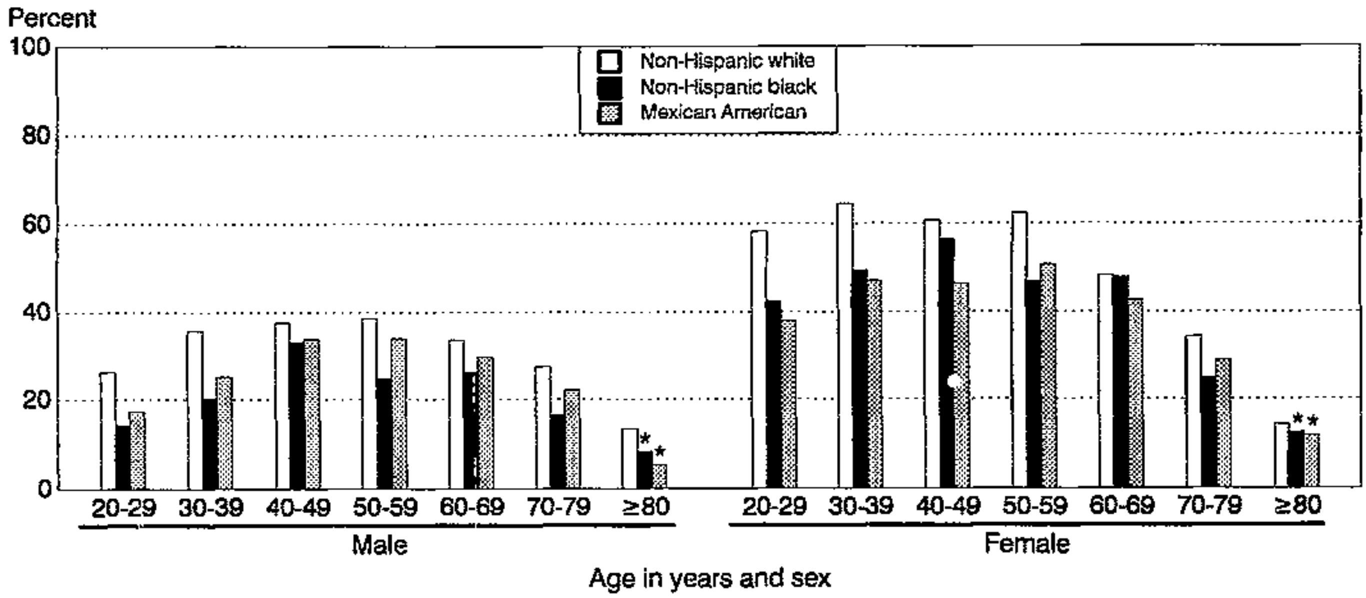

Figure ES-10. Percentage of people 20 years of age and older who have tried to lose weight during the past 12 months, by age, sex, and race/ethnicity, 1988-91

SOURCE: HHS, NHANES III, 1988-91.

participate in any physical activity in the past month. The goal of Healthy People 2000 Objective 1.3 is to increase to at least 30% the proportion of people 6 years of age and older who engage regularly, preferably daily, in light to moderate physical activity for at least 30 minutes per day. In 1992, 30% of male and 27% of female adults reported that they participated in regular physical activity (fig. ES-6).

Judging by the trends observed, Americans will not attain Healthy People 2000 Objective 2.3—to reduce the prevalence of overweight in adults to no more than 20% and in adolescents, to no more than 15%—by the year 2000. Increases in overweight are likely to increase health-care costs. Similarly, current levels of physical activity make it unlikely that Healthy People 2000 objectives related to activity (1.3, 1.4, and 1.5) will be achieved. It is unlikely that the prevalence of overweight will decrease without making substantial progress toward meeting the Healthy People 2000 physical-activity objectives.

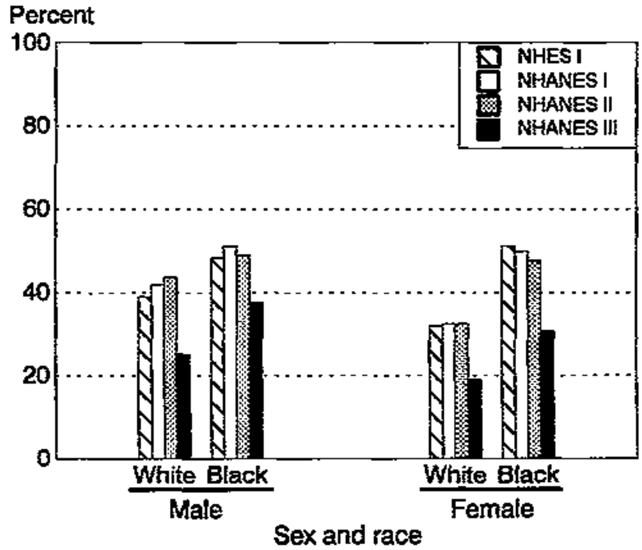

Figure ES-11. Age-adjusted percentage of people 20-74 years of age who have hypertension, by sex and race, 1960-62, 1971-74, 1976-80, and 1988-91

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

Hypertension

Although the prevalence of hypertension has decreased since 1960, hypertension remains a public health problem. As many as 50 million Americans have elevated blood pressure or take antihypertensive medications. Epidemiological studies have linked prevalence of hypertension to dietary intakes of several essential minerals. For example, consistent positive associations have been shown between higher dietary salt (sodium) intake and hypertension. Low calcium and potassium intakes have been associated with higher prevalence of hypertension. Inverse associations have been reported between serum magnesium and blood pressure.

- Between 1960 and 1980, the prevalence of hypertension remained relatively stable. However, by 1988-91, a striking drop in prevalence was observed (fig. ES-11). This finding was unexpected, given the positive association between overweight and hypertension and the increase in the prevalence of overweight in the U.S. population between 1976-80 and 1988-91. The age-adjusted prevalence of hypertension between 1960 and 1991 was consistently higher in blacks than in whites. Procedural differences among the surveys may account for part of the decrease in prevalence seen in recent years, although the extent of their contribution cannot be determined. Some of the decrease has been attributed to primary prevention, such as following advice from health-care professionals to lower sodium intake, to lose weight if overweight, and to increase physical activity.

- Hypertension remains a substantial problem in middle-aged and elderly people (table ES-2). In 1988-91, the overall prevalence of hypertension was 25% in adults 20 years of age and older. The prevalence of hypertension was higher with each decade of age for both males and females, and it was higher for males than for females 20-59 years of age. In older people, the prevalence of hypertension was higher in females. About 75% of females 80 years of age and older had high blood pressure compared with 60% of males in the same age group.

- In 1988-91, median intakes of sodium from food were above recommended levels, and median intakes of calcium and potassium from food were below recommended levels. Sodium intakes were similar for non-Hispanic whites, non-Hispanic blacks, and Mexican Americans. However, median potassium and calcium intakes were lower for non-Hispanic blacks, who are at highest risk for development of hypertension, than for the other two groups.

Table ES-2. Percentage of people 20 years of age and older who have hypertension, by sex, age, and race/ethnicity, 1988-91 (%)[1]

Sex and age in years	All groups	Non-Hispanic white	Non-Hispanic black	Mexican American
Overall population				
Total, crude	25.4	25.8	30.9	15.6
Total, age-adjusted	25.4	24.5	34.0	23.8
Male				
20-29	5.1	4.3*	8.2	3.3
30-39	13.0	12.8	20.9	9.3
40-49	24.4	23.4	36.8	22.4
50-59	42.2	41.8	55.9	36.0
60-69	52.1	51.3	63.6	53.8
70-79	60.7	60.3	68.0	52.1
≥80	60.5	60.3	62.4	70.5*
Total, crude	25.7	26.4	31.6	15.5
Total, age-adjusted	27.0	26.4	35.3	24.4
Female				
20-29	1.0*	0.8*	2.4*	1.1*
30-39	6.2	5.0	12.1	6.5
40-49	14.4	12.7	30.5	10.7
50-59	38.8	36.8	47.9	33.5
60-69	53.5	50.9	77.8	59.3
70-79	67.6	66.9	72.6	67.0
≥80	74.7	74.3	80.5	71.0
Total, crude	25.1	25.3	30.2	15.7
Total, age-adjusted	23.7	22.4	32.6	22.9

[1]Excludes pregnant females. "All groups" includes data for racial/ethnic groups not shown separately. "Hypertension" was defined as mean systolic blood pressure ≥140 mm Hg, mean diastolic blood pressure ≥90 mm Hg, or under current treatment for hypertension with a prescription medication. These values represent the mean of six or fewer blood pressure measurements. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

- In 1989-91, 88% of female main meal planners and preparers were aware of health problems related to salt or sodium intake. The proportion of women in this group who were aware of this diet-health relationship was higher among those with higher incomes. A substantial proportion of Americans appears to be trying to limit salt used at the table; about 58% of males and 68% of females reported never using salt, using "lite" salt, or rarely using ordinary table salt.

- In 1988-91, most people with diagnosed hypertension were told by a physician to take medications and/or to change their diet. About 90% reported that they were complying with advice to change their diet, and 76% reported that they were complying with advice to take medications. About half of those who were told they had hypertension were told to lose weight to control their blood pressure, and about three-quarters of these individuals reported that they were complying with this advice. About 30% were told to increase exercise, stop smoking, restrict alcohol consumption, reduce stress, and/or change some other aspect of their life-style to control their blood pressure; almost two-thirds said that they were following the advice given.

To achieve Healthy People 2000 Objective 2.9—to decrease salt and sodium intake so at least 65% of home meal preparers prepare food without adding salt, at least 80% of people avoid using salt at the table, and at least 40% of adults regularly purchase food with modified or lower sodium content—Americans will have to decrease their intake of salt and sodium. Many people are apparently trying to avoid using salt at the table. However, because the major portion of dietary sodium is provided by sodium added to processed foods and home-, deli-, and restaurant-prepared foods, greater reductions in sodium consumption may be achieved by reducing sodium used to process and prepare foods and by encouraging consumers to select products that are lower in sodium.

Calcium and osteoporosis

Many Americans are not getting the calcium they need to maintain optimal bone health and prevent age-related bone loss. Development of osteopenia (less-than-optimal bone density) and osteoporosis (decreased bone mass) is associated with loss of bone mineral, including calcium. Low calcium intake and lack of weight-bearing exercise, among other factors, contribute to bone loss.

- Many people, particularly adolescents, adult females, and elderly people across racial/ethnic groups and non-Hispanic black adult males, consumed less than the recommended amount of calcium from food in 1988-91. Mean calcium intakes from food in the U.S. population have not changed substantially since 1977-78.

- In 1988-91, median calcium intakes from foods were below recommended levels for male and female adolescents other than non-Hispanic white males. Achieving peak bone mass and maintaining bone mass appear to be related to adequate calcium intake in adolescence and early adulthood. Because of the high rates of bone accretion during adolescence, continued monitoring of calcium intake is important.

- In 1988-91, bone density was measured for the first time in a nationally representative sample of Americans. Among females 50 years of age and older, femoral osteopenia occurred in 39% of non-Hispanic whites, 29% of non-Hispanic blacks, and 36% of Mexican Americans. Prevalence estimates for osteoporosis in these three groups were 21%, 10%, and 16%, respectively. Significant bone accretion occurs during adolescence and early adulthood. The low calcium intakes from food by many adolescents and adults, particularly females, suggest that many Americans are not getting the calcium they need to maintain optimal bone health and prevent age-related bone loss.

- About 67% of female main meal planners and preparers were aware of health problems associated with the quantity of calcium consumed. About 50% of female main meal planners and preparers from households with incomes <131% of the Federal Poverty Income guidelines (i.e., low incomes) were aware of these associations.

Maternal and child health and nutrition

Diets and nutritional status of pregnant women, mothers, and children continue to be causes for public health concern.

- Data on the dietary intakes of pregnant women in 1988-91 indicate that mean intakes from food were lower than recommended levels for several key nutrients (folate, calcium, vitamin B_6, iron, zinc, and magnesium). This is evident across racial/ethnic groups. (The intake data did not include vitamin and mineral supplements.)

- The prevalences of breastfeeding among mothers 15-44 years of age and the proportion of their babies who were breastfed for 4 or more months were lower among mothers who were black, younger, or living below the poverty level (table ES-3). Among infants born in 1984-86, 55% were breastfed, up from 46% of infants born in 1978-80. Although it appears that the overall prevalence of breastfeeding is increasing slightly over time, it is still below the goals set in Healthy People 2000 Objective 2.11, which states that at least 75% of mothers breastfeed their babies in the early postpartum period. It also states that at least 50% of all mothers breastfeed until their babies are 5-6 months of age. About 30% and 34% of all infants were breastfed for this long in 1978-80 and 1984-86, respectively (data not shown). Although there has been some increase in the percentage of infants who are breastfed, greater emphasis is needed to encourage more mothers to initiate breastfeeding and to breastfeed longer.

- In 1988-91, the prevalences of shortness and thinness among children and adolescents were about 5% or lower, indicating that these conditions did not occur with greater frequency than expected for children and adolescents in the overall population (5%) (table ES-4). The prevalence of overweight in children and adolescents is discussed as a part of the findings under "Overweight" (above).

Table ES-3. Prevalence of breastfeeding among mothers 15-44 years of age and proportion of their babies who were breastfed for 4 or more months, by year of baby's birth and selected characteristics of the mothers, 1978-80 and 1984-86 (%)[1]

	Ever breastfed		Breastfed for ≥4 months	
Characteristics of mother	1978-80	1984-86	1978-80	1984-86
Overall population	46.1	55.0	65.3	61.9
Race				
White	50.3	59.9	65.4	62.6
Black	22.8	23.4	60.1	50.1
Educational level				
<9 years	26.4*	49.1	I	52.3
9-11 years	33.7	34.5	72.2	66.5
12 years	42.8	51.9	57.8	55.5
≥13 years	63.4	75.0	71.7	66.9
Age				
<20 years	25.0	16.6	50.7	46.2
20-29 years	48.4	57.2	61.3	58.7
30-39 years	52.1	66.7	83.1	71.0
40-44 years	I	I	I	I
Region of residence				
Northeast	38.4	63.5	59.3	69.1
South	49.8	45.6	64.4	55.5
Midwest	35.5	51.3	64.0	56.6
West	65.7	68.8	70.4	68.0
Poverty status				
<100% poverty	30.7	27.3	54.4	55.5
≥100% poverty	50.0	62.3	66.9	62.7

[1]An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; I indicates that minimum-sample-size requirements were not met.

SOURCE: HHS, NSFG, 1982 and 1988.

Table ES-4. Prevalence of shortness, thinness, high weight for recumbent length, high weight for height, and overweight in children and adolescents in the U.S. population, by age and sex, 1988-91 (%)[1]

Growth-status indicators for selected age groups	Male	Female
Shortness		
Low recumbent length for age		
2-5 months	4.9*	3.7*
6-11 months	4.4	3.9*
12-23 months	3.8	3.5
Low height for age		
2-5 years	5.2	5.1
6-11 years	4.7	4.1
12-17 years	6.1	1.5*
Thinness		
Low weight for recumbent length		
2-5 months	1.3*	—
6-11 months	1.6*	2.7*
12-23 months	3.4	3.2*
Low weight for height		
2-5 years	2.7	0.6*
6-9 years	2.6*	3.6
High weight for recumbent length		
2-5 months	11.9	12.0
6-11 months	8.5	11.5
12-23 months	10.5	10.6
High weight for height		
2-5 years	4.2	7.5
Overweight		
6-11 years	9.4	12.6
12-19 years	10.1	9.0

[1]Excludes pregnant females. For low recumbent length for age and low weight for recumbent length for children 6-23 months of age, percentages are those below the NCHS growth chart 5th percentiles (Hamill et al., 1979). For high weight for recumbent length for children 6-23 months of age, and for high weight for height for children 2-5 years of age, percentages are those above the NCHS growth chart 95th percentiles (Hamill et al., 1979). For low height for age for children 2-17 years of age and low weight for height for children 2-9 years of age, percentages are those below the NCHS growth chart 5th percentiles (Hamill et al., 1979). For overweight children 6-19 years of age, percentages are those above the NHANES I 95th percentile of body mass index for age (Must et al., 1991). An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; a dash (—) indicates that the observed percentage was 0.0.

SOURCE: HHS, NHANES III, 1988-91.

Dietary status

Data collected in the NNMRRP surveys and surveillance systems provide information on the dietary status of the U.S. population. Dietary status is assessed by examining the types and amounts of foods, food components, and nutrients consumed. An evaluation of total nutrient intake requires that both food and nonfood nutrient sources be considered.

Data are available from the NNMRRP on several levels of food consumption—individual intake, household food use, and national food supply—and on dietary supplement use. In addition, data are available from the NNMRRP on related dietary measurements, including food expenditures, food insufficiency, breastfeeding practices, weight-loss practices, reported levels of physical activity, nutrition knowledge, and the awareness of relationships between diet and health.

Estimates of nutrient intakes from food in this report represent only partial estimates because they do not include nutrient intakes from dietary supplements, drinking water, discretionary salt use, or medications and because underreporting of intake may occur. The resulting data may affect estimates of food energy intakes and food and nutrient intakes in relation to recommended levels. Nonetheless, such dietary intake estimates serve a critical role in assessing dietary status and, in turn, in assessing nutritional and nutrition-related health status. The major themes and findings on the dietary status of the U.S. population are highlighted below.

Food consumption, nutrient intakes from food, and dietary supplement use

The abundant U.S. food supply allows most Americans many food choices. Although there are many similarities in the food choices of people in different age, sex, racial, and income groups, there are also some notable differences.

- Virtually all people reported that they consumed ***meat, poultry, and fish:***
  - — higher percentages of white than black adults reported consuming beef, whereas the opposite was true for pork and poultry, and
  - — higher percentages of adults with higher than lower incomes reported consuming beef and fish and shellfish.
- Differences in the types of ***milk and milk products*** consumed were observed across age, racial, and income groups:
  - — higher percentages of black than white adults reported consuming whole milk, whereas higher percentages of white than black adults reported consuming low-fat and skim milks;
  - — higher percentages of adults with lower than higher incomes reported consuming whole milk; and
  - — a higher percentage of adults than children reported consuming skim milk.
- ***Fruits*** were consumed less frequently than ***vegetables***. Over a 3-day period, about 30% of adolescents and of adult males and 24% of adult females did not eat any fruits, and about 6% of individuals did not eat any vegetables. These values do not include fruits and vegetables eaten as part of food mixtures. Furthermore,
  - — higher percentages of older than younger adults of both sexes reported consuming dark-green and deep-yellow vegetables, lettuce, and other vegetables;
  - — higher percentages of adults with higher than lower incomes reported consuming dark-green and deep-yellow vegetables, lettuce, tomatoes, and other vegetables; and
  - — higher percentages of black than white adults reported consuming dark-green vegetables, and higher percentages of white than black adults reported consuming deep-yellow vegetables, lettuce, and other vegetables.

The goal of Healthy People 2000 Objective 2.6 is that people consume 5 or more servings of fruits and vegetables per day. This objective reflects the recommendation shown in the 1990 *Dietary Guidelines for Americans* and the Food Guide Pyramid to eat a minimum of 2 servings of fruits and 3 servings of vegetables daily. Fewer than one-third of American adults meet this recommendation (fig. ES-12). Data from 1989-91 suggest that the average daily intake of fruits and vegetables for the general population is about 4 servings.

- Virtually all people of all ages consumed ***grain products***:
  - — higher percentages of children and adolescents than adults reported consuming mixtures in which the main component is grain, such as pizza, enchiladas, and egg rolls, and adults

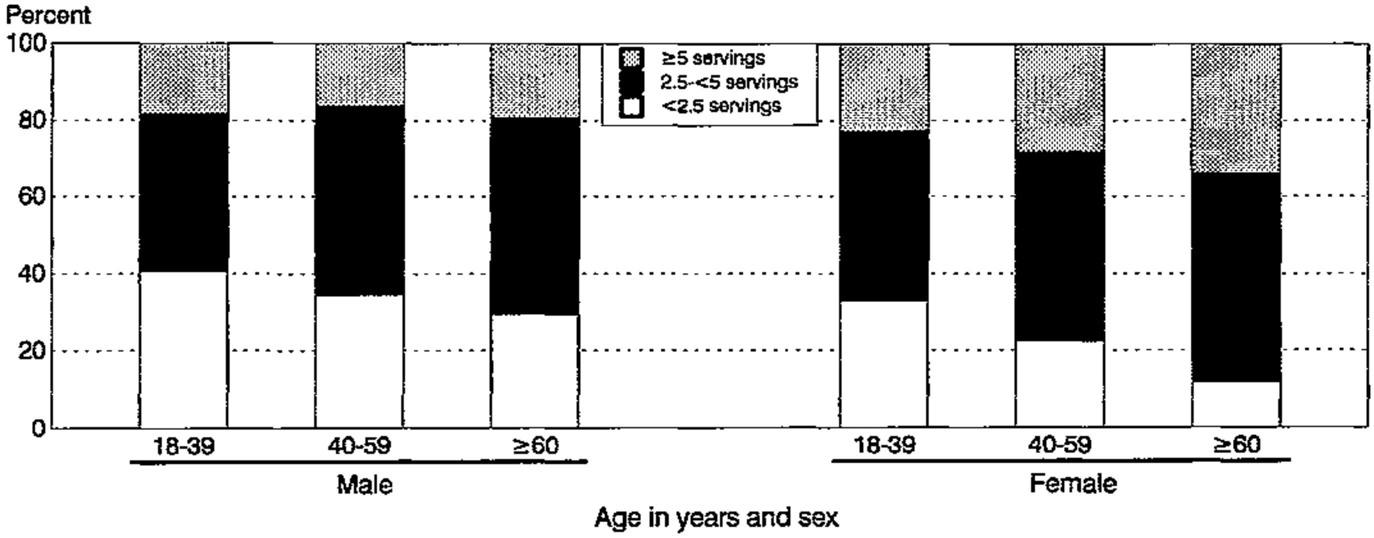

Figure ES-12. Percent distribution of daily servings of fruits and vegetables consumed by people 18 years of age and older, by age and sex, 1991

SOURCE: HHS, 5 A Day for Better Health Baseline Survey, 1991.

70 years of age and older were least likely to report consuming these products;

— higher percentages of children 6-11 years of age and adults 70 years of age and older reported consuming cereals and pasta than did adolescents and other adults;

— higher percentages of white than black adults and of adults with higher than lower incomes reported consuming cakes, cookies, pastries, and pies and crackers, popcorn, pretzels, and corn chips;

— the percentages of adults reporting consumption of yeast breads and rolls and cereals and pasta were similar across race, sex, and income levels; and

— the percentages of adults reporting consumption of quick breads, pancakes, and French toast were similar for whites and blacks.

- Higher percentages of black than white adults and of adults with lower than higher incomes reported consuming ***eggs*** (including whole eggs, egg substitutes, and eggs in other forms).

- Use of ***table fats***, such as butter and margarine, was reported by higher percentages of white than black adults, of older than younger adults, and of adults with higher than lower incomes.

- Higher percentages of white than black adults and of adults with higher than lower incomes reported consuming salad dressings, which often contain ***oil***.

- Higher percentages of adults with higher than lower incomes, higher percentages of whites than blacks, and higher percentages of younger than older people reported consuming ***candy***.

- Higher percentages of adolescents and young adults reported consuming regular ***soft drinks*** than did other age groups.

Trends in the amounts of food available for consumption suggest that Americans are slowly changing their eating patterns toward more healthful diets. However, a considerable gap still appears to exist between what Americans are eating and what they should be eating.

- On a per capita basis, less red meat and more poultry were available for consumption in 1992 than in 1972 (fig. ES-13). Per capita annual availability of shell eggs also decreased considerably, from 268 in 1972 to 180 in 1992.

- Per capita availability of lower-fat milk increased while availability of whole milk decreased (fig. ES-14). However, the greater availability of

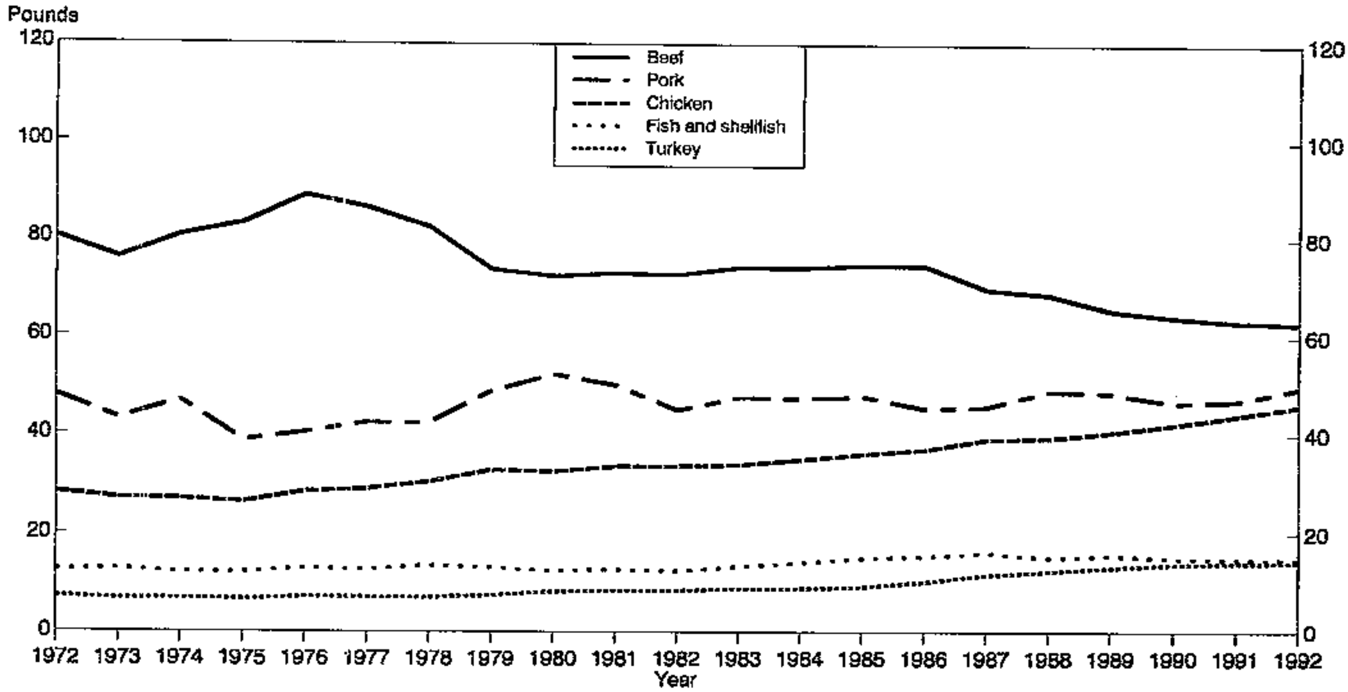

Figure ES-13. Annual per capita consumption of meat, poultry, and fish and shellfish, by year, 1972-92

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

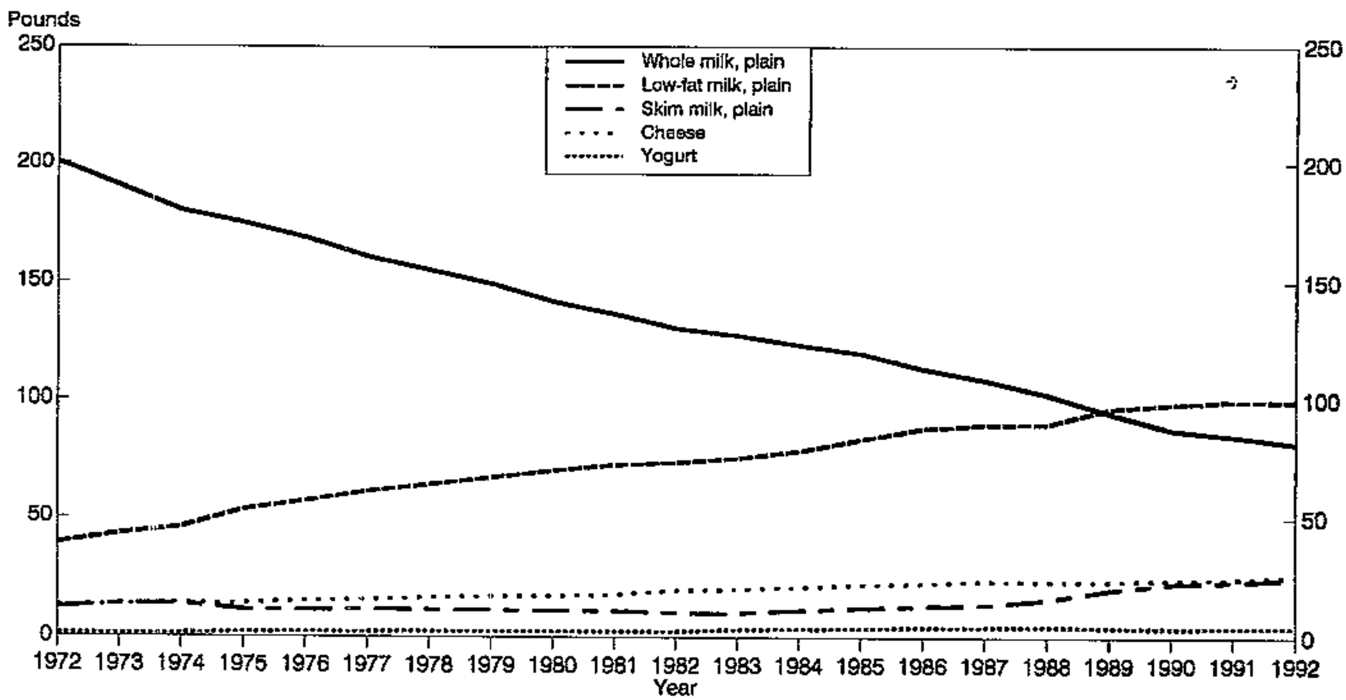

Figure ES-14. Annual per capita consumption of milk, yogurt, and cheese, by year, 1972-92

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

lower-fat fluid milk appears to have been accompanied by an increase in the availability of fluid-cream products and cheese.

- Per capita availability of grains, fruits, vegetables, and legumes increased between 1972 and 1992.

- Caloric sweeteners available for consumption reached a high of 143 lb per capita in 1992. A large portion of this increase can be attributed to the use of corn sweeteners, mainly high-fructose corn syrup. Per capita availability of low-calorie sweeteners (mainly aspartame and saccharin) has more than tripled since 1980.

- Between 1972 and 1992, availability of regular and low-calorie soft drinks climbed from 26 to 44 gal per capita. By 1976, per capita availability of soft drinks had become greater than that of milk, fruit juices, coffee, or bottled water (fig. ES-15).

Certain population subgroups are consuming diets that provide less-than-recommended amounts of some nutrients.

- Reported median food energy intakes were below recommended energy intakes for most adolescents and adults in 1988-91. However, the increased prevalence of overweight suggests that this finding reflects underreporting in surveys as well as low energy expenditures, rather than underconsumption (see "Overweight" discussion, above). The lack of change in the prevalence of nutrient intakes below recommended values suggests that dietary quality has not changed substantively.

- Median intakes of vitamin A, vitamin E, vitamin B_6, zinc, and copper from food were below recommended values for most age, sex, and racial/ethnic subgroups.

- Median calcium intakes from food were below recommended values for non-Hispanic black children 1-11 years of age, all adolescents except non-Hispanic white males 12-15 years of age, all females aged 20 years and older, non-Hispanic black males 20-59 years of age, and all males 60 years of age and older.

- Median iron intakes from food were below recommended values for children 1-2 years of age, female adolescents 12-19 years of age, and female adults 20-59 years of age across racial/ethnic groups.

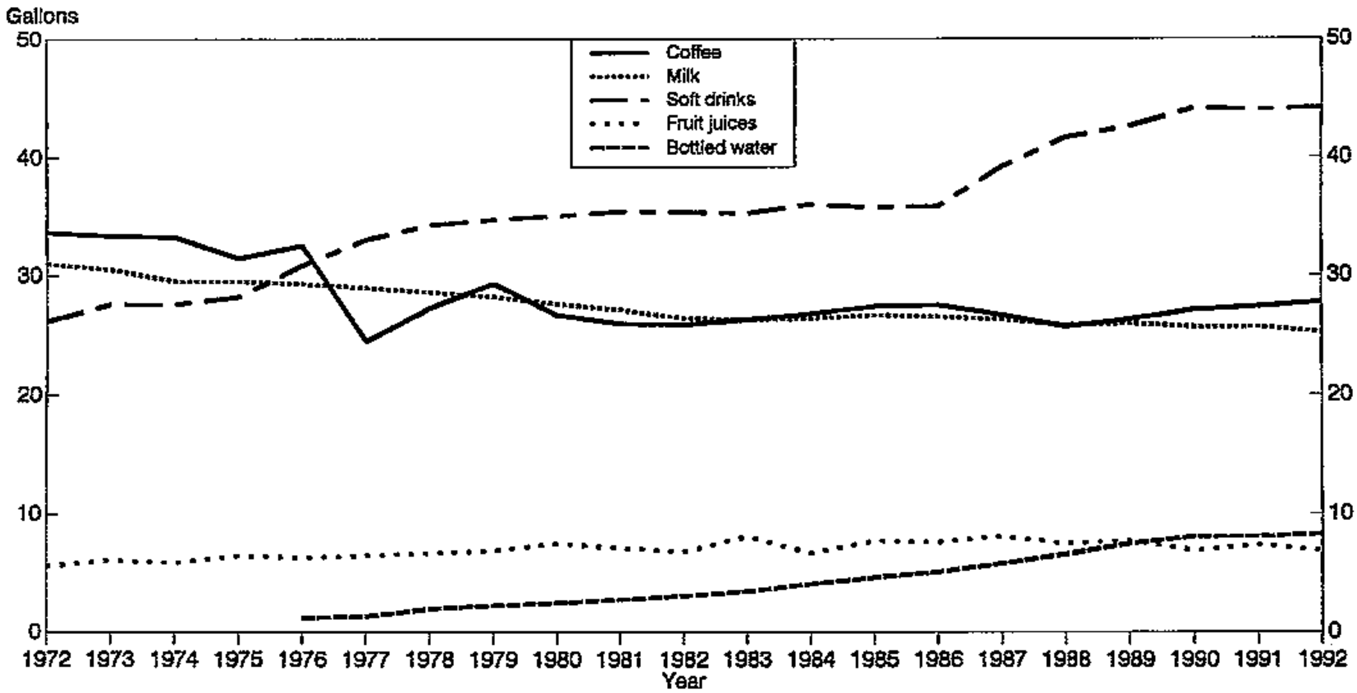

Figure ES-15. Annual per capita consumption of selected nonalcoholic beverages, by year, 1972-92

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

- Median intakes of magnesium from food were below recommended values for all adolescents and adults except adolescent males 12-15 years of age.

- Median folate intakes from food were below recommended values for non-Hispanic black females 16 years of age and older and for Mexican-American females 60 years of age and older.

- Lunches provided in the National School Lunch Program contributed more fat in 1992 than recommended in the 1990 *Dietary Guidelines for Americans.*

Many Americans take dietary supplements.

- At least 35-40% of Americans took dietary supplements between 1988 and 1991. Females were more likely to take supplements than males, and non-Hispanic whites and older adults were more likely to take supplements than non-Hispanic blacks and younger adults.

- In 1986, people with incomes at or above the poverty level were more likely to use supplements than those with incomes below the poverty level. Use was also higher in adults who were more educated and their children than in adults who were less educated and their children.

- In 1986, more than 70% of all supplements used by adults and children were taken daily. The supplements most commonly used by adults were vitamin-mineral combinations and single vitamins and minerals (specifically, vitamin C and calcium), whereas for children 2-6 years of age, the most commonly used supplements were multivitamins.

- The ability to examine excessive intakes of vitamins and minerals in the TRONM was limited because a product-specific data base to use for calculating quantitative intakes of nutrients from supplements has not been developed.

Food insufficiency

Some Americans are not always getting enough to eat. Nutritional status is a critical factor in children's development. Recent research findings indicate that inadequate food intake due to lack of money or resources (i.e., food insufficiency) is likely to impair growth and cognitive development.

- About 9-13% of people living in low-income households or families experience some degree of food insufficiency.

- In 1988-91, Mexican Americans and non-Hispanic blacks were more likely than non-Hispanic whites to report that they sometimes or often did not have enough food to eat (table ES-5). For low-income households, the prevalence of food insufficiency in 1989-91 was higher among blacks than whites, and Food Stamp Program participants were more likely to report a food-insufficiency problem than nonparticipants (table ES-6).

Household food expenditures

Americans changed their patterns of spending for different types of food and for food away from home between 1980 and 1992.

- Per person spending (expressed in 1988 dollars here) in urban households decreased 37% for beef and 19% for pork between 1980 and 1992, whereas spending for poultry climbed 20%. Yearly fluctuations between 1980 and 1992 were seen for fish and seafood. Purchases of eggs declined by about one-third, and purchases of fresh whole milk fell by one-half during that same period.

- Per person spending for fresh fruits and vegetables in urban households dropped between 1980 and 1992. The decline for fresh vegetables (11%) was not as dramatic as the decline for fresh fruits (22%). Purchases of processed fruits and vegetables remained relatively stable during this time.

- Between 1980 and 1992, per person spending for frozen prepared food in urban households nearly doubled (fig. ES-16). During this time, purchases of potato chips, nuts, and similar types of snack foods climbed nearly 60%, and purchases of carbonated drinks rose by 21%.

- Between 1980 and 1992, urban households spent more than one-third of their total food expenses on food away from home.

- The share of total food expenditures for food away from home increased during the 1980s across racial and income groups (figs. ES-17 and ES-18).

Table ES-5. Prevalence of a reported family food-sufficiency problem in individuals, by race/ethnicity and poverty status, 1988-91 (%)[1]

Race/ethnicity and poverty status	Enough food	Sometimes not enough	Often not enough
Overall population	96.1	3.3	0.6*
Race/ethnicity			
Non-Hispanic white	97.4	2.1	0.5*
Non-Hispanic black	92.7	6.7	0.6*
Mexican American	84.5	14.2	1.3
Poverty status			
≥100% poverty	98.3	1.5	0.1*
<100% poverty	84.1	13.2	2.7*
<131% poverty	87.0	10.7	2.2*

[1]An asterisk (*) indicates a statistic that is potentially unreliable because of a large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

Table ES-6. Household food sufficiency of the low-income population, by Food Stamp Program (FSP) participation and race, 1989-91 (%)[1]

FSP participation and race	Enough of the kinds of food we want	Enough, but not always what we want	Sometimes not enough	Often not enough
Overall low-income population	53.9	36.7	7.2*	1.9*
FSP participation				
Participant	43.0	43.3	10.2*	3.5*
Nonparticipant	58.7	33.8	5.9*	1.2*
Race				
White	58.2	34.4	5.9*	1.2*
Black	44.3	42.7	8.9*	4.0*

[1]Based on households with gross incomes <131% of the Federal Poverty Income guideline. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, CSFII, 1989-91.

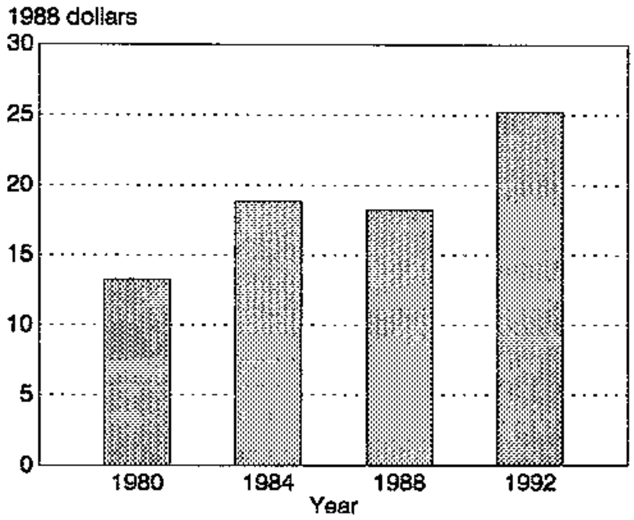

Figure ES-16. Average annual expenditures per person in urban households for frozen prepared foods, 1980, 1984, 1988, and 1992

SOURCE: DOL, CES, 1980-92 (Smallwood et al., 1994).

Spending for food away from home peaked in 1990, began to decline in 1991, and continued to decrease in 1992.

- In urban households, the share of total food expenditures between 1980 and 1992 for food away from home was generally higher in white households than in black and other-race households and was higher in households with higher incomes.
- Eating away from home is also common among children, who often eat lunch and sometimes breakfast at school. In 1992, the National School Lunch Program and School Breakfast Program provided two of the three major meals for 1 in 10 school-age children, and one of the three major meals for more than half of school-age children on school days.

Turning awareness into action

People who are aware of diet and health relationships may be motivated to follow eating habits consistent with dietary recommendations. However, awareness does not automatically translate into action.

- In general, awareness of diet and health relationships among female main meal planners and preparers in 1989-91 was lowest for those who were black, less educated, and from lower-income households. Younger and older women were less likely to be aware of diet and health relationships than were middle-aged women.

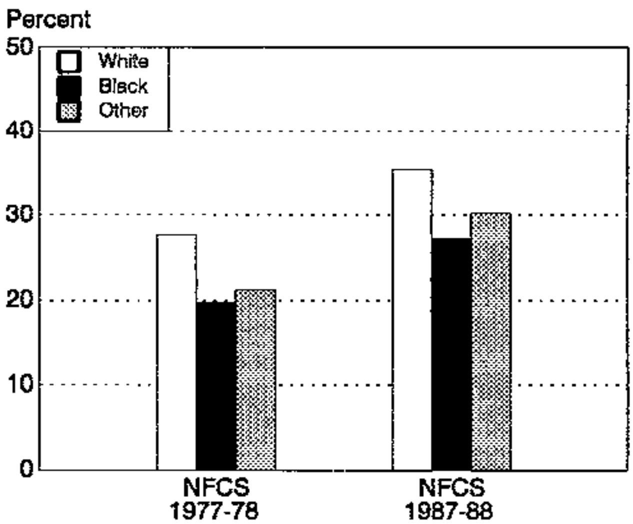

Figure ES-17. Percentage of total food expenditures spent on food away from home, by race, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

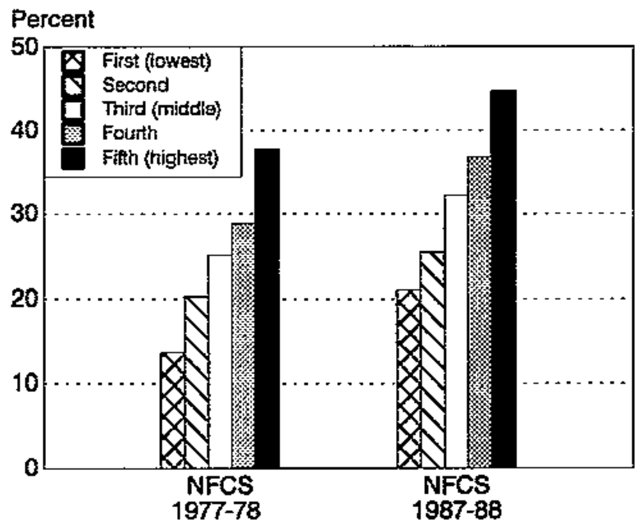

Figure ES-18. Percentage of total food expenditures spent on food away from home, by income quintile, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

- Even though, in general, female main meal planners and preparers who were aware of diet and health relationships were more likely than those who were not aware of diet and health relationships to believe that following the principles of the 1990 *Dietary Guidelines for Americans* was highly important to them personally, little difference was found between the dietary intakes of those who were aware and those who were not aware of diet and health relationships. This finding underscores the need for research about what causes people to change their dietary behavior.

Food composition data

High-quality data on the composition of foods as they are actually eaten are critical for estimating nutrient intakes of Americans and for comparing intakes over time. However, it is difficult to maintain a complete and current food composition data base because the types of foods available in the marketplace are constantly changing and the food composition data available by brand name are limited.

Maintaining a complete and current food composition data base requires that all foods, including traditional ethnic foods and new foods introduced into the marketplace, be characterized and that the data be updated continually, as improved methodologies are developed. Priority must be given to analyzing commonly consumed foods and foods that are primary sources of nutrients associated with public health issues in the United States.

The high cost of analyzing the nutritional composition of foods makes maintaining an accurate food composition data base difficult. The development of acceptable assay methods that are faster and less expensive than current methods will help to bring down the costs of food analysis.

For nutrition monitoring purposes, the food composition data for total fat, fatty acids including* trans *fatty acids, dietary fiber, carotenes, folate, sodium, and cholesterol need to be improved and expanded. Data on the selenium content of foods should be added to the Survey Nutrient Data Base.

- The methodology for determining the total fat content of foods is in critical need of improvement. There is no "gold standard" method for determining total fat, and there are considerable differences in the results obtained with the different methods and by different laboratories. Because the total fat content of foods affects nutrition monitoring and public health issues—such as the energy content of foods and the percent of calories from fat—it is important that accurate and comparable data be available for the total fat content of foods in the American diet.

- Consistency in the measurement of the total fat content of foods is becoming problematic because of differences in the traditionally used definition of "total fat" and that used in the Nutrition Labeling and Education Act (NLEA) of 1990 (Public Law 101-535). Accepted assay methods for "total fat," as defined by the NLEA, have yet to be developed. Efforts will have to be made to ensure that a consistent definition of "total fat" is used for foods incorporated into the U.S. Department of Agriculture (USDA) Nutrient Data Base for Standard Reference and the USDA Nutrient Data Base for Individual Food Intake Surveys (Survey Nutrient Data Base).

Concerns for low-income, high-risk populations

NNMRRP surveys provide information on the dietary, nutritional, and nutrition-related health status of different population groups. By comparing the prevalence estimates of these groups, characteristics of the groups most at risk for nutrition-related health problems can be identified. Selected findings on populations at nutritional risk are listed below. The groups at risk differ depending on the risk factor being considered.

The risk of nutrition-related health problems is high among people with low incomes. Certain subpopulations, such as elderly people, some minorities, pregnant women, infants, and children, are also at nutritional risk, particularly those with low incomes.

- Among low-income pregnant females, non-Hispanic blacks of all ages and adolescents across racial/ethnic groups had the highest prevalences of ***anemia*** in 1992.

- Among low-income women participating in government-supported service programs, the prevalence of ***low birth weight*** in 1992 was higher for those who smoked (fig. ES-19) or who had low prepregnancy weight, less-than-ideal weight gain during pregnancy, or anemia during pregnancy than it was for other women in that sample. Low prepregnancy weight, less-than-ideal weight gain, and anemia are often related to maternal diet and nutrient intake. Effective prenatal care can beneficially affect the latter two nutrition-related factors.

- Mothers who were younger, black, or living below the poverty level were less likely to ***breastfeed*** their babies than were other mothers (table ES-3).

- In 1992, about 10% of a population of low-income children and adolescents participating in government-supported service programs had high weight for height, which is higher than the percentage expected for the overall U.S. population (5%) but similar to the percentage found in children in the overall U.S. population (10%). The prevalence of ***shortness*** in this subpopulation —about 9%—may reflect, in part, the racial/ethnic composition of low-income families who participated in these programs. The prevalence of ***thinness*** among low-income children was about 3%, which is less than expected for the overall U.S. population (5%) but similar to that found in the overall U.S. population (about 3%) (table ES-4).

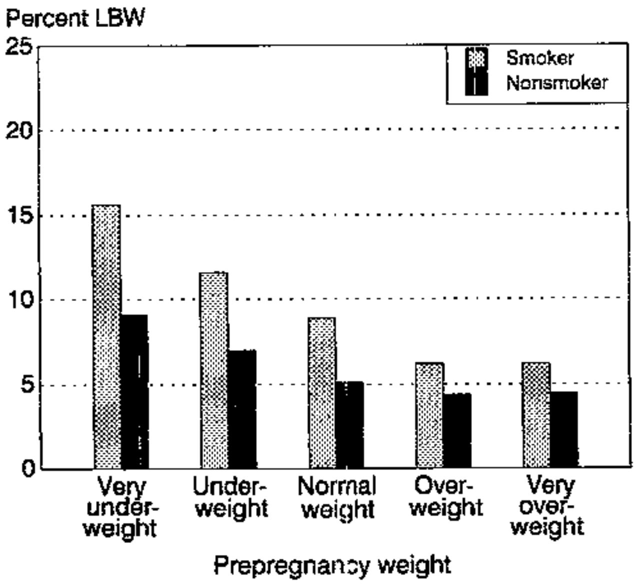

Figure ES-19. Low-birth-weight (LBW) prevalence among low-income, high-risk females who smoked and did not smoke during pregnancy, by prepregnancy weight, 1992

SOURCE: HHS, PNSS, 1992.

- Mexican-American children and adolescents 6-19 years of age had a relatively high prevalence of ***overweight*** and a relatively low prevalence of ***thinness*** compared with the U.S. population of children and adolescents as a whole.

- The mean BMI of American Indian school children in 1990-91 was higher than that of children in the overall U.S. population in 1988-91, suggesting that the prevalence of ***overweight*** is likely to be higher in American Indian children than in other American children.

- In 1988-91, the prevalence of ***overweight*** was highest in females with incomes below 131% of poverty in all racial/ethnic groups, ranging from 45% for non-Hispanic whites to 50% for Mexican Americans and 51% for non-Hispanic blacks. For non-Hispanic blacks, the prevalence of overweight was much higher in females than in males (28%). For non-Hispanic black and Mexican-American males, the prevalence of overweight was lowest in the low-income group.

- Non-Hispanic white males with incomes below poverty in 1988-91 had a higher age-adjusted prevalence of ***high serum total cholesterol*** levels than males in other racial/ethnic or income groups.

- In 1988-91, non-Hispanic black males and females had higher age-adjusted prevalences of ***hypertension*** than did non-Hispanic whites or Mexican Americans (table ES-2). Non-Hispanic white and non-Hispanic black females with incomes below the poverty level had higher age-adjusted prevalences of hypertension than did females with higher incomes in these two groups.

- ***Hypertension*** remains a substantial problem in middle-aged and elderly people. In 1988-91, about 75% of females 80 years of age and older had high blood pressure compared with 60% of males in that group (table ES-2).

- The prevalence of femoral ***osteoporosis*** in females 50 years of age and older was 21% for non-Hispanic whites, 10% for non-Hispanic blacks, and 16% for Mexican Americans in 1988-91. Although the prevalence of osteoporosis was only 6% among non-Hispanic white females 50-59 years of age, it rose in each succeeding decade of age, reaching 52% among the group 80 years of age and older.

- Female main meal planners and preparers who were black or from low-income households were less likely to be ***aware of diet-health relationships*** than were females who were white or from higher-income households. Higher percentages of adults with low incomes and of black adults reported eating certain foods containing higher levels of total fat (e.g., whole milk) and cholesterol (e.g., whole milk and eggs) than of adults with higher incomes and of white adults. Lower percentages of adults with low incomes and of black adults reported using fats and oils.

- Percentages of low-income adults and of black adults who had ***total fat intakes*** within the recommended range (≤30% of calories) were somewhat lower than percentages of higher-income and of white adults (table ES-1).

- Median ***calcium intakes*** from food were below recommended values for non-Hispanic black children 1-11 years of age, all adolescents except non-Hispanic white males 12-15 years of age, females 20 years of age and older, non-Hispanic black males 20-59 years of age, and males 60 years of age and older.

- Children 1-2 years of age, female adolescents, and female adults 20-59 years of age had median ***iron intakes*** from food that were below recommended values.

- Non-Hispanic black females 16 years of age and older and Mexican-American females 60 years of age and older had median ***folate intakes*** from food that were below recommended values.

- Pregnant females had lower-than-recommended mean intakes from food of ***folate, calcium, vitamin B_6, iron, zinc, and magnesium***. Pregnant non-Hispanic black females had a mean calcium intake that was lower than that of non-Hispanic white and Mexican-American pregnant females.

- Low-income adolescents and adults (but not children) in 1989-91 had lower mean intakes of vitamins and minerals that were considered current or potential public health concerns in the second nutrition monitoring report—***vitamin A, vitamin C, vitamin B_6, folate, calcium, iron, and zinc***—than did adolescents and adults from higher-income groups. However, mean intakes of the low-income groups were not more likely to be below Recommended Dietary Allowance (RDA) values than mean intakes of higher-income groups.

- People in low-income households or families were more likely to report that they experienced ***food insufficiency*** than people in households or families with higher incomes (tables ES-5 and ES-6). About 9-13% of people in low-income households experienced some degree of food insufficiency, compared with about 4% in the overall U.S. population. Mexican Americans and non-Hispanic blacks were more likely than non-Hispanic whites to report that they sometimes or often did not have enough food to eat.

Assessments

The decision-making process developed for the second nutrition monitoring report was used to assess monitoring priority status for food components in the TRONM. As shown in figure ES-20, the evaluation of each food component begins with the dietary intake data. However, the evidence for adverse health consequences ultimately determines the categorization of the component. NNMRRP data that were available as of June 1994 were used for assessing monitoring priority status. The decision to start evaluating each food component by considering the dietary intake data was made because such data were available for most of the food components by June 1994. Analyses of much of the biochemical and clinical data on nutritional status were not completed by then.

Nutrient intake data collected in NHANES III 1988-91 and the Continuing Survey of Food Intakes by Individuals (CSFII) 1989-91 were used with contemporaneous information on nutritional status and nutrition-related health status from the NNMRRP and, in some instances, the general biomedical literature, to update the assessment of the public health monitoring priority for each food component. When nutrient intake data were not available from these surveys, data from the Food and Drug Administration's (FDA's) Total Diet Study (1982-89) were used. Each food component was considered independently.

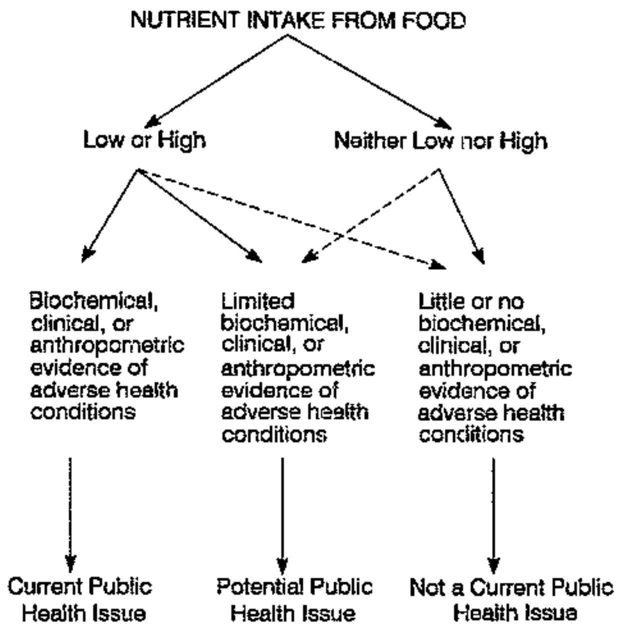

Figure ES-20. Decision-making process used to categorize food components by monitoring priority status

SOURCE: Modified from LSRO (1989).

Evidence for health consequences was provided mainly by the biochemical and clinical data from the NNMRRP. The criteria established by authoritative groups for assessing specific diseases and health conditions were used to evaluate these data. As noted by the Joint Nutrition Monitoring Evaluation Committee of HHS and USDA in the first nutrition monitoring report in 1986, "Much can be inferred about the nutritional status of the population, even with imperfect data judged by imperfect criteria, especially when a wider knowledge of nutrition is brought to bear." In this regard, the Expert Consultants and the Life Sciences Research Office (LSRO) used their experience and judgment in categorizing food components.

Food components were assigned to three categories of public health issues: current public health issues, potential public health issues for which further study is required, and not current public health issues (table ES-7). High-priority monitoring status is recommended for food components considered current public health issues. Monitoring efforts for these components should include biochemical, clinical, and anthropometric assessments, as appropriate. Moderate-priority monitoring status is recommended for food components considered potential public health issues, with continued assessment in at least those subgroups suspected to be at risk. Food components not considered current public health issues are recommended for lower-priority monitoring status; continued assessment should include, at a minimum, estimation of dietary intake. Assigning food components to this category does not necessarily indicate that there are no known health problems associated with these components, but that the prevalence of such problems on a national basis is known or expected to be so low that a lower level of monitoring effort than for food components in the other categories is appropriate.

The assignments of food components to particular monitoring classifications should be regarded as provisional. It is likely that as new data from the NNMRRP and other sources become available, future assessments of public health significance and of the levels of monitoring needed will result in changes in the categorization of some food components. More detailed assessments of individual nutrients can be found in the main report.

Current public health issues

The following criteria were used to assign current public health issue status to a food component. If median intakes of a food component fell below the recommended values (usually the 1989 RDA), undernutrition was considered to be a possible problem. Additional evidence of a nutritional problem based on clinical or biochemical data from the NNMRRP was needed to determine that the component should be considered a current public health issue. Such clinical and biochemical data were accorded more weight than were the dietary intake data. If such data were not available from the NNMRRP, information in the general medical literature was used to assess the possibility that the specified component be considered a current public health issue. The interpretation of dietary intake data was complicated by the lack of information on total nutrient intakes (i.e., intakes from dietary supplements and from foods).

High intakes of food components were also assessed, although the RDA was less useful in identifying potential public health problems related to excessive intake. If the median intake was near or above the recommended value and the distribution of intakes was skewed to the side of high intakes, the

Table ES-7. Classification of food components as public health issues in the TRONM[1]

Current public health issues	Potential public health issues for which further study is required	Not current public health issues
Food energy	⇒ Total carbohydrate	Thiamin
Total fat	Dietary fiber	Riboflavin
Saturated fatty acids	Sugars‡	Niacin
Cholesterol	Polyunsaturated and	Iodine‡
Alcohol	monounsaturated fatty acids‡	
Iron	*Trans* fatty acids‡	
Calcium	Fat substitutes‡	
Sodium	⇒ Protein	
	Vitamin A	
	Antioxidant vitamins	
	Vitamin C	
	⇒ Vitamin E	
	Carotenes	
	Folate	
	Vitamin B_6	
	⇒ Vitamin B_{12}	
	⇒ Magnesium	
	Potassium	
	Zinc	
	⇒ Copper	
	Selenium‡	
	⇒ Phosphorus	
	Fluoride	

[1]Arrows (⇒) point to components whose monitoring priority status has changed since the second report on nutrition monitoring was published (LSRO, 1989). Double daggers (‡) indicate components that are being evaluated for the first time for the NNMRRP.

SOURCE: LSRO, 1995.

possibility of deleterious health effects was evaluated. Consumption from dietary supplements should also be considered when effects of high intakes are considered. However, estimates of total nutrient intakes from foods and dietary supplements were not available for the preparation of the TRONM, so estimates of nutrient intakes were based only on nutrients provided by food. Standards established by other expert groups and specified in the assessments below were applied to evaluate components for which there is evidence that excessive intakes are harmful, such as food energy, total fat, saturated fatty acids, cholesterol, and sodium. Confirmatory clinical or biochemical evidence from the NNMRRP data or from other sources about adverse effects resulting from high intakes is required for the categorization of high intakes as current or potential public health issues.

Food components meeting the criteria for classification as current public health issues are food energy, total fat, saturated fatty acids, cholesterol, alcohol, iron, calcium, and sodium (table ES-7). Except for iron and calcium, these food components were classified as current public health issues because of evidence of adverse effects of high intakes. The classification of these nutrients as current public health issues was consistent with their classification in the first and second nutrition monitoring reports.

Food energy

Although median intakes of food energy reported by adolescents and adults in 1988-91 were below recommended levels, approximately one-fifth of the adolescents and one-third of the adults were overweight. The high prevalence of overweight indicates that energy balance is a continuing public health problem (i.e., that food energy intakes exceed energy expenditures for many Americans).

Total fat, saturated fatty acids, and cholesterol

Median intakes of total fat and saturated fatty acids for most adults, adolescents, and children older than 2 years of age in 1988-91 were above recommended values (≤30% of calories for total fat and 8-10% of calories for saturated fatty acids). Median intakes of cholesterol were generally within the recommended range of 300 mg/d or less. Although serum total cholesterol levels and median intakes of total fat, saturated fatty acids, and cholesterol appear to be decreasing, substantial proportions of the U.S. population still have high serum total cholesterol levels and high intakes of total fat, saturated fatty acids, and cholesterol. High intakes of total fats, saturated fatty acids, and cholesterol are associated with elevated blood lipids, a risk factor for coronary heart disease.

Alcohol

Intake of alcohol is considered a current public health issue because alcoholic beverages are a source of food energy and may displace other sources of nutrients and because of the serious public health and social consequences of excessive alcohol intake.

Iron and calcium

Low intakes of iron and calcium are of public health concern. Median intakes of iron from food were below RDA values for children 1-2 years of age and for adolescent and adult females in 1988-91. Prevalences of low hemoglobin levels indicative of anemia were generally higher in these groups than in other age-sex groups. A comprehensive assessment of iron status will require that multiple biochemical and hematologic indicators of iron status be evaluated.

Median calcium intakes from food were consistently below RDA values for adolescent and adult females and for males of most age and racial/ethnic groups. Current calcium intakes by these groups may be insufficient to attain optimal peak adult bone mass and to prevent age-related loss of bone mass.

Sodium

In 1988-91, median intakes of sodium from food alone, excluding salt added at the table, were above the recommended maximum value of 2,400 mg/d. High sodium intakes are associated with high prevalences of hypertension.

Potential public health issues for which further study is required

The following criteria were used to classify a food component as a potential public health issue for which further study is required to determine the nature and extent of the potential problem. If median intakes were low by the criteria described above and data on health or nutritional status were not available from the NNMRRP or any other source to assess the potential for deficiency, then the component was considered a potential public health issue for which further study is required. If the median intakes were above the recommended values (usually the 1989 RDA) for a population subgroup, then in most cases, few individuals would be at risk of deficiency in that subgroup. However, if additional evidence from the NNMRRP or other sources indicated that the potential for deficiency existed in at least some groups in the population, the food component was considered a potential public health issue for which further study is required.

The following food components met the criteria for classification as potential public health issues for which further study is required (table ES-7): total carbohydrate and certain carbohydrate constituents (dietary fiber and sugars); certain fat constituents (polyunsaturated and monounsaturated fatty acids and *trans* fatty acids) and substances used as fat substitutes, including modified fats, proteins, gums, and dietary fiber; protein; vitamin A; antioxidant vitamins (vitamin C, vitamin E, and carotenes); certain water-soluble vitamins (folate, vitamin B_6, and vitamin B_{12}); and several minerals (magnesium, potassium, zinc, copper, selenium, phosphorus and fluoride). This group of food components is diverse and the reasons for classifying them as potential public health issues are varied. (These reasons are summarized for each component in the main report.) Some changes occurred since the second report in the evaluation of nutrients considered to be potential public health issues. The classifications changed for total carbohydrate, protein, vitamin E, vitamin B_{12}, magnesium, copper, and phosphorus, now potential public health issues rather than not current public health issues. The change in the classification of total carbohydrate was made on the basis of Healthy People 2000 Objective 2.6—to increase consumption of fruits, vegetables, and grains, which are rich sources of complex carbohydrates and dietary fiber. This objective reflects the recommendations shown in the 1990 *Dietary Guidelines for Americans* and the Food Guide Pyramid to eat a minimum of 2 servings of fruit and 3 servings of vegetables daily and 6 or more daily servings of grain products. Changes in the classification of the other nutrients were made on the basis of evidence from the general biomedical literature, rather than on the basis of evidence of changes in intakes of these nutrients or of changes in the nutritional and nutrition-related health status of the U.S. population. This is the first assessment for the NNMRRP of monitoring priority status for polyunsaturated and monounsaturated fatty acids, *trans* fatty acids, fat substitutes, sugars, selenium, and iodine.

Total carbohydrate and carbohydrate constituents

In 1989-91, median intakes of total carbohydrate and dietary fiber (a carbohydrate constituent) were lower than recommended values. Eating fruits, vegetables, and grain products, which contain complex carbohydrates including dietary fiber, is associated with maintenance of health. Higher intakes of soluble and insoluble fiber fractions have been associated with lower serum cholesterol levels and a lower risk of colon cancer, respectively. The consumption of carbohydrate-containing foods needs to be monitored so that progress toward meeting Healthy People 2000 Objective 2.6 (for increasing consumption of fruits, vegetables, and grain products) can be evaluated.

Sugars (simple carbohydrates) provide food energy, may contribute to energy intakes in excess of energy expenditures, and may displace other sources of nutrients. The consumption of sucrose in particular is also associated with the development of dental caries. When the fat content of food is reduced, the sugar content may increase and result in higher intakes of sugars by people who consume fat-free, low-fat, or reduced-fat foods. Because there is concern about high intakes of sugars, it is preferable to replace fat in the diet with sources of complex carbohydrates such as fruits, vegetables, and grain products, rather than sugars. The monitoring of sugars intake is needed to track the sources of carbohydrates in the U.S. diet.

Polyunsaturated and monounsaturated fatty acids, trans *fatty acids, and fat substitutes*

Median intakes of polyunsaturated and saturated fatty acids were within recommended ranges (≤10% of calories and ≤15% of calories, respectively) in 1988-91. When substituted for saturated fatty acids in the diet, polyunsaturated and monounsaturated fatty acids lower serum low-density-lipoprotein (LDL) cholesterol (elevated serum levels of LDL cholesterol are a risk factor for coronary heart disease).

High dietary levels of *trans* fatty acids, another type of unsaturated fatty acid found naturally in meat and dairy products and produced during hydrogenation of vegetable oils to produce solid fats, may increase levels of serum total and LDL cholesterol. Questions remain, however, about whether *trans* fatty acids actually have this effect. Intakes of *trans* fatty acids cannot be determined because the necessary food composition data are not yet available. Intakes of polyunsaturated, monounsaturated, and *trans* fatty acids should be monitored in conjunction with the monitoring of total fat, saturated fatty acids, and cholesterol and with the assessment of the levels of serum total, high-density-lipoprotein (HDL), and LDL cholesterol.

With the many new developments in fat substitutes and high consumer demand for low-fat and fat-free foods, fat substitutes (including modified fats, proteins, gums, and dietary fiber) are being incorporated into many foods. Because the increased consumption of these substances could result in significant changes in the U.S. diet, including lower fat intakes, lower intakes of fat-soluble vitamins, and higher intakes of carbohydrates, consumption of foods containing these substances should be monitored.

Protein

Median intakes of protein from food were well above RDA values for most demographic groups in 1988-91. Clinical studies have provided evidence that high protein intakes increase urinary calcium excretion when calcium intakes are low, and some epidemiological evidence suggests that higher intakes of animal protein are associated with higher prevalences of hip fractures in women over 50 years of age.

In adults 60 years of age and older, median protein intakes were somewhat lower than they were for other age groups, although they were still at or above the RDA. Protein requirements of older people may be higher when food energy intakes are low. Because of high protein intakes by most age-sex groups, including those who have low calcium intakes, and because of the potential for low protein and low food energy intakes by elderly people, the monitoring of dietary protein intakes should continue.

Vitamin A

Median intakes of vitamin A from food in 1988-91 were below RDA values for adults and some subgroups of older children, but the prevalence of low serum levels of vitamin A was very low in these groups. Median vitamin A intakes of younger children were above RDA values, but the prevalence of low serum vitamin A levels in younger children was relatively high when the cutoff values for adults and adolescents were used. The misuse of high doses of preformed vitamin A in dietary supplements may lead to high intakes of vitamin A. Because of adverse health effects associated with low and high intakes of vitamin A, it continues to be classified as a potential public health issue.

Antioxidant vitamins (vitamin C, vitamin E, and carotenes)

Epidemiological and clinical studies suggest that antioxidants in food can lower the risk of heart disease, some forms of cancer, cataracts, and macular degeneration, one of the leading causes of visual loss among people aged 65 years and older. In 1988-91, median intakes of vitamin C from food were above RDA values for population subgroups, but interpreting these data is difficult because 1) the range of intakes necessary for optimal antioxidant activity of vitamin C remains unknown and 2) interpretive criteria are needed for serum vitamin C values obtained with the more sensitive and specific methods used in NHANES III 1988-91.

Median intakes of vitamin E from food were below RDA values for all population subgroups of people 1 year of age and older. Dietary vitamin E intakes are difficult to interpret, however, because of the addition to foods of vitamin E as α-tocopherol (to provide antioxidant functions) and in an esterified form (to provide a dietary source of vitamin E). Thus, the vitamin E contents of a food when the food is analyzed and when it is eaten are likely to differ, so the food composition data on vitamin E have little meaning in the evaluation of vitamin E intakes. Serum levels of vitamin E were measured in NHANES III 1988-91, but criteria for their interpretation remain to be developed.

The nutritional status of carotenes was not evaluated because of a lack of interpretive criteria for assessing dietary intakes and serum levels of carotenes. The evaluation of the antioxidant vitamin status of the U.S. population requires improved criteria for the evaluation of dietary intake and serum concentrations of antioxidant nutrients. Additional research is needed on the biochemical and health effects of diets containing specified levels and combinations of antioxidant nutrients.

Certain water-soluble vitamins (folate, vitamin B_6, and vitamin B_{12})

Median intakes of folate from food were higher than 1989 RDA values for all age, sex, and racial/ethnic groups except non-Hispanic black females 16 years of age and older and Mexican-American females 60 years of age and older. Serum and red blood cell levels of folate were measured in NHANES III 1988-94, but because of analytical problems related to the kit used in NHANES III 1988-91, the biochemical indices of folate status were not evaluated in time for consideration in this report. In light of epidemiological evidence that low serum folate levels are associated with elevated serum homocysteine levels (a risk factor for atherosclerosis) and that the use of dietary supplements containing folate by females before they become pregnant and during early pregnancy is associated with a decreased incidence of some types of neural-tube defects in some populations, monitoring of folate status is needed. However, the prevalence of neural-tube defects in the U.S. population is sufficiently low that national surveys and surveillance systems would not be able to detect changes in that prevalence in response to changes in folate intakes.

Low serum levels of vitamin B_6 have also been associated with elevated homocysteine levels, as well as with biochemical and clinical signs of deficiency. Median intakes of vitamin B_6 from food were below RDA values for adults and adolescents in 1988-91, more so for females than males, and for females 6-11 years of age. Further research is needed on vitamin B_6 requirements and on techniques for assessing vitamin B_6 nutritional status so that the public health importance of these intakes can be interpreted effectively.

Median intakes of vitamin B_{12} from food were above RDA values in 1988-91 for all age, sex, and racial/ethnic groups in the U.S. population. However, intakes from food and dietary supplements may not provide sufficient vitamin B_{12} if absorption is impaired, as it appears to be in some elderly people. Serum concentrations of vitamin B_{12}, which will be available for NHANES III 1991-94, may prove to be more useful than dietary data for evaluating vitamin B_{12} status. Further investigations and monitoring of activities should focus on elderly people.

Certain minerals (magnesium, potassium, zinc, copper, selenium, phosphorus, and fluoride)

In 1988-91, median intakes of magnesium, potassium, zinc, and copper from food were lower than RDA or Estimated Safe and Adequate Daily Dietary Intake (ESADDI) values for some population subgroups. The significance of the observed low dietary intakes of these minerals for nutritional status or nutrition-related health status cannot be evaluated from survey data until adequate biochemical and/or clinical indicators are available. Meanwhile, because epidemiological and clinical studies have suggested that certain of these minerals are associated with hypertension (potassium and, possibly, magnesium), growth retardation in children (zinc), and ventricular arrhythmias (copper), these minerals were classified as potential public health issues.

Data from the Total Diet Study (1982-89) indicate that mean selenium intakes from food were above RDA values for all age and sex groups assessed. Serum selenium levels were measured in NHANES III 1988-91, but the analyses were not completed in time for consideration in this report. Because evidence from epidemiological and laboratory studies has suggested that low selenium levels are associated with higher risk of cancer or heart disease and because incidents of selenium toxicity have been reported in the United States, monitoring of selenium status should be included in nutrition monitoring activities.

Median phosphorus intakes from food were near or above RDA values in 1988-91; however, calcium intakes from food were below RDA values for adolescent and adult females and for males of most age and racial/ethnic groups. Because high phosphorus and protein intakes may increase calcium losses when calcium intakes are low, phosphorus was classified as a potential public health issue. (See "Protein," above.)

Data are not currently available in the NNMRRP surveys for evaluating fluoride intakes from food or water. However, food contributes only small amounts of fluoride, and monitoring the diet for fluoride intake is not very useful for current public health concerns. Because mild dental fluorosis (mottled teeth) is associated with high fluoride intakes, fluoride was classified as a potential public health issue. Dental-examination data from NHANES III 1988-91 may provide a means to estimate the prevalence of mottled teeth and, thus, of high fluoride intakes.

Not current public health issues

The following criteria were used to classify food components as not current public health issues. For mean intakes above the recommended values (usually the 1989 RDA) for a population subgroup, in most cases, few individuals would likely be at risk of deficiency in that subgroup. If the biochemical and clinical evidence available from the NNMRRP or other sources did not suggest the presence of a nutritional-deficiency problem for a particular component, it was not considered to be a current public health issue with respect to deficiency in the population surveyed. For intakes below recommended values, if data from the NNMRRP or elsewhere did not indicate that there was a nutritional-deficiency problem for a component, it was not considered to be a current public health issue. Nutrients considered not to be current public health issues were thiamin, riboflavin, niacin, and iodine (table ES-7).

Classification of thiamin, riboflavin, and niacin as nutrients that are not current public health issues is consistent with the monitoring priority assignments in the second nutrition monitoring report. This is the first assessment for the NNMRRP of the monitoring priority status of iodine.

Thiamin, riboflavin, and niacin

Median intakes of thiamin, riboflavin, and niacin from food were generally above RDA values in 1988-91, and no other evidence suggests that intakes of these vitamins pose a public health problem. However, because there is some indication that intakes may be low in some groups of Hispanic females, monitoring intakes of these vitamins should continue, with a focus on these subpopulations.

Iodine

Data from the Total Diet Study (1982-89) indicated that mean iodine intakes from food were above RDA values for all age and sex groups assessed. No epidemiological or clinical evidence suggests that low or high iodine intakes are currently of public health concern in the United States.

Recommendations for future monitoring and research activities

Monitoring needs

The NNMRRP should monitor intakes from food and dietary supplements for all of the food components evaluated in the TRONM with the exception of fluoride and, possibly, vitamin E. In addition, for food components that are current public health issues, the program should monitor appropriate anthropometric, biochemical, and clinical indices of nutritional status and nutrition-related health status for food energy, total fat, saturated fatty acids, cholesterol, iron, calcium, and sodium. For food components that are potential public health concerns, the program should monitor appropriate biochemical and clinical indices of nutritional status and nutrition-related health status. The monitoring of biochemical and clinical indices is not recommended for food components that are not current public health issues; however, the monitoring of dietary intakes of those components should continue.

Research needs

During the course of interpreting and evaluating NNMRRP data for the TRONM, the Expert Consultants and LSRO identified information needed to improve future monitoring efforts. Additional research is required to obtain this information. The most immediate research needs are 1) to develop interpretive criteria to link nutrition monitoring data to functional or health outcomes, 2) to improve biochemical assays, and 3) to improve food composition data. Table ES-8 presents recommendations for those food components requiring further research. If more than one research need is indicated for a given food component, the research need considered of highest priority for use in interpreting existing data and in comparisons with data collected in future surveys is listed first. However, all research action listed for each nutrient should be considered of high priority.

Recommendations for the National Nutrition Monitoring and Related Research Program

The United States' national nutrition monitoring system takes a broad, multidisciplinary approach to monitoring the nutritional and nutrition-related health status of the U.S. population, with particular emphasis on high-risk subgroups, such as low-income and certain minority groups. The cornerstone surveys of the NNMRRP (CSFII and NHANES) provide a unique opportunity for the comprehensive and coordinated evaluation of the dietary, behavioral, anthropometric, clinical, and biochemical status of the U.S. population and certain subgroups considered to be at high risk for nutrition-related problems.

The need to continue these two cornerstone surveys and adjunct activities at a national level is critical for several reasons. First, within each survey cycle, data on many factors related to diet and health are

Table ES-8. Recommendations for further research for national nutrition monitoring in the United States

Classification and food component[1]	Recommended research action[2]
Current public health issue	
Food energy	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Total fat	• Improve food composition data.
Saturated fatty acids	• Improve food composition data.
Cholesterol	• Improve food composition data.
Iron	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Calcium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Sodium	• Improve food composition data.
Potential public health issue for which further study is required	
Total carbohydrate	• Improve food composition data.
Dietary fiber	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Sugars	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., metabolic effects of sugars such as high-fructose corn syrup). • Improve food composition data.
Monounsaturated fatty acids	• Improve food composition data.
Polyunsaturated fatty acids	• Improve food composition data.
Trans fatty acids	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Protein	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., effects of high phosphorus and high protein intakes on bone density when calcium intakes are low).
Fat substitutes	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., cutoff values for serum retinol in children). • Improve food composition data.
Vitamin A	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.

Table ES-8. Recommendations for further research for national nutrition monitoring in the United States —continued

Classification and food component[1]	Recommended research action[2]
Carotenes	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Vitamin C	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays. • Improve food composition data.
Vitamin E	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Folate	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays. • Improve food composition data.
Vitamin B_6	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays.
Magnesium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Potassium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Zinc	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays.
Copper	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Selenium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Phosphorus	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., effects of high phosphorus and high protein on bone density when calcium intakes are low).

[1]Further research actions are not recommended at this time for nutrition monitoring purposes for food components not listed here (alcohol, fluoride, iodine, vitamin B_{12}, thiamin, riboflavin, and niacin), although further monitoring is recommended for all of them.
[2]Recommended research actions are listed in descending order from the most immediate need for interpreting existing data and for comparisons with data collected in future surveys; however, all research actions listed for each nutrient should be considered high priority. The Expert Consultants and LSRO regarded recommended monitoring activities as separate from recommended research actions. Further monitoring was recommended for all food components (see text).

SOURCE: LSRO, 1995.

collected from a single, large, nationally representative sample of people. Meaningful comparisons of health effects can be made within and among many age, sex, racial/ethnic, and income-level groups. Such comparisons cannot be made with as much confidence with data from surveys that do not use nationally representative samples. Second, continuing to use the complex survey designs of the cornerstone surveys, which require large sample sizes, will minimize such potentially confounding effects as population mobility and variabilities in the distribution of domestic and imported foods throughout the country. Third, centralized laboratory analyses with well-defined protocols and quality-control procedures, although difficult, can be carried out in large surveys such as NHANES, but achieving this uniformity of procedures and quality control across several surveys is much more difficult. Finally, collecting data in future nutrition surveys at the national level should permit comparisons with information from other cycles of these surveys. Trends in the dietary, nutritional, and nutrition-related health status of the U.S. population can then be identified and monitored, and the information can be used to recommend appropriate interventions to improve Americans' health.

Comparability among the surveys has been improved since the publication of the second nutrition monitoring report in 1989. To allow more direct comparisons among surveys, a common set of population descriptors and guidelines for statistical and reporting categories for those descriptors were recommended by the Interagency Board on Nutrition Monitoring and Related Research Survey Comparability Working Group in 1992. A joint policy on variance estimation and statistical reporting standards for NHANES III 1988-91 and CSFII 1989-91 reports was developed by an HNIS/NCHS Analytic Working Group in 1993. That group also developed a set of statistical guidelines for reporting data for the TRONM. As the Expert Consultants and LSRO reviewed data provided for the TRONM, they found the use of the common descriptors and reporting categories vital for comparing results across surveys. Use of these common entities should continue, and further consideration should be given to developing more common descriptors that could be recommended for across-survey comparisons.

The NNMRRP is still evolving. At various points during its evolution, expert committees and other groups have made recommendations for its improvement. Key publications that include these recommendations are

- *National Survey Data on Food Consumption: Uses and Recommendations,*
- *Nutrition Monitoring in the United States: A Progress Report from the Joint Nutrition Monitoring Evaluation Committee,*
- *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring,*
- *Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program; notice,*
- *Nutrition Monitoring: Progress in Developing a Coordinated Program,*
- *Nutrition Monitoring: Data Serve Many Purposes; Users Recommend Improvements*, and
- *Nutrition Monitoring: Establishing a Model Program.*

To strengthen the program and overcome some limitations of the present system, specific gaps in knowledge and recommendations for enhancing the usefulness of the survey data are identified in chapters 3 through 9 of the main report. Recommendations that apply broadly to the NNMRRP are listed below.

General

- Support basic research and epidemiological studies by Federal agencies and academia or assume the responsibility to do so in order to maximize the NNMRRP's usefulness in nutrition and health monitoring. Conducting basic research or epidemiological studies to establish or evaluate the scientific validity of various interpretive criteria of biochemical and behavioral parameters of nutrition and health is not a primary mission of the NNMRRP. However, the interpretation and use of NNMRRP data for public policy decisions rely upon the validity of the interpretive criteria. Part of the mission of the NNMRRP should be the development of interpretive criteria. The program should provide for research to improve methodology for all aspects of nutritional assessment, including food composition, food consumption, biochemical evaluations, and behavioral indices so that interpretive criteria can be based on the best and most current methodology.

- Develop statistical models to examine relationships and interactions among the many types of data collected for NNMRRP surveys.

- Encourage and support efforts of agencies that participate in the NNMRRP to publish survey and surveillance system data in agency reports and peer-reviewed scientific journals. Although resources for these activities are limited, making data available in a timely fashion to the public, the scientific community, and for public policy consideration is an essential component of the NNMRRP. The agencies should also release the primary data (i.e., reports and data tapes) to the research community as quickly as possible.

- Conduct special studies of high-risk population subgroups (e.g., American Indians, pregnant females, and migrant populations) concurrently with national surveys using comparable data-collection methodologies.

- Develop, standardize, and disseminate nutrition methodologies for comparable use at national, State, local, and community levels to allow for appropriate data comparisons.

- Improve the system for the electronic transfer of nutrition survey data to data base users. This capability enhances the States' abilities to use NNMRRP data. Consideration should be given to implementing a system in which States can obtain NNMRRP data that pertain to their specific needs. Any system for electronic data transfer must require strict adherence to quality-control criteria for inclusion of data and would have to include protection against change by unauthorized individuals or organizations.

- Support the development of a comprehensive catalog of the types of data and analyses available from all surveys and surveillance systems of the NNMRRP. Such a catalog should be patterned after the *Catalog of Electronic Data Products*. The currently available *Nutrition Monitoring in the United States: The Directory of Federal and State Nutrition Monitoring Activities* could be expanded or supplemented by a more comprehensive listing of data that are available on tape, diskette, or CD-ROM or as published reports. Such a comprehensive source document on the entire NNMRRP would be quite valuable to research investigators, State agencies, and others.

- Start planning for the fourth report on nutrition monitoring immediately. The quantity of data generated by the NNMRRP is substantial and the data are complex, requiring careful planning of analyses. Early initiation of planning, including a sharper focus on topics to be included in the next comprehensive 5-year report, is critical.

National food-supply determinations and household-based food expenditures

- Continue to collect reliable food-supply data from a variety of government and private sources and to calculate estimates of the total available food supply, per capita consumption, and nutrient availability annually.

- Continue to collect and analyze data on household food use and expenditures for food at home, including preprepared foods (foods purchased in a ready-to-eat form and taken home for consumption).

- Continue to gather information on the amount of money spent for food away from home. Expand efforts to capture information for food away from home by type of food item and by facility where food is eaten (e.g., school cafeteria, restaurant with counter service, restaurant with waiter-waitress service, and vending machine).

Food composition and nutrient data bases

- Develop acceptable assay methods that are faster and less expensive than current methods. Efforts should involve coordination with the food industry and other groups to increase the accuracy of methods, improve data quality, and make food composition data more accessible.

- Enhance communication between government and the food industry so that the development of food composition methodologies used for food-safety and food-labeling (i.e., regulatory) purposes and those used to generate food composition data for food composition data bases can be coordinated. Such coordination should allow for greater use of brand-specific information in the Survey Nutrient Data Base.

- Improve and expand food composition data for total fat, fatty acids including *trans* fatty acids, fat substitutes, dietary fiber, vitamin A, carotenes, vitamin C, folate, sodium, copper, cholesterol, total carbohydrate, and sugars. Incorporate food composition data for selenium into the Survey Nutrient Data Base.

- Continue to collect and compile food composition data for analytical research purposes and to use, develop, and maintain nutrient data bases for estimating nutrient intakes from food consumption surveys. Maintain the USDA Nutrient Data Base for Standard Reference and the Survey Nutrient Data Base as two separate entities because their data are used in very different ways.

- Continue to develop a survey nutrient data base for trend analysis that will permit food composition data added in the future to be used to analyze food consumption data collected earlier.

- Create and maintain a product-specific data base for the nutrient composition of dietary supplements so that nutrient intakes from supplements—as well as from foods—can be analyzed.

Food consumption and nutrient intakes

- Continue monitoring foods consumed by individuals to examine differences in food consumption patterns among population subgroups and to track progress toward meeting Healthy People 2000 objectives and adopting dietary recommendations in the Food Guide Pyramid and the *Dietary Guidelines for Americans*.

- Monitor nutrient intakes from foods and from dietary supplements.

- Support research to determine the mean and variance of requirements for each nutrient. This information is needed to adequately assess the risk of dietary inadequacies and excesses in the U.S. population.

- Support research to determine whether nutrient requirements of population subgroups differ. Give higher priority to groups at nutritional risk and whose numbers are increasing in the population, such as elderly people.

- Support research to determine the extent of underreporting of food consumption that occurs in nutrition surveys, improve food consumption survey methodology and instruments that minimize underreporting, and develop analytic approaches to adjust for underreporting.

- Continue monitoring the magnitude and severity of food insufficiency in future nutrition monitoring surveys. Identify groups within low-income and other populations at risk for food insufficiency and examine factors that influence the development of food insufficiency.

Nutritional status and nutrition-related health status

- Continue monitoring indicators of nutritional status, including anthropometric, biochemical, hematologic, and clinical measures, and of nutrition-related health conditions, including low birth weight, growth status in children, overweight in adults, serum lipids, hypertension, osteoporosis, and anemia. Monitoring efforts should not be restricted to these conditions and should continue to include other diseases that have a nutritional component, such as diabetes mellitus, dental conditions, and gallbladder disease.

- Develop interpretive criteria to link nutrition monitoring data to functional or health outcomes.

- Conduct studies to improve the validity of biochemical and other methodologies used to assess nutritional status and nutrition-related health status.

- Explore links between nutritional status, particularly anthropometric indicators, and food insufficiency.

- In future nutrition monitoring reports, nutrition monitoring assessments should be based on health conditions and intakes of nutrients of public health concern.

Knowledge, attitudes, and behavior assessments

- Continue coordination among Federal agencies to enhance the collection and use of survey data on diet, nutrition, and health-related knowledge, attitudes, and behavior. Such efforts help reduce information gaps and duplication of effort, identify and prioritize monitoring needs, and strengthen the links between national surveys and programs that use these data for program planning and evaluation.

- Collect information on people's perceptions of dietary and nutrition issues and of health-related behaviors to improve approaches to translating knowledge into action. Determine the perceived internal and external barriers that keep people from adopting and maintaining healthier food and life-style choices.

- Establish better measures to evaluate physical-activity levels in children, adolescents, and adults.

- Identify and monitor factors that contribute to the low levels of physical activity in the general population and in population subgroups and factors that influence people to become more active and to maintain more active life-styles.

- Collect in-depth information from consumers on their use and understanding of information on the food label, and analyze the data for the general population and for population subgroups. For nutrition monitoring purposes, focus on the impact of the food label's nutrition panel on food purchases and consumption, on what specific information on the nutrition panel is used and found to be valuable, on where food-label information is used (at home and/or in the supermarket), and on the effect of food-label use on subsequent food purchases.

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Figure notes

Figure ES-4. "Overweight" was defined for males as body mass index (BMI) $\geq$27.8 kg/m^2 and for females as BMI $\geq$27.3 kg/m^2. Pregnant females were excluded from analyses.

Figure ES-5. Percentages for children 2-5 years of age were based on weight for height greater than the NCHS growth chart 95th percentile for age (Hamill et al., 1979). Percentages for children and adolescents 6-19 years of age were based on body mass index greater than the NHANES I 95th percentile for age (Must et al., 1991). Excludes pregnant females.

Figure ES-6. "None" was defined as no physical activity in the past month. "Irregular" was defined as any physical activity or pair of activities done for <20 minutes or fewer than 3 times per week. "Regular" was defined as any physical activity or pair of activities done for $\geq$20 minutes 3 or more times per week at <50% of functional capacity. The HP2000 definition for "vigorous physical activity" is any rhythmic, repetitive physical activity that uses large muscle groups at $\geq$60% of maximum heart rate for age 3 or more days per week for $\geq$20 minutes per occasion. Maximum heart rate for age equals roughly 220 beats per minute minus age.

Figure ES-7. "Vigorous physical activity" was described to respondents as hard exercise done for at least 20 minutes that causes one to breathe heavily and makes the heart beat fast (e.g., playing basketball, jogging, fast dancing, and fast bicycling).

Figure ES-8. "Overweight" was defined for males as body mass index (BMI) ≥ 27.8 kg/m^2 and for females as BMI ≥ 27.3 kg/m^2. Excludes pregnant females. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

Figure ES-9. "Overweight" was defined for males as body mass index (BMI) ≥ 27.8 kg/m^2 and for females as BMI ≥ 27.3 kg/m^2. Male and female respondents had a measured BMI <27.8 and <27.3 kg/m^2, respectively. Excludes pregnant females.

Figure ES-10. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

Figure ES-11. "Hypertension" was defined as systolic blood pressure ≥ 140 mm Hg, diastolic blood pressure ≥ 90 mm Hg, or under current treatment for hypertension with a prescription medication. Excludes pregnant females.

Figure ES-13. Data are based on boneless, trimmed equivalent.

Figure ES-15. "Fruit juices" includes citrus juices (orange, grapefruit, lemon, and lime) and noncitrus juices (apple, grape, and prune).

Figure ES-19. Data were collected from low-income, high-risk pregnant females who participated in government-funded prenatal nutrition and food-assistance programs. Measured height and prepregnancy weight were used to calculate body mass index (BMI). Prepregnancy weight categories, as specified for this analysis, were very underweight (BMI 10.0-17.9 kg/m^2), underweight (BMI 18.0-19.7 kg/m^2), normal weight (BMI 19.8-27.3 kg/m^2), overweight (BMI 27.4-31.0 kg/m^2), and very overweight (BMI 31.1-74.9 kg/m^2).

Figure ES-20. Whenever nutrient intake data were available from surveys, they were used and evaluated by established criteria. When survey data were not available, Total Diet Study data were used and evaluated by established criteria. Dashed lines indicate less likely outcomes.

Acronyms and abbreviations

ARS: Agricultural Research Service, USDA
BMI: body mass index
BRFSS: Behavioral Risk Factor Surveillance System
CDC: Centers for Disease Control and Prevention, HHS
CES: Consumer Expenditure Survey
CSFII: Continuing Survey of Food Intakes by Individuals
DHKS: Diet and Health Knowledge Survey
DOD: U.S. Department of Defense
DOL: U.S. Department of Labor
ESADDI: Estimated Safe and Adequate Daily Dietary Intake
FASEB: Federation of American Societies for Experimental Biology
FDA: Food and Drug Administration, HHS
HANES: Health and Nutrition Examination Survey
HHANES: Hispanic Health and Nutrition Examination Survey 1982-84
HHS: U.S. Department of Health and Human Services
HNIS: Human Nutrition Information Service, USDA (now part of ARS, USDA)
IBNMRR: Interagency Board for Nutrition Monitoring and Related Research
LSRO: Life Sciences Research Office, FASEB
NCHS: National Center for Health Statistics, CDC, HHS
NFCS: Nationwide Food Consumption Survey
NHANES I: first National Health and Nutrition Examination Survey (1971-74)
NHANES II: second National Health and Nutrition Examination Survey (1976-80)
NHANES III: third National Health and Nutrition Examination Survey (1988-94)
NHES: National Health Examination Survey
NLEA: Nutrition Labeling and Education Act of 1990
NNMRRP: National Nutrition Monitoring and Related Research Program
NSFG: National Survey of Family Growth
PedNSS: Pediatric Nutrition Surveillance System
PNSS: Pregnancy Nutrition Surveillance System
RDA: Recommended Dietary Allowance
TRONM: *Third Report on Nutrition Monitoring in the United States*
USDA: U.S. Department of Agriculture
YRBS: Youth Risk Behavior Survey

Chapter 1

Introduction

Background

In the National Nutrition Monitoring and Related Research Act of 1990 (Public Law 101-445), nutrition monitoring and related research was defined as "the set of activities necessary to provide timely information about the role and status of factors that bear on the contribution that nutrition makes to the health of the people of the United States, including—(A) dietary, nutritional, and health status measurements; (B) food consumption measurements; (C) food composition measurements and nutrient data banks; (D) dietary knowledge and attitude measurements; and (E) food supply and demand determinations . . . " (U.S. Congress, 1990). In that legislation, the U.S. Congress authorized the establishment of the National Nutrition Monitoring and Related Research Program (NNMRRP) and directed the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA) to share responsibility for implementing the program. Current nutrition monitoring activities and planned activities required to improve and expand the NNMRRP were described in the *Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program* (HHS and USDA, 1993).

As one NNMRRP requirement, Congress specified that the coordinating agencies "contract with a scientific body, such as the National Academy of Sciences or the Federation of American Societies for Experimental Biology, to interpret available data analyses, and publish . . . a report on the dietary, nutritional, and health-related status of the people of the United States and the nutritional quality (including the nutritive and nonnutritive content) of food consumed in the United States . . . at least once every five years." The *Third Report on Nutrition Monitoring in the United States* (TRONM) was prepared by the Life Sciences Research Office (LSRO) of the Federation of American Societies for Experimental Biology (FASEB) under contract with USDA as a project of the Interagency Board for Nutrition Monitoring and Related Research (IBNMRR) under the joint leadership of the Departments of Agriculture and Health and Human Services.

Previous nutrition monitoring reports

Before the National Nutrition Monitoring and Related Research Act of 1990 was passed, nutrition monitoring research was conducted as a part of the National Nutrition Monitoring System (NNMS). The history of the goals and milestones of Federal nutrition monitoring in the United States can be found in Kuczmarski and Kuczmarski (1994), Kuczmarski et al. (1994), HHS and USDA (1986, 1993), and LSRO (1989).

Two comprehensive reports on nutrition monitoring activities conducted as part of the NNMS were published in the late 1980s, one in 1986 and one in 1989. Each drew upon the wide range of data components that were available at the time the reports were prepared and that were later emphasized in the NNMRRP, including data on the food supply, household-based food expenditures, food composition, food consumption, nutritional status and nutrition-related health measurements, and knowledge, attitudes, and behavior.

The first report, *Nutrition Monitoring in the United States: A Progress Report from the Joint Nutrition Monitoring Evaluation Committee*, was prepared by the Joint Nutrition Monitoring Evaluation Committee

(JNMEC), a Federal advisory committee jointly sponsored by HHS and USDA (HHS and USDA, 1986). This report provided an overview of the dietary and nutritional status of the U.S. population and was intended to serve as a reference, or baseline, for subsequent reports. In preparing the first report, the JNMEC focused on the two major components of the NNMS available in 1986: the second National Health and Nutrition Examination Survey (NHANES II 1976-80), conducted by HHS, and the 1977-78 Nationwide Food Consumption Survey (NFCS 1977-78), conducted by USDA. The JNMEC integrated and interpreted data from these surveys to reach conclusions about the dietary and nutritional status of the U.S. population. The JNMEC report presented findings for the entire range of food components for several subgroups of the general population by age, sex, and race. The committee assigned food components to three categories on the basis of whether the component warranted public health monitoring priority status, further investigation, or public health monitoring consideration. In addition, the committee made recommendations for improving the NNMS.

The second report, *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring*, was prepared in 1989 by the ad hoc Expert Panel on Nutrition Monitoring (EPONM) of LSRO (LSRO, 1989). The EPONM used nutrition monitoring data produced or released since publication of the 1986 report to provide an update on the dietary and nutritional status of the U.S. population and on selected health conditions and behaviors. Selected data from the Hispanic Health and Nutrition Examination Survey (HHANES 1982-84), conducted by HHS's National Center for Health Statistics (NCHS), and data from the 1985-86 Continuing Survey of Food Intakes by Individuals (CSFII), conducted by USDA's Human Nutrition Information Service (HNIS), constituted the major portion of newly available information for the second report.

The EPONM was also charged with reevaluating 1) the categorization of food components for public health monitoring priority with respect to the completeness of relevant data and 2) the type and extent of monitoring that each food component should receive. The EPONM developed a classification system for food components that was similar philosophically to the classification scheme used by the JNMEC, but the categories were labeled to emphasize their public health significance: food components considered to be current public health issues, those considered to be potential public health issues for which further study is required, and those not considered to be current public health issues. The EPONM and JNMEC classifications for monitoring priority status of food components are shown in table 1-1.

The second report also provided in-depth integrated analyses of two topics selected to demonstrate how NNMS health and dietary data could contribute to the understanding of public health concerns: 1) dietary and nutritional factors in cardiovascular disease and 2) the assessment of iron nutriture. The question of whether surveys of the kind used for the first and second reports can identify the nature and magnitude of nutrition-related problems in the U.S. population was also addressed, with a special focus on trends; demographic factors, such as age, sex, race, poverty status, and education; the ability of the NNMS to identify populations at risk; limits to data

Table 1-1. Classification categories of food components by the Joint Nutrition Monitoring Evaluation Committee (JNMEC) and by the Expert Panel on Nutrition Monitoring (EPONM)

JNMEC	EPONM
Warranting public health monitoring priority	Current public health issues
Requiring further investigation	Potential public health issues for which further study is required
Warranting continued public health monitoring consideration	Not current public health issues

SOURCE: LSRO (1989).

interpretation; and gaps in data bases. In addition, the report included recommendations from the EPONM for improvements in the NNMS, based on the EPONM's experiences in evaluating the data provided for the second report. Between publication of the second and third nutrition monitoring reports, the IBNMRR published a report that presents selected recent results and trend data from the NNMRRP in a graphic format (IBNMRR, 1993).

Charge to the Life Sciences Research Office

The charge for preparing the TRONM directed that LSRO use data and information available through the NNMRRP, provided by the Federal Government, to conduct a scientific review and assessment of the nutritional status of Americans and the nutritional quality of food consumed in the United States. The charge specified that the third report build on the philosophy and intent of the first and second nutrition monitoring reports and provide an update of the nutritional status of the U.S. population based on new data available since the second report. In particular, the charge required an update of the dietary and nutritional status of the U.S. population presented in the second report, based on data provided by the NNMRRP, with an integral focus on low-income and high-risk population subgroups.

The charge also required that the reevaluation and classification of food components of public health concern use the classification criteria described in the second report (see table 1-1, "EPONM"). Food components that were not included in the second report could be added, and food components could be reclassified from the second report, if the rationale and supporting data for addition and reclassification were provided. Recommendations were requested for ways to strengthen the NNMRRP based on experiences in data analysis and interpretation encountered in the preparation of the third report.

LSRO's approach

This report represents a broad and multidisciplinary approach to the monitoring of nutritional status in the United States. For evaluation and interpretation of NNMRRP data, LSRO enlisted the assistance of Expert Consultants with specialties in dietary intake and food consumption patterns, food composition and analysis, public health nutrition, community nutrition, clinical nutrition, behavioral aspects of the interrelationships of nutrition and health, nutrition monitoring and surveillance research, agricultural economics, and statistics and biostatistics. The Expert Consultants reviewed data, suggested interpretations, and reviewed and edited drafts of the report. Scientists with expertise in areas outside the Expert Consultants' specialties were consulted as needed.

LSRO prepared the TRONM in a manner similar to that used for preparing the second report. To produce a report that would update and expand the second report, the Expert Consultants and LSRO used the general conceptual model, the decision-making process, and the classifications for monitoring priority status of food components developed by the EPONM for the second report. The general conceptual model is described below. The decision-making process and classifications for monitoring priority status of food components are detailed in chapter 9.

General conceptual model

A general conceptual model that represents the relationships among food choices, food and nutrient intakes, and nutritional and health status, developed originally by the EPONM and used in the second report on nutrition monitoring in the United States, is presented in figure 1-1. The model provided a framework for discussions of the nutritional status of the U.S. population for the TRONM. The major stages at which the effects of food and nutrient intake on nutrition-related health status can be assessed as well as the factors that influence each stage are identified in the model. The model represents a starting point rather than an exhaustive description of all possible factors and interrelationships; it is designed to allow for expansion or elaboration of detail.

The Expert Consultants and LSRO made only minor changes to the model presented in the second report. The model was updated to show that in addition to the influences of food production and imports, foods consumed by individuals (consumer demand) influence the food supply. Interactions between away-from-home food available and away-from-home food acquired and between household food available and household food acquired are also shown, as is the role of food composition data in the estimation of nutrient intakes. "Dietary supplement use," in

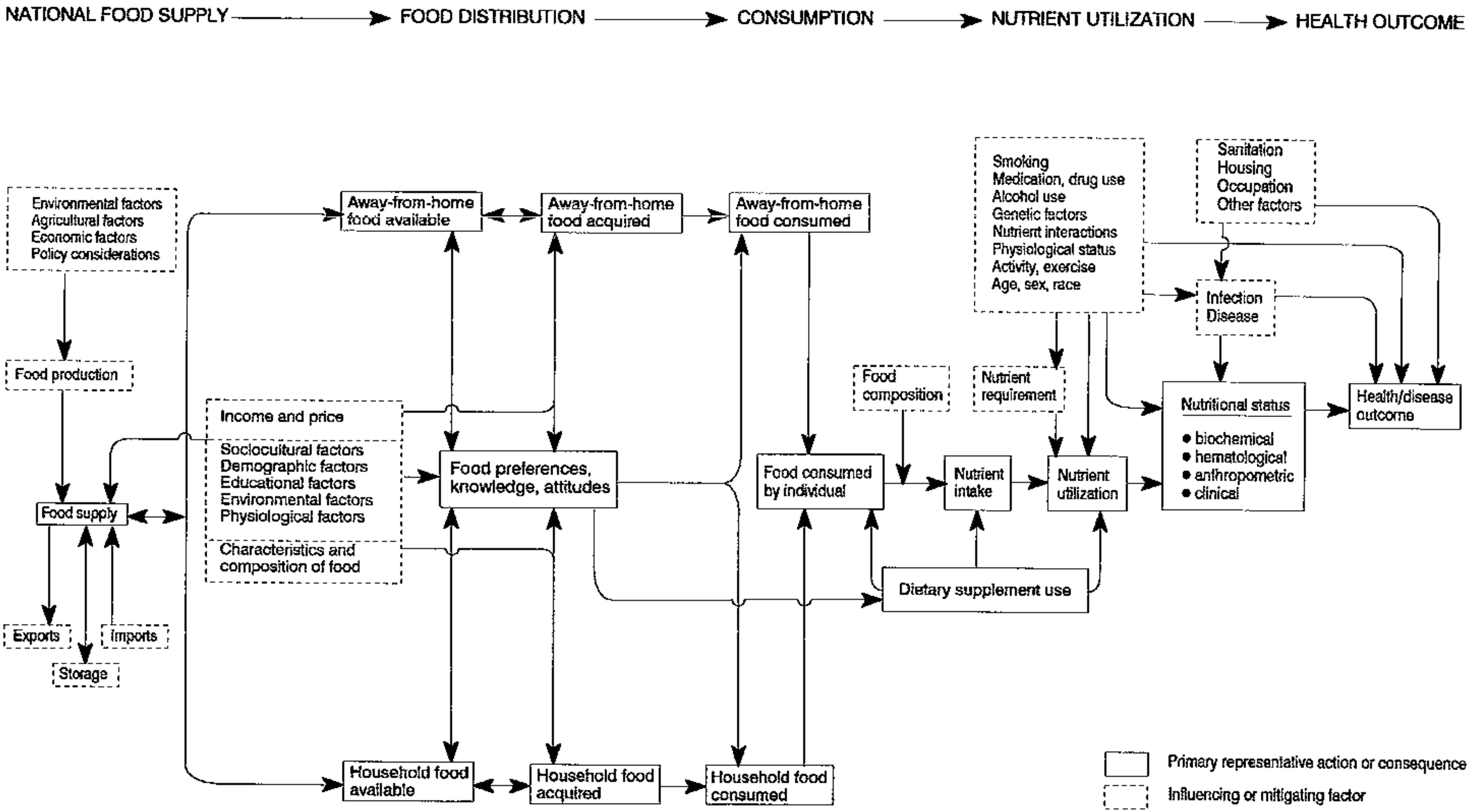

Figure 1-1. General conceptual model highlighting food choice and food and nutrient intake in the relationship of food to health (see text for explanation)

SOURCE: LSRO (1989).

addition to its connection with nutrient intake and utilization, is connected to the box on "food consumed by individual" because some foods are fortified to contain levels of nutrients similar to those in dietary supplements (e.g., some fortified breakfast cereals).

The components of the model shown in solid-line boxes represent the primary stages in the sequence from the food supply to the health outcome, and the components shown in broken-line boxes represent factors that may influence each primary stage. The model does not distinguish factors that have indirect effects from those that have direct effects. To emphasize the major components of the model, a truncated diagram of the general conceptual model is shown in figure 1-2. Chapters 3 through 8 explore these components in detail.

Sources of the data

Data were made available for the TRONM from 36 surveys and surveillance systems used in the NNMRRP. CSFII 1989-91, conducted by USDA's Human Nutrition Information Service (HNIS)[1], and the third National Health and Nutrition Examination Survey (NHANES III 1988-91), conducted by NCHS, now part of HHS's Centers for Disease Control and Prevention (CDC), provided extensive data on food consumption, nutrient intakes, and nutrition-related health status in nationally representative samples of the general U.S. population. Data for NHANES III were collected in two phases between 1988 and 1994. A nationally representative sample was used for each phase. Data collected in 1988-91 for Phase 1 of NHANES III are included in this report. Other surveys from USDA and HHS and from the Departments of Defense and Labor provided additional information on specific subgroups of the general population, including populations at higher risk for nutrition-related health conditions, and on the food supply, household-based food expenditures, food composition, and knowledge, attitudes, and behaviors related to diet, nutrition, and health.

The data collected, population description, time period, and sponsoring agency for each of the surveys and studies submitted for consideration by the Expert Consultants and LSRO are summarized in table 1-2. A more complete description of each NNMRRP component can be found in *Nutrition Monitoring in the United States: The Directory of Federal and State Nutrition Monitoring Activities*, a report by the IBNMRR (1992).

Selection of data for the TRONM

The Expert Consultants and LSRO were given more than 1,800 data tables from 36 surveys and surveillance systems administered by Federal agencies and used as the sources of data for the NNMRRP (table 1-2). Space and time constraints limited the amount of data that could be included in the TRONM. Thus, the Expert Consultants and LSRO selected those data judged to be most useful in providing an update of the dietary and nutritional status of the U.S. population, including low-income and high-risk population subgroups. The general criteria used by the Expert Consultants and LSRO for selecting data sets included, but were not limited to, the following six criteria:

- The data had become available since the second report on nutrition monitoring was prepared, and requisite analyses could be completed within the time frame planned for preparation of the TRONM. For the data to be included, the data analyses for the TRONM had to be essentially completed by June 30, 1994.

- The data were nationally representative or provided baseline data from multiple ethnic groups or high-risk populations.

- The data were provided in a timely manner, in usable format, and with an indication of reliability.

- The data had potential for comparison with previously published data.

[1]Legislation passed on Feb. 20, 1994, transferred the functions and staff of USDA's Human Nutrition Information Service (HNIS) to the existing Agricultural Research Service (ARS) of that department.

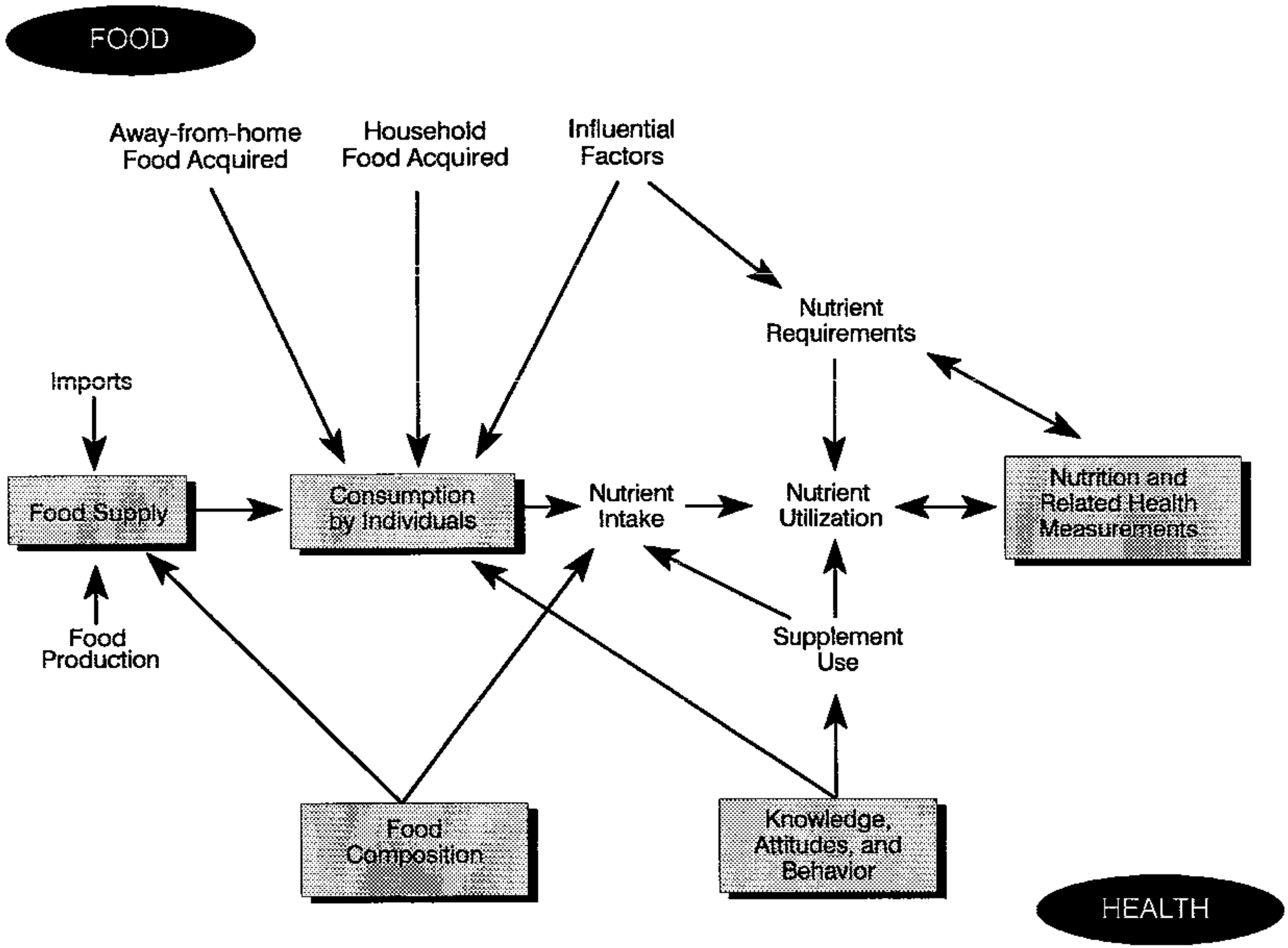

Figure 1-2. Relationship of food to health, highlighting the NNMRRP's major components

SOURCE: HHS and USDA (1993).

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*[1]

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Nutritional Status and Nutrition-Related Health Measurements				
Survey of Army Female Basic Trainees	ARIEM (DOD)	1993	Volunteers from females entering basic training at Fort Jackson, SC.	Nutrition knowledge and beliefs, eating habits, and food attitudes; 7-day dietary intake; bone mineral mass, body fat, and biochemical analyses of blood.
Nutritional and Physiological Assessment of the Special Forces Assessment and Selection Course	ARIEM (DOD)	1993	Special Operations Forces male soldiers.	Body fat and bone mineral mass; biochemical analyses on blood drawn prior to conditions of deficient energy intakes.
Ranger School Nutrition Intervention Study	ARIEM (DOD)	1992	Special Operations Forces male soldiers.	Body fat and bone mineral mass; biochemical analyses on blood drawn prior to conditions of deficient energy intakes.
Pregnancy Nutrition Surveillance System (PNSS)	NCCDPHP, CDC (HHS)	1992	Convenience population of low-income, high-risk pregnant women.	Demographic information; pregravid-weight status, maternal weight gain during pregnancy, anemia (hemoglobin, hematocrit), pregnancy behavioral risk factors (smoking and drinking), birth weight, breastfeeding, and formula-feeding data.
Pediatric Nutrition Surveillance System (PedNSS)	NCCDPHP, CDC (HHS)	1973-92	Low-income, high-risk children, birth-17 years of age, with emphasis on birth-5 years of age.	Demographic information; anthropometry (height and weight), birth weight, and hematology (hemoglobin, hematocrit), breastfeeding.
National Vital Registration System—Natality Statistics	NCHS, CDC (HHS)	1991	All live births for total U.S. population.	Infant birth weight, gestational age, Apgar score, anemia, fetal alcohol syndrome, hyaline membrane disease, congenital anomalies; maternal weight gain during pregnancy, alcohol and tobacco use, and anemia, diabetes, and hypertension during pregnancy.
Longitudinal Followup to the 1988 National Maternal and Infant Health Survey (NMIHS)	NCHS, CDC (HHS)	1991	Mothers of 3-year-olds who participated in the 1988 NMIHS, pediatricians, and hospitals.	Use of vitamin and mineral supplements, WIC participation, and growth and hematological measurements from birth to 3 years of age.
Assessment of Nutritional Status and Immune Function during the Ranger Training Course	ARIEM (DOD)	1991	Special Operations Forces male soldiers.	Body fat and bone mineral mass; biochemical analyses of blood drawn prior to conditions of deficient energy intakes.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Survey of Heights and Weights of American Indian School Children	IHS and CDC (HHS)	1990-91	American Indian school children 5-18 years of age.	Height, weight, and body mass index.
National Ambulatory Medical Care Survey (NAMCS)	NCHS, CDC (HHS)	1989-91	Visits to office-based physicians and hospital emergency and outpatient departments of non-Federal, short-stay general and specialty hospitals.	Patients' symptoms and demographic characteristics, physicians' diagnoses, drugs prescribed, and referrals. Nutrition-related information is collected, including physician-reported hypertension, hyper-cholesterolemia, and obesity and whether the physician ordered or recommended counseling services for diet, exercise, cholesterol reduction, and weight reduction.
Third National Health and Nutrition Examination Survey (NHANES III)	NCHS, CDC (HHS)	1988-91	Civilian, noninstitutionalized population 2 months of age and older. Oversampling of non-Hispanic blacks and Mexican Americans, children <6 years of age, and adults aged ≥60 years.	Dietary intake (one 24-hour recall and food frequency), socioeconomic and demographic information, biochemical analyses of blood and urine, physical examination, body measurements, blood pressure measurements, bone densitometry, dietary and health behaviors, and health conditions. Two additional 24-hour recalls for participants 50 years of age and older.
Hispanic Health and Nutrition Examination Survey (HHANES)	NCHS (HHS)	1982-84	Civilian, noninstitutionalized Mexican Americans in five Southwestern States, Cuban Americans in Dade County, FL, and Puerto Ricans in metropolitan New York City; 6 months-74 years of age.	Dietary intake (one 24-hour recall), food frequency, socioeconomic and demographic information, dietary and health behaviors, biochemical analyses of blood and urine, physical examination, body measurements, and health conditions.
Second National Health and Nutrition Examination Survey (NHANES II)	NCHS (HHS)	1976-80	Civilian, noninstitutionalized population of the United States; 6 months-74 years of age.	Dietary intake (one 24-hour recall), food frequency, socioeconomic and demographic information, biochemical analyses of blood and urine, physical examination, and body measurements.
First National Health and Nutrition Examination Survey (NHANES I)	NCHS (HHS)	1971-74	Civilian, noninstitutionalized population of the conterminous United States; 1-74 years of age.	Dietary intake (one 24-hour recall), food frequency, socioeconomic and demographic information, biochemical analyses of blood and urine, physical examination, and body measurements.
First National Health Examination Survey (NHES I)	NCHS (HHS)	1960-62	Civilian, noninstitutionalized population of the conterminous United States; 18-79 years of age.	Socioeconomic and demographic information, biochemical analyses of blood, physical examination, and body measurements.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Food and Nutrient Consumption				
Survey of Army Female Basic Trainees	ARIEM (DOD)	1993	Volunteers from females entering basic training at Fort Jackson, SC.	Nutrition knowledge and beliefs, eating habits, and food attitudes; 7-day dietary intake; bone mineral mass, body fat, and biochemical analyses of blood.
School Nutrition Dietary Assessment Study (SNDA)	FCS (USDA)	1992	325 nationally representative schools in the 48 conterminous States and the District of Columbia and children and adolescents in grades 1-12 who attend those schools.	For schools: lists of all foods served as part of a USDA meal (or all foods served if the school did not participate in the USDA meal programs), by meal and day of the week; complete descriptions of foods, recipes, and labels for prepared items; estimates of quantity served; á la carte food items; and food and beverage items in vending machines. For individuals: foods consumed and 24-hour recall by students (grades 3-12) or students and parents (grades 1-2).
Consumer Expenditure Survey (CES)	BLS (DOL)	1980-92	Civilian, noninstitutionalized population and a portion of the institutionalized population in the United States.	No direct nutrition-related indicators collected. Weekly food expenditures collected at a detailed item level in the Diary Survey. Food Stamp Program participation data collected in the Interview Survey.
5 A Day for Better Health Baseline Survey	NCI (HHS)	1991	Adults 18 years of age and older in the United States.	Demographic information; fruit and vegetable intake; knowledge, attitudes, and behaviors regarding fruit and vegetable intake.
Longitudinal Followup to the 1988 National Maternal and Infant Health Survey (NMIHS)	NCHS, CDC (HHS)	1991	Mothers of 3-year-olds who participated in the 1988 NMIHS, pediatricians, and hospitals.	Use of vitamin and mineral supplements, WIC participation, and growth and hematological measurements from birth to 3 years of age.
Continuing Survey of Food Intakes by Individuals (CSFII)	HNIS[2] (USDA)	1989-91	Individuals in households in the 48 conterminous States. The survey was composed of two separate samples: households with incomes at any level (basic sample) and households with incomes $\leq$130% of the poverty thresholds (low-income sample).	One-day and 3-day food and nutrient intakes by individuals of all ages, names and times of eating occasions, and sources of food obtained and eaten away from home. Data collected over 3 consecutive days by use of a 1-day recall and a 2-day record. Intakes are available for 28 nutrients and food components.
Strong Heart Dietary Survey	IHS and CDC (HHS)	1989-91	American Indian adults 45-74 years of age residing in South Dakota, Arizona, and Oklahoma areas.	Food intake by 24-hour recall and quantitative food frequency.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Third National Health and Nutrition Examination Survey (NHANES III)	NCHS, CDC (HHS)	1988-91	Civilian, noninstitutionalized population 2 months of age and older. Oversampling of non-Hispanic blacks and Mexican Americans, children <6 years of age, and adults aged ≥60 years.	Dietary intake (one 24-hour recall and food frequency), socioeconomic and demographic information, biochemical analyses of blood and urine, physical examination, body measurements, blood pressure measurements, bone densitometry, dietary and health behaviors, and health conditions. Two additional 24-hour recalls for participants 50 years of age and older.
Total Diet Study (TDS)	FDA (HHS)	1982-89	NA	Chemical analysis of nutrients and contaminants in the U.S. food supply. Food composition data are merged with food consumption data to estimate daily intake of nutrients and contaminants.
Nationwide Food Consumption Survey (NFCS)	HNIS (USDA)	1987-88	Households in the 48 conterminous States and individuals residing in those households. The survey was composed of two samples: a basic sample of all households and a low-income sample of households with incomes ≤130% of the poverty threshold.	For households: quantity (pounds), money value (dollars), and nutritive value of food used. For individuals: 1-day and 3-day food and nutrient intakes by individuals of all ages, names and times of eating occasions, and sources of food obtained and eaten away from home. Data collected over 3 consecutive days using a 1-day recall and a 2-day record. Intakes are available for 28 nutrients and food components.
National Health Interview Survey on Vitamin and Mineral Supplements	NCHS and FDA (HHS)	1986	Civilian, noninstitutionalized children 2-6 years of age and adults 18 years of age and older in the United States.	Prevalence of use; sociodemographic characteristics of the users; intakes of 24 nutrients from supplements (12 vitamins and 12 minerals); potency, form, and the units used to declare potency; specific chemical compounds for mineral supplements; number of supplements taken, duration of use, and whether the supplement was prescribed.
Continuing Survey of Food Intakes by Individuals (CSFII)	HNIS (USDA)	1985-86	Individuals in households in the 48 conterminous States. The survey was composed of two separate samples: households with incomes at any level (basic sample) and households with incomes ≤130% of the poverty thresholds (low-income sample), including in 1985, women 19-50 years of age and their children aged 1-5 years and men 19-50 years of age, and in 1986, women 19-50 years of age and their children aged 1-5 years.	Six 1-day food and nutrient intakes by individuals, names and times of eating occasions, and sources of food obtained and eaten away from home. Data collected at about 2-month intervals over a 1-year period.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Hispanic Health and Nutrition Examination Survey (HHANES)	NCHS (HHS)	1982-84	Civilian, noninstitutionalized Mexican Americans in five Southwestern States, Cuban Americans in Dade County, FL, and Puerto Ricans in metropolitan New York City; 6 months-74 years of age.	Dietary intake (one 24-hour recall), food frequency, socioeconomic and demographic information, dietary and health behaviors, biochemical analyses of blood and urine, physical examination, body measurements, and health conditions.
Vitamin and Mineral Supplement Use Survey	FDA (HHS)	1980	Civilian, noninstitutionalized adults 16 years of age and older in the United States.	Prevalence of use, sociodemographic characteristics of the users, intakes of 24 nutrients (12 vitamins and 12 minerals) and other miscellaneous substances, and supplement-use behaviors of the users by telephone interview.
Second National Health and Nutrition Examination Survey (NHANES II)	NCHS (HHS)	1976-80	Civilian, noninstitutionalized population of the United States; 6 months-74 years of age.	Dietary intake (one 24-hour recall), food frequency, socioeconomic and demographic information, biochemical analyses of blood and urine, physical examination, and body measurements.
Nationwide Food Consumption Survey (NFCS)	ARS (USDA)	1977-78	Private households in the 48 conterminous States and the individuals in those households (all income and low income).	For households: quantity (pounds), money value (dollars), and nutritive value of food used. For individuals: 1-day and 3-day food and nutrient intakes by individuals of all ages, names and times of eating occasions, and sources of food obtained and eaten away from home. Data collected over 3 consecutive days using a 1-day recall and a 2-day record. Intakes are available for 15 nutrients and food components.
First National Health and Nutrition Examination Survey (NHANES I)	NCHS (HHS)	1971-74	Civilian, noninstitutionalized population of the conterminous United States; 1-74 years of age.	Dietary intake (one 24-hour recall), food frequency, socioeconomic and demographic information, biochemical analyses of blood and urine, physical examination, and body measurements.
First National Health Examination Survey (NHES I)	NCHS (HHS)	1960-62	Civilian, noninstitutionalized population of the conterminous United States; 18-79 years of age.	Socioeconomic and demographic information, biochemical analyses of blood, physical examination, and body measurements.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Knowledge, Attitudes, and Behavior Assessments				
Survey of Army Female Basic Trainees	ARIEM (DOD)	1993	Volunteers from females entering basic training at Fort Jackson, SC.	Nutrition knowledge and beliefs, eating habits, and food attitudes; 7-day dietary intake; bone mineral mass, body fat, and biochemical analyses of blood.
Behavioral Risk Factor Surveillance System (BRFSS)	NCCDPHP, CDC (HHS)	1992	Adults 18 years of age and older residing in households with telephones in participating States.	Demographic information; height, weight, smoking, alcohol use, weight-control practices, diabetes, preventable health problems, mammography, pregnancy, cholesterol-screening practices, awareness, treatment, and modified food frequencies for dietary fat, fruit, and vegetable consumption by telephone interview.
5 A Day for Better Health Baseline Survey	NCI (HHS)	1991	Adults 18 years of age and older in the United States.	Demographic information; fruit and vegetable intake; knowledge, attitudes, and behaviors regarding fruit and vegetable intake.
Weight Loss Practices Survey (WLPS)	FDA and NHLBI (HHS)	1991	Individuals currently trying to lose weight, 18 years of age and older.	Demographic information; body mass index; diet history and other health behaviors; self-perception of overweight by telephone interview.
Youth Risk Behavior Survey (YRBS)	NCCDPHP, CDC (HHS)	1990, 1991	Youths attending school in grades 9-12 in the 50 States, District of Columbia, Puerto Rico, and the Virgin Islands.	Demographic information; smoking, alcohol use, weight-control practices, exercise, and eating-practices information.
Nutrition Label Format Studies	FDA (HHS)	1990, 1991	Primary food shoppers 18 years of age and older.	Demographic information; objective performance measures and preference measures for the various formats for revised nutrition labels; frequency of food-label reading; health status of household members with respect to heart disease, diabetes, high blood pressure, stroke, and cancer; household members' dieting practices with respect to weight control and intake of sodium, cholesterol, and fat.
Diet and Health Knowledge Survey (DHKS)	HNIS (USDA)	1989-91	Main meal planner and preparer in households in the 48 conterminous States who participated in CSFII 1989-91.	Self-perceptions of relative intake levels, awareness of diet-health relationships, use of food labels, perceived importance of following dietary guidance for specific nutrients and food components, beliefs about food safety, and knowledge about food sources of nutrients. These variables can be linked to data on individuals' food and nutrient intakes from CSFII 1989-91.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Continuing Survey of Food Intakes by Individuals (CSFII)	HNIS (USDA)	1989-91	Individuals in households in the 48 conterminous States. The survey was composed of two separate samples: households with incomes at any level (basic sample) and households with incomes ≤130% of the poverty thresholds (low-income sample).	One-day and 3-day food and nutrient intakes by individuals of all ages, names and times of eating occasions, and sources of food obtained and eaten away from home. Data collected over 3 consecutive days by use of a 1-day recall and a 2-day record. Intakes are available for 28 nutrients and food components.
Third National Health and Nutrition Examination Survey (NHANES III)	NCHS, CDC (HHS)	1988-91	Civilian, noninstitutionalized population 2 months of age and older. Oversampling of non-Hispanic blacks and Mexican Americans, children <6 years of age, and adults aged ≥60 years.	Dietary intake (one 24-hour recall and food frequency), socioeconomic and demographic information, biochemical analyses of blood and urine, physical examination, body measurements, blood pressure measurements, bone densitometry, dietary and health behaviors, and health conditions. Two additional 24-hour recalls for participants 50 years of age and older.
Health and Diet Survey (HDS)	FDA and NHLBI[3] (HHS)	1983, 1986, 1988, 1990	Civilian, noninstitutionalized adults 18 years of age and older in the 48 conterminous States.	Demographic information; data on awareness, beliefs, attitudes, knowledge, and reported behaviors regarding food, nutrition, and health; self-reported height, weight, health history, and health status by telephone interview.
Nationwide Food Consumption Survey (NFCS)	HNIS (USDA)	1987-88	Households in the 48 conterminous States and individuals residing in those households. The survey was composed of two samples: a basic sample of all households and a low-income sample of households with incomes ≤130% of the poverty threshold.	For households: quantity (pounds), money value (dollars), and nutritive value of food used. For individuals: 1-day and 3-day food and nutrient intakes by individuals of all ages, names and times of eating occasions, and sources of food obtained and eaten away from home. Data collected over 3 consecutive days using a 1-day recall and a 2-day record. Intakes are available for 28 nutrients and food components.
National Survey of Family Growth (NSFG)	NCHS, CDC (HHS)	1982, 1988	Females 15-44 years of age.	Demographic information; birth weight, breastfeeding, and prenatal care.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Food Composition and Nutrient Data Bases				
National Nutrient Data Bank (NNDB)	ARS (USDA)	NA[4]	NA[4]	Nutrient content of foods. Data from the National Nutrient Data Bank are used in the USDA Survey Nutrient Data Base for analysis of national dietary intake surveys and are also made available in published tables of food composition and as computerized data bases. Periodic updates to the data are also available on the Nutrient Data Bank Electronic Bulletin Board.
USDA Nutrient Data Base for Standard Reference	ARS (USDA)	NA[5]	NA[5]	A computer file for *Agriculture Handbook No. 8* (UDSA, 1992) produced from the National Nutrient Data Bank and the main source of the data for the USDA Survey Nutrient Data Base. This data base includes data on food energy, 28 food components, and 18 amino acids for about 5,200 food items.
USDA Survey Nutrient Data Base	ARS (USDA)	NA[6]	NA[6]	The data base is used for analysis of nationwide dietary intake surveys. It is updated continuously and includes data on food energy and 28 food components for >7,100 food items. The data base used for CSFII 1989-91 and NHANES III 1988-91 contained approximately 6,700 items.
Food Label and Package Survey (FLAPS)	FDA (HHS)	Biennially, 1977-90	NA	Use of nutrition labeling; declaration of selected nutrients and ingredients; nutrition claims; other label statements and descriptors; nutrient analysis of a representative sample of packaged foods with nutrition labels.

Table 1-2. Sources of data from the five component areas of the NNMRRP considered in the *Third Report on Nutrition Monitoring*—continued

Component area and survey or study	Sponsoring agency (department)	Date	Population	Data collected
Food-Supply Determinations				
U.S. Food Supply Series	CNPP and ERS[7] (USDA)	1970-92	U.S. total population.	Quantities of foods available for consumption on a per capita basis; quantities of food energy, nutrients, and food components provided by these foods (calculated).

[1]Within each component area, entries are listed in reverse chronological order. Some surveys and studies are listed more than once because their data are used in more than one component area. ARIEM, Army Research Institute of Environmental Medicine; DOD, Department of Defense; NCCDPHP, National Center for Chronic Disease Prevention and Health Promotion; CDC, Centers for Disease Control and Prevention; HHS, Department of Health and Human Services; NCHS, National Center for Health Statistics; WIC, Special Supplemental Nutrition Program for Women, Infants, and Children; IHS, Indian Health Service; FCS, Food and Consumer Service; USDA, U.S. Department of Agriculture; BLS, Bureau of Labor Statistics; DOL, Department of Labor; NCI, National Cancer Institute; HNIS, Human Nutrition Information Service; FDA, Food and Drug Administration; ARS, Agricultural Research Service; NHLBI, National Heart, Lung, and Blood Institute; CNPP, Center for Nutrition Policy and Promotion; ERS, Economic Research Service; NA, not applicable.
[2]Legislation passed on Feb. 20, 1994, transferred the functions and staff of USDA's Human Nutrition Information Service (HNIS) to the existing Agricultural Research Service (ARS) of that department.
[3]Cosponsored with NHLBI in 1983, 1986, and 1990.
[4]The work leading to the establishment of the NNDB was initiated in 1892 and has been maintained by USDA since that time. The sponsoring agency is currently ARS.
[5]The USDA Nutrient Data Base for Standard Reference was initiated in 1980 and has been maintained by USDA since then. The sponsoring agency is currently ARS.
[6]The USDA Survey Nutrient Data Base appropriate for the years of the following surveys was used: NFCS 1977-78, HHANES 1982-84, CSFII 1985-86, NFCS 1987-88, NHANES III 1988-91, CSFII 1989-91, and Strong Heart Dietary Survey 1989-91. The sponsoring agency was ARS (USDA) for the 1977-81 and HNIS (USDA) for 1981-91.
[7]On Dec. 1, 1994, the U.S. Food Supply Series work conducted by ARS was transferred to the Center for Nutrition Policy and Promotion (CNPP).

SOURCE: IBNMRR (1992) and LSRO, 1994.

- The data provided an opportunity to establish a baseline for future comparisons.

- The data were from studies that used generally accepted methodologies and statistical treatments and that had acceptable response rates.

When two or more NNMRRP components provided similar or complementary data, information from one survey or surveillance system is used in graphic or tabular presentations, and other data are mentioned in the text. Additional criteria for selection of specific types of data are discussed, as appropriate, in chapters 3 through 8.

Organization of the report

The TRONM presents information on each survey, surveillance system, and area of emphasis of the NNMRRP; an assessment of food components that emphasizes public health issues in national nutrition monitoring; and recommendations for improvements in the NNMRRP. Chapter 2 presents an overview of the general issues that should be considered when dietary, nutritional, and nutrition-related health-status data are being assessed. These issues include what statistical criteria should be used and how data should be reported and interpreted, applied to subpopulations, and used for trend analysis. Chapters 3 through 8 provide updates on each component or area of emphasis of the NNMRRP:

- Population-Based Estimates of the Food Supply and Food and Nutrient Availability (ch. 3),

- Household-Based Estimates of Food Consumption and Expenditures (ch. 4),

- Food Composition and Survey Nutrient Data Bases (ch. 5),

- Food Consumption and Nutrient Intake (ch. 6),

- Nutritional Status and Nutrition-Related Health Measurements (ch. 7), and

- Knowledge, Attitudes, and Behavior Assessments (ch. 8).

Household-based estimates of food expenditures are part of the food-consumption and nutrient-intake component of the NNMRRP. Because the Expert Consultants and LSRO concluded that household-based estimates of food expenditures represented a dimension of food consumption separate from and complementary to individual-based estimates of food consumption and nutrient intake, this topic is included as a separate chapter in the TRONM (ch. 4).

Chapter 9 provides an assessment of food components that are public health issues in national nutrition monitoring. This assessment was made using the classification system developed by the EPONM for the second report (LSRO, 1989).

Recommendations about ways to strengthen the NNMRRP and to overcome some limitations of the present system are summarized in chapter 10. The Expert Consultants and LSRO based these recommendations on their analyses and interpretation of NNMRRP data for the TRONM.

The appendices include a glossary and a list of acronyms and abbreviations, with definitions (app. I); the 1989 Recommended Dietary Allowance values (app. II); the statistical and reporting guidelines used for the TRONM (app. III); response rates for NNMRRP surveys and surveillance systems (app. IV); and supporting data, notes, and acknowledgments (app. V).

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Chapter 2

General Considerations in the Assessment of Dietary, Nutritional, and Nutrition-Related Health-Status Data

Introduction

Comparability in the analysis and reporting of results among diverse types of surveys, surveillance systems, and other activities is essential for data integration in the National Nutrition Monitoring and Related Research Program (NNMRRP). The need for improved comparability among surveys was recognized by the Expert Panel on Nutrition Monitoring (EPONM) in *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring* (LSRO, 1989). Since that report was published, specific efforts of the Interagency Board for Nutrition Monitoring and Related Research (IBNMRR) to improve comparability in the NNMRRP have focused on using the same food codes and nutrient composition data bases for the CSFII 1989-91 and NHANES III 1988-91, developing a common core of sociodemographic descriptors (IBNMRR Survey Comparability Working Group, 1992), and developing statistical and reporting guidelines for the TRONM (HNIS/NCHS Analytic Working Group, 1993). Most of the data presented in chapters 3 through 8 were prepared by Federal agencies for inclusion in this report. Other data were obtained from agency publications or the peer-reviewed literature.

Because the NNMRRP draws upon information from many surveys and surveillance systems, commenting on all the data and interpreting every component of the program are neither possible nor appropriate for this report. Each section that follows includes information that describes both of the cornerstone surveys that have provided data for this report, CSFII 1989-91 and NHANES III 1988-91. In addition, selected information about other surveys and surveillance systems is included to highlight some similarities and differences in procedures that must be taken into account in comparisons of data from different sources.

Statistical criteria and other considerations in data reporting and interpretation

Statistical criteria

In most instances, the reporting and interpretation of data for the TRONM followed the recommendations of the IBNMRR Survey Comparability Working Group (for population-descriptor variables) and of the Human Nutrition Information Service/National Center for Health Statistics (HNIS/NCHS) Analytic Working Group (1993) (for nutrition-related health variables). (See app. III.) In interpreting data for this report, the Expert Consultants and LSRO relied upon the specific recommendations and suggested practices for data reporting and the suggested criteria for evaluating the reliability of estimates developed by the HNIS/NCHS Analytic Working Group (1993). The working group considered those guidelines, which assumed a design-based approach, representative of conditions that would yield the soundest statistical conclusions. The minimum-sample-size requirements recommended by the working group for estimating specified proportions of a distribution given specified design effects are shown in table 2-1.

Design effects are calculated by dividing the actual variance from a complex sample by the expected variance of the same estimate if the sample had been drawn from a simple random sample. When there is

Table 2-1. Minimum sample sizes recommended for estimating a statistic reliably in specified proportions of a distribution given specified design effects

	Design effect													
Proportion (p)	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.5	3.0	3.5
0.99	800	880	960	1040	1120	1200	1280	1360	1440	1520	1600	2000	2400	2800
0.95	160	176	192	208	224	240	256	272	288	304	320	400	480	560
0.90	80	88	96	104	112	120	128	136	144	152	160	200	240	280
0.85	53	59	64	69	75	80	85	91	96	101	107	133	160	187
0.80	40	44	48	52	56	60	64	68	72	76	80	100	120	140
0.75	32	35	38	42	45	48	51	54	58	61	64	80	96	112
—	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.55	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.50	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.45	30	33	36	39	42	45	48	51	54	57	60	75	90	105
—	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.25	32	35	38	42	45	48	51	54	58	61	64	80	96	112
0.20	40	44	48	52	56	60	64	68	72	76	80	100	120	140
0.15	53	59	64	69	75	80	85	91	96	101	107	133	160	187
0.10	80	88	96	104	112	120	128	136	144	152	160	200	240	280
0.05	160	176	192	208	224	240	256	272	288	304	320	400	480	560
0.01	800	880	960	1040	1120	1200	1280	1360	1440	1520	1600	2000	2400	2800

NOTE: For a simple random sample (SRS), sample size is determined based on the general rule for normal approximation: for mid-range proportions ($0.25 < p < 0.75$), the minimum sample size is 30. For extreme proportions ($p \leq 0.25$ or $p \geq 0.75$), the SRS sample size (n) satisfies the rule: $np \geq 8$ and $n(1-p) \geq 8$. For a complex sample, minimum-sample-size requirements are adjusted for the relative inefficiency in the sample design by a factor equal to the design effect, where design effect equals complex-sample variance divided by SRS variance.

SOURCE: HNIS/NCHS Analytic Working Group (1993).

no design effect, that ratio is equal to 1.0. Estimated means or proportions in the graphs and tables in chapters 3 through 8 are marked with an asterisk if they are potentially unreliable. Estimates may be unreliable because 1) the sample size on which they are based is fewer than a fixed number of individuals (e.g., reporting of mean values with statistical confidence requires a sample size of 30 assuming a design effect of 1.0, or 30 times the design effect for design effects greater than 1.0) or 2) the coefficient of variation (CV) is greater than a designated value (commonly 25% or 30%) set by the agency that supplied the data. The CV is calculated as (standard error (SE) of the estimate divided by the estimate) × 100, or as (SE of the proportion divided by the proportion) × 100. In appendix VA, potentially unreliable estimated means or proportions are marked with an asterisk, dagger, or footnote.

The TRONM also follows the philosophy expressed by the EPONM in the second report, *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring*, that a descriptive report best serves the needs of the intended audience (LSRO, 1989). In general, formal statistical procedures were not applied to the data, and statements of difference should not be interpreted as statistically significant or biologically meaningful without further analyses. For population characteristics, or descriptors, categorized into several levels (e.g., age categorized into age decades), the observation of a consistent pattern across levels for data for a given variable suggests an association between the characteristic and that variable. For example, an increase in mean serum total cholesterol with each successive decade of age suggests that age may be associated with serum total cholesterol level. If other scientific studies also suggest the existence of a difference associated with a variable, then the finding of a large difference in surveys evaluated for this report is probably meaningful. However, if the existence of a large difference is not consistent with other published scientific reports, the finding must be replicated in order for its importance to be evaluated.

Formal statistical methods, such as multiple-comparison techniques, could be applied to adjust for the number of comparisons that are implicitly included when only one difference is singled out for comparison. These types of procedures often mask real differences because the procedures emphasize type I errors (falsely concluding that a difference exists) at the expense of type II errors (falsely concluding that a difference does not exist). The Expert Consultants and LSRO shared the philosophy of the EPONM when they were interpreting nutrition monitoring data for the TRONM, that is, they were more concerned about failing to find real differences than about finding differences that may not exist. The informal evaluative procedures described above are consistent with this philosophy.

Coverage and noncoverage of certain population groups

The surveys and surveillance systems that provided data for the NNMRRP were originally designed for specific purposes that help fulfill the role of the administering agency in policy and program planning and evaluation and in assessment of public health status. For this reason, no single survey or surveillance system completely characterizes the dietary and nutritional status of the heterogeneous U.S. population for nutrition monitoring purposes. However, each of the contributing surveys and surveillance systems provides data that augment and substantiate information provided by other components of the program.

National surveys and surveillance systems

The national surveys and surveillance systems participating in the NNMRRP, such as NHANES III 1988-94, CSFII 1989-91, and BRFSS, target the noninstitutionalized population of various age ranges who reside in households in the entire United States or in the 48 conterminous States. Participation in these surveys and surveillance systems requires a fixed address for mailings or personal interviews or, for those surveys conducted by telephone interview, a telephone. Because of these requirements, such large national surveys do not consistently cover populations of people with no fixed addresses (migrants and homeless people), military personnel (those living on base in the United States and overseas), people living in institutions (long-term-care facilities and prisons), and American Indians living on reservations. Although samples for national surveys and surveillance systems include ethnic subgroups such as Asian Americans and Pacific Islanders, the numbers of participants in these subgroups are typically not sufficient to allow analysis by subgroup. Sizes of some of these subgroups in the total population are shown in table 2-2.

Table 2-2. Estimates of population groups in the United States in 1990

Population group	Number
Total population	248,710,000
Civilian	247,759,000
White	208,704,000
Black	30,483,000
American Indian and Alaska Native	2,065,000
Asian and Pacific Islander	7,458,000
Group-quarters population, total[1,2]	6,698,000
Institutionalized people, total[2]	3,334,000
Correctional institutions	1,115,000
Juvenile institutions	104,000
Nursing homes	1,772,000
College dormitories	1,954,000
Military quarters	590,000
Emergency shelters for homeless people	190,000
People visible in street locations	50,000

[1]These populations are not included in samples for nationally representative surveys.
[2]These numbers include people in other types of group quarters and other institutionalized people not shown separately.

SOURCE: U.S. Bureau of the Census (1994).

Surveys and surveillance systems for population subgroups

Without oversampling (i.e., without sampling disproportionately), some groups may be included in national surveys in numbers that are inadequate for subgroup analysis. Surveillance systems such as the Pregnancy Nutrition Surveillance System (PNSS) and the Pediatric Nutrition Surveillance System (PedNSS) target specific populations, such as low-income, high-risk pregnant women, infants, and children participating in publicly funded health, nutrition, and food-assistance programs such as the Special Supplemental Nutrition Program for Women, Infants and Children (WIC). Such targeted systems include only pregnant women, infants, and children who meet eligibility requirements for program participation. Although the data should reflect what is occurring in the population participating in these programs, results may not be generalizable to the entire population. Changes in the characteristics of these populations and in the number of States participating may occur over time, making analyses of trends and patterns even more difficult.

Population changes

The U.S. population is changing, and when survey results are being interpreted and future surveys are being planned, attention should be given to the characteristics of the population, particularly to changes in dietary and nutritional status over time. Characteristics of the population that are key to the interpretation of nutrition monitoring data include 1) the size of the total population, 2) the distribution of households of various sizes, 3) the age structure (or age-sex composition) of the population, 4) the racial and ethnic composition of the population, 5) the percentages of women in the labor force, 6) the distribution of income, and 7) other demographic shifts (e.g., migration to various regions of the country and shifts between metropolitan and nonmetropolitan areas).

The U.S. population continues to grow at a rate of about 1% per year. The total population was 248.7 million in 1990. By 2020, the total population is expected to be nearly 326 million, or an increase in people using the food supply in the United States of approximately 75 million (U.S. Bureau of the Census, 1994). In particular, the population is growing older, living longer, residing in smaller households, and migrating principally to the South and West. Expected changes in several characteristics important for nutrition monitoring efforts are detailed in the following paragraphs.

Household size

Household size and characteristics have changed significantly since 1960 (U.S. Bureau of the Census, 1994). In 1960, mean household size was 3.33 people; in 1990, it was 2.63 people. The largest decrease was observed between 1970, when mean household size was 3.14, and 1980, when it was 2.76 people. In 1980, family households made up 74% of all households; in 1990, they made up 71%. A drop in married-couple family households was observed between 1980, when 61% of family households were married-couple families, and 1990, when 57% were in this category. Single-parent families increased from 13% of households in 1980 to 15% in 1990, with most single-parent households headed by females. Nonfamily households increased from 26% of households in 1980 to 29% in 1990. Single-person households made up 23% of all households in 1980 and 25% in 1990. The number of unmarried couples living in the same household increased by 80% from 1980 to 1990 (U.S. Bureau of the Census, 1994). Over half of all households in 1990 consisted of only one or two people. Effects of household size on food consumption patterns are discussed in chapter 4.

Age distribution

The median age of the population increased from 28.0 years in 1970 to 32.8 years in 1990. This trend is expected to continue through at least the first half of the next century, with a median age of 35.5 years expected in 2000 (U.S. Bureau of the Census, 1994). Of particular interest for nutrition monitoring is that the percentage of the population 65 years of age and older grew at an average annual rate between 1980 and 1990 of 2.2%. This rate was more than double the rate of increase for the total population. In 1980, 11.2% of the population (about 25 million people) was 65 years of age and older; in 1990, 12.5% (about 31 million) was in this age category. Between 1980 and 1990, there was a disproportionate increase in people 85 years of age and older. The average annual growth rate of this group was 3.5%. In 1980, 0.9% of the population was 85 years of age or older; in 1990, 1.2% was in this age category (HHS, 1993). According to projections from the U.S. Bureau of the Census (1994), about 2.1% of the U.S. population will be 85 years of age or older in 2020. This increase means that more and more Americans will be concerned about nutrition and the health implications of food and about eating foods that meet their special needs, such as low-sodium, low-fat, or cholesterol-free foods.

The trend toward an increasing number of older people is expected to continue into the next century. Between 1990 and 2020, population groups 18-24, 25-34, and 35-44 years of age are expected to show small increases (1-3%) while population groups 45-54, 55-64, and 65 years of age and older are expected to increase by 50-100%. In 1990, there were about 31 million people 65 years of age and older in the United States; in 2020, there will be about 53 million (U.S. Bureau of the Census, 1994). As noted in chapter 6, this population shift has important implications for nutrition monitoring.

Racial and ethnic composition

Changes in proportions of racial/ethnic subgroups are expected between 1990 and 2020 (U.S. Bureau of the Census, 1994). The fastest-growing ethnic groups are Hispanic and Asian. In 1990, about 76% of the population was non-Hispanic white, about 12% was non-Hispanic black, about 9% was of Hispanic origin, and about 3% was of Asian origin. In 2020, these proportions are expected to be about 64% for non-Hispanic whites, 13% for non-Hispanic blacks, 16% for Hispanics, and 7% for Asians. Implications of these changes for nutrition monitoring are noted in chapter 6.

Women in the labor force

The percentage of women in the labor force has continued to increase between 1980 and 1990. In 1980, about 52% of women 16 years of age and older were in the labor force; in 1990, this figure had risen to 58%. This trend suggests that there will continue to be little time for food preparation by much of the population and that the use of convenience and preprepared foods will increase. Convenience, not surprisingly, is now one of the most important attributes of food products. According to Senauer et al. (1991), half of all women do not like to cook every day, and three-quarters want to finish cooking as quickly as possible.

Household income

Median annual household income in 1990 in the United States was $29,943 in 1990 dollars. Median incomes differed by race and Hispanic origin, with median incomes of $31,231 for white households, $18,676 for black households, and $22,330 for Hispanic households. In 1990, nearly 14% of the total population had incomes below the poverty level. About 11% of the white population, 32% of the black population, and 28% of the Hispanic population had incomes below the poverty level. The distribution of income has been changing over time. Greater numbers of households now fall into either the "low-income" category or the "high-income" category, resulting in what the popular media calls the "shrinking middle class."

Other demographic characteristics

In 1990, approximately 79% of the U.S. population lived in metropolitan areas while 21% lived in nonmetropolitan areas. In that year, about 20% lived in the Northeast, 24% in the Midwest, 34% in the South, and 21% in the West. Projections for 2010 suggest that the percentages of the population living in the Northeast and Midwest will fall to about 18% and 22%, respectively, while percentages living in the South and West will increase to about 36% and 24%. Typically, when people change locations, they shed some old food habits and acquire some of the tastes indigenous to their new region.

Different age groups among surveys

Age ranges of individuals included in the most recent cycles of CSFII 1989-91 and NHANES III 1988-91 are broader than those included in earlier cycles of these surveys. People of all ages were included in CSFII 1989-91, and individuals 2 months of age and older were included in NHANES III 1988-91. Previously, NHANES II 1976-80 and HHANES 1982-84 included people 6 months-74 years of age. CSFII 1985-86 included women 19-50 years of age and their children 1-5 years of age, and men 19-50 years of age. Inclusion of nearly identical age ranges for NHANES III 1988-91 and CSFII 1989-91, and use of uniform age groupings (IBNMRR Survey Comparability Working Group, 1992) for the data analysis have broadened the potential for comparisons between these two surveys.

The age ranges in the NNMRRP surveys and surveillance systems other than CSFII 1989-91 and NHANES III 1988-91 are more restricted because of their primary purposes. For example, the National Survey of Family Growth (NSFG) included only women of reproductive age (15-44 years of age); the BRFSS and the Weight Loss Practices Survey (WLPS) included people 18 years of age and older; and the Youth Risk Behavior Survey (YRBS) included only high school students. Although the age ranges targeted by particular surveys may differ, the application of the recommended uniform age groupings for data analyses allows for certain comparisons of data among NNMRRP surveys.

Response and adjustments for nonresponse

Low rates of response in surveys raise concern about the validity and generalizability of the surveys' data. When survey response rates are low, the demographic characteristics that may be associated with food consumption in the sample population may be compared with the corresponding demographic characteristics from another nationally representative sample from a survey that had an acceptable response rate and that was conducted at or about the same time. Use of the data can then be evaluated in terms of the size of the differences in demographic characteristics between the surveys and the strength of associations between a particular demographic characteristic and food consumption. Response rates for surveys considered in this report are tabulated in appendix IV.

Nonresponse, which contributes to nonsampling errors, may occur at various levels in surveys. For example, in NHANES III 1988-91, individuals in the households included in the survey may not be interviewed or interviewed subjects may not be examined (each a type of "unit nonresponse"), and subjects who are interviewed and examined may not complete all items ("item nonresponse"). Similarly, in CSFII 1989-91, individuals in the households selected may not be interviewed for the household portion of the survey; individuals interviewed for the household portion may not be interviewed for the individual 24-hour recall; and those who complete the 24-hour recall may not participate further or may only partially complete one or both days of dietary records. In telephone interviews, complete or partial nonresponse occurs if a participant cannot be reached or ends the interview. Differences in definitions and in interpretation of questions, interviewer variability, and coding or recording errors may also contribute to nonsampling errors. Several approaches are used to deal with nonresponse. No method is perfect, and all are based on assumptions that may or may not be correct.

General approaches to adjusting survey data for nonresponse were described in the second report on nutrition monitoring (LSRO, 1989). These approaches include weighting and imputation procedures, such as predicting missing values from regression equations and from the sample mean for people with similar characteristics or from the value of another person with the same characteristics ("hot-" and "cold-deck" approaches, respectively). Specific aspects of nonresponse in some of the larger surveys that contributed data to this update report are discussed below.

NHANES III 1988-91

Overall analytic response rates for each survey were calculated by multiplying the participation rates for each survey component. In NHANES III 1988-91, 100% of households were screened, and 86% of those screened were interviewed. Eighty-nine percent of those interviewed were examined in the mobile examination center (MEC), which results in a MEC examination rate of 77% (100% × 86% × 89%); 95% of those examined completed 1-day recalls, which results in an overall analytic rate of 73%. Examination rates were higher for non-Hispanic blacks and Mexican Americans (about 80%) than for non-Hispanic whites (about 70%). Such rates were greater than 70% in all racial/ethnic groups through 59 years of age, and they decreased with each additional decade of age. The lowest examination rate was in individuals 80 years of age or older (53% across racial/ethnic groups). Procedures for adjusting for nonresponse and selected techniques for imputing missing data were reported by Ezzati and Khare (1991, 1992) and Ezzati-Rice et al. (1993, 1994). Nonresponse bias has been evaluated for NHANES III 1988-91, along with recommendations for studying potential bias in any survey analysis (Khare et al., in press; Mohadjer et al., 1994).

HHANES 1982-84

In HHANES 1982-84, 87% of Mexican Americans were interviewed and 75% were examined, 89% of Puerto Ricans were interviewed and 75% were examined, and 79% of Cuban Americans were interviewed and 61% were examined. The respondents and nonrespondents from the Mexican-American and Puerto Rican groups did not appear to differ in the variables examined by the EPONM in 1989.

CSFII 1989-91

In the CSFII 1989-91, 84% of target households were successfully screened. Of those screened, 80% completed a household interview, and 86% of the individuals in participating households provided complete 1-day intake information. Thus, the overall analytic response rate for a 1-day intake was 58% (84% × 80% × 86%). For each year of the survey, response rates were higher for the low-income sample than for the basic sample, which included all income levels.

DHKS 1989-91

To be considered for DHKS 1989-91, a CSFII 1989-91 household was required to have completed a household interview before completing a DHKS interview; of the households that completed a household interview (67%), 85% completed a DHKS interview. The overall DHKS 1989-91 household response rate, then, was 57% (67% × 85%). Sixty-seven percent provided 3 days of dietary intake. The overall analytic response rate was thus 45%. Response rates were higher for the low-income sample than for the basic sample for each year of the survey.

NFCS 1987-88

Response rates in NFCS 1987-88 were very low. For the household component that estimated food used by households during a 7-day period and the cost of that food, the final response rate was 37%. For the individual food consumption portion of the survey, in which data were collected on foods eaten by individuals in the same households during a 3-day period, 31% of targeted individuals completed the first-day dietary intake and 25% completed the dietary recalls and records for all 3 days (Guenther and Tippett, 1993). A regression weighting approach was developed and used to adjust for nonresponse (Fuller et al., 1993). Scientists differ in their opinions about whether this approach or any alternate adjustment procedures can provide unbiased estimates of dietary intake in the United States (Guenther and Tippett, 1993; LSRO, 1991). Because data were available from CSFII 1989-91, which was more recent and had a better response rate, CSFII 1989-91 data were used together with NHANES III 1988-91 and HHANES 1982-84 data to examine dietary intakes of the general population and population subgroups.

Data from the household portion of NFCS 1987-88 are used in this report to examine changes in household food consumption and expenditures between the NFCS 1977-78 and NFCS 1987-88. Procedures to adjust for nonresponse in the two surveys were described by Fuller et al. (1993) and Lutz et al. (1992, 1993). When the data on the sociodemographic and economic characteristics of households were examined, they appeared to be adjusted sufficiently to provide reasonable estimates of food consumption and expenditures at the household level.

Sample weights, variances, and design effects

Because of the stratified, multistage designs used in large national surveys designed to be representative of the U.S. population, traditional methods of statistical analysis based on the assumption of a simple random sample are not applicable. All individuals do not have the same probability of being selected in surveys with complex designs; therefore, to provide estimates of population means, medians, and other descriptive statistics that would have been obtained if the entire sample had been surveyed, the responses of each sample person must be weighted to account for the probability of being selected and for the response rate. Likewise, because of complex survey designs, estimates of variance cannot be calculated directly using methods for random sampling. Variances that account for the effects of sampling techniques, such as clustering and stratification, must be calculated. Design effects are often used to estimate some of the effects of the various sampling techniques used with complex survey designs (see table 2-1). A design effect is the ratio of the actual variance of an estimate from a complex sample to the expected variance of the same estimate from a simple random sample.

Recommendations on joint policy for variance estimation and statistical reporting standards for NHANES III 1988-91 and CSFII 1989-91 were summarized by the HNIS/NCHS Analytic Working Group (1993). Methods to use in analyzing NHANES III 1988-91 and HHANES 1982-84 data that account for the complex survey design, the use of sample weights and estimation of variance, and the determination of design effects have been described in detail (CDC, 1992; Delgado et al., 1990; Landis et al., 1982; NCHS, 1985; Rowland and Forthofer, 1993; Yetley and Johnson, 1987). Similar information is provided for users of CSFII data (USDA, in press).

The analyses of CSFII 1989-91 and NHANES III 1988-91 included in this report are based on the use of appropriate procedures for weighting and estimating variances and take into account the complex survey design for each survey. For reporting purposes, an average design effect of 2.3 across variables was assumed for CSFII 1989-91. Variable design effects were used for all NHANES and NHES analyses. Average design effects were calculated separately for each descriptive analysis for any specific dependent variable. These average design effects were generally less than 1.5. Analyses of other NNMRRP components included in this report have been conducted using the guidelines of the HNIS/NCHS Analytic Working Group, inasmuch as possible, coupled with the experience and expertise of statisticians in the agencies administering the surveys and surveillance systems.

PNSS and PedNSS take advantage of information already being collected by public health programs. Those surveillance systems' populations are thus considered convenience samples and cannot be generalized. They include only high-risk pregnant women, infants, and children who participate in these programs. The Centers for Disease Control and Prevention (CDC) analyzes the PNSS and PedNSS data.

PNSS and PedNSS information is collected on each individual who participates in certain public health programs. CDC uses an extensive editing process to eliminate any invalid data items. Because these data are from the whole population that is under surveillance, they are not weighted. Variances are not calculated for the national data set.

Data-collection methods used in selected NNMRRP surveys and surveillance systems

The data-collection methods used in each survey were evaluated for this report in terms of their applicability to nutrition monitoring. Issues to consider include whether recently developed or improved methods vs. past methods were used, whether the methods allow comparability over time, and what limitations the methods may introduce in applying the data to small geographic regions or small subgroups of the population.

The methodology used for NFCS has traditionally included the collection of data on household food use for the 7-day period before the interview and on individual food consumption data on the day before the interview (by 24-hour recall) and on the day of the interview and the following day (by food records). Methods have generally been selected to provide for comparability over time. In CSFII 1989-91, 3 consecutive days of individual food consumption data were also collected by a single 24-hour recall and 2 days of food records. In DHKS 1989-91, main meal planners and preparers in households that participated in CSFII 1989-91 provided information by telephone interview about their knowledge and attitudes about dietary guidance and food-safety and food-choice decisions, which could then be coupled with information on their nutrient intakes collected in CSFII 1989-91. No household-level food-use data were included in CSFII 1989-91.

Trained interviewers conducted dietary interviews for NFCS 1987-88 and CSFII 1989-91 in the home. The interviewers, who were knowledgeable about food and food preparation, were trained to use a food-information guide to probe for detailed information about the foods eaten. The in-home setting allowed the interviewer to gather package-weight and ingredient information from food labels and descriptions of home-prepared mixtures from the food preparers. Procedures for handling unusual foods and interviewing situations were provided in the field manual that all interviewers received during their training. The population samples for these surveys were designed to provide national coverage year-round.

Data-collection methodologies for NHANES III 1988-91 included household interviews, 24-hour dietary recalls, physical examinations, body-composition measures, and biochemical and hematological assays selected for both descriptive and analytic capabilities. NCHS solicited and received recommendations about methodology for use in NHANES III 1988-91 from several sources, including independent expert working groups, participants in an HHS dietary-methodology workshop (NCHS, 1992), Klasing and Pilch (1985), and other groups within and outside government. The solicitation process was summarized in the *Plan and Operation of the Third National Health and Nutrition Examination Survey, 1988-94* (NCHS, 1994) and by Woteki et al. (1988).

Extensive training of interviewers and examiners, pretesting and refinement of interview and examination procedures, use of computer-assisted personal-interviewing procedures and automated data-collection procedures, and use of a standard environment and operation allowed for collection of data under identical conditions for all locations in NHANES III 1988-91. The relevant protocols were described in detail by Briefel (1994), Briefel and Johnson (1990), Gunter and McQuillan (1990), NCHS (1994), and Westat, Inc. (1991, 1992).

For PNSS and PedNSS, CDC and the participating States have collaborated on developing a list of standard data items and questions. States have adapted their existing computer and data-collection mechanisms to ensure that all of the information required by each surveillance system is collected. Local clinic staff collect the data as part of the routine health care of participating individuals. CDC provides materials and training to State and local clinic staff on standardized anthropometric techniques, proper laboratory techniques for hematology, and the basics of how to ask for behavioral information. This training occurs over 2-to 3-year cycles, approximately, within the participating States.

Limitations of the data

Most epidemiological data included in the NNMRRP are cross-sectional, and different people are most likely to be selected as participants in each cycle of a survey. Cross-sectional data may provide accurate information about the characteristics and status of the target population at single points in time; however, extreme caution must be exercised when cross-sectional data collected on different samples of the population at different times are used to assess changes over time. Limitations to the use of cross-sectional data for time-trend analysis are discussed below.

Survey and surveillance data often provide better estimates of means, proportions, and percentiles at the central portion of the distribution than at the extremes. Less variance is associated with measures made at the center of the distribution, and smaller cell sizes are needed for reliable estimates, unless there is a large measurement, or nonsampling, error. Estimates of the upper and lower percentiles are less reliable because the variability inherent in these values and the effect of bias are greater at the extremes of the distribution, even for the population as a whole.

Differences in methodologies among and within surveys limit the comparability of data. Many surveys in the NNMRRP use complex survey designs, which—although appropriate for the primary purposes of the survey—result in differences in sampling strategies that can limit comparisons of data among surveys. The use of different questions, interview methodologies, and analytical laboratory methods for different surveys or between different cycles of the same survey precludes some direct comparisons of data. In addition, the use of different cutoff values among and within surveys may result in the evaluation of different aspects of nutritional or health status, and the results may not be comparable. Discussions of data presented in chapters 3 through 8 include cautions about comparisons because of such differences.

The target populations of particular surveys may restrict comparisons of data among surveys. For example, because of the high-risk populations targeted in PNSS and PedNSS, data from these two surveillance systems cannot be used to characterize the status of all pregnant women, infants, and children. Nonetheless, the data are valuable for identifying some nutrition-related parameters of concern, such as risk of anemia in high-risk populations participating in government-sponsored programs.

Analytical data that provide the basis for prevalence estimates may differ among surveys, and some comparisons among surveys may not be possible. For example, prevalence values for iron-deficiency anemia based only on hemoglobin and hematocrit data collected in PNSS and PedNSS differ from prevalence values for iron-deficiency anemia based on multiple measures of iron status in NHANES. Thus, differences in estimates of prevalence of anemia between NHANES on the one hand and PNSS and PedNSS on the other may be the result of differences in definition of anemia or methodological differences as well as, or instead of, population differences.

Appropriate uses of the data

Data collected from nationally representative samples can be used to describe the total population and some large subgroups of the population but not all age or racial/ethnic subgroups. With appropriate oversampling of subgroups (e.g., low-income individuals or elderly people in racial/ethnic subgroups), the data can also be used to describe the status of particular age, income, or racial/ethnic subgroups.

The quality of survey and surveillance data may vary, depending on what is being measured. Because of the cross-sectional nature of most components of the NNMRRP, the data may be used to provide assessments of dietary status, nutritional status, and nutrition-related health status of *populations* and of the roles of factors associated with these conditions at the points in time when the data were collected. The dietary, nutritional, and nutrition-related health status of *individuals* cannot be determined from data collected for nutrition monitoring purposes, however. Issues to consider when these data are being used to evaluate changes over time are discussed in the following section.

The interpretation of epidemiological data about relationships between diet and health status must be made with caution because neither nutritional status nor health status can be observed directly. Inferences about both must be made from indicators that are associated with a large degree of uncertainty (Ware et al., 1981). However, when supported by clinical, pathological, and experimental evidence, results from epidemiological studies can provide a basis for making judgments of causality. The U.S. Surgeon General's Advisory Committee on Smoking and Health (HEW, 1964) summarized the role of statistics in epidemiological studies, including its criteria for establishing causality, as follows:

> "Statistical methods cannot establish proof of a causal relationship in an association. The causal significance of an association is a matter of judgment which goes beyond any statement of statistical probability. To judge or evaluate the causal significance of the association between the attribute or agent and the disease, or effect upon health, a number of criteria must be utilized, no one of which is an all-sufficient basis for judgment. These criteria include:
> a) the consistency of the association
> b) the strength of the association
> c) the specificity of the association
> d) the temporal relationship of the association
> e) the coherence of the association."

In recognition of these criteria, the data analyses included in chapters 3 through 8 are intended to describe dietary status, nutritional status, nutrition-related health conditions, and statistical associations rather than to establish causal relationships. It should also be noted that although the data are used by Federal agencies and other groups for program evaluation, the TRONM is not intended to serve the purpose of program evaluation.

Applicability of the data for trend analysis

As indicated above, determining whether comparisons can be made among cross-sectional data collected at different times must be done carefully. To establish that there are differences in dietary intakes over time, certain conditions must be met (Guenther et al., 1994). The survey designs and sampling strategies must yield estimates for the same or nearly the same target population. The dietary data-collection methodologies should be the same or very similar. The values in the survey nutrient data bases should be appropriate for foods at the time they were eaten, and older food consumption data bases should be revised so that any artifactual differences are removed.

When nutritional status or nutrition-related health status is being analyzed, the conditions that should remain consistent include the survey design and sample selection, the methodology (including interview procedures), the analytical methodology for biochemical analyses, the procedures used for anthropometric measurements, and the assumptions that underlie the analytical procedures. If changes are made in the survey design, the data-collection methodology, laboratory analyses, or statistical analyses, comparison studies are needed to determine whether data are directly comparable and, if not, whether adjustment is possible (Johnson and Woteki, 1990). All comparisons should be evaluated to determine whether observed changes (or lack of changes) are real or artifactual.

Data for surveillance systems are collected continuously over time to monitor trends in the targeted populations. Although characteristics of the targeted populations may vary over time, the data collected are generally regarded as reflecting trends in the targeted populations over time. Changes in methodologies and in the quality of data may also affect apparent trends in the targeted populations.

Few comparisons over time were made in the TRONM. When comparisons were made over time, consistency in survey designs, sample selection, and data-collection methodologies were examined carefully.

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Chapter 3

Population-Based Estimates of the Food Supply and Food and Nutrient Availability

Introduction

Food-supply estimates are an important component of the NNMRRP because they provide unique and essential information on the amount of food and nutrients available for human consumption. Food-supply data are also invaluable for monitoring the potential of the food supply to meet the nutritional needs of the U.S. population and for examining relationships between food and nutrient availability and nutrient-disease associations. Economists find these data particularly useful when estimating how responsive consumer demand is to changes in price and income (Putnam and Allshouse, 1993). Figure 3-1 highlights the relationships of the various components of the food supply to the other components of the conceptual model.

This chapter updates data from the second report on nutrition monitoring (LSRO, 1989) on the annual average total available supply and per capita consumption of food commodities in the United States for the 20-year period 1972 through 1992. Also updated in this chapter are data from the second report on the amounts of nutrients in foods available for consumption between 1970 and 1990 and the percentage contributions of major food groups to nutrient availability in 1990.

Background

The U.S. food-supply-series data provide measures of national aggregate consumption of several hundred foods. It is the only source of time-series data in the United States that provides historical data on food and nutrient availability dating back to the turn of the century. The types of data that can be derived from the U.S. food-supply series include 1) the total available supply of food commodities per year, 2) per capita consumption of food commodities per year, 3) per capita per day nutrient availability, and 4) estimates of percentage contributions made by major food groups to nutrient availability. These four types of data and the sources of these data are summarized in table 3-1. Because food-supply data extend back to 1909, they are often used to examine trends in the total available food supply and in the amount of food and nutrients available for consumption in this country.

Most data are collected near the farm and at primary processing levels. USDA's Economic Research Service (ERS) converts food available for consumption from primary weight to retail-weight equivalents using conversion factors that account for subsequent processing, trimming, shrinkage, or loss in the distribution system. Retail-weight equivalents measure food availability as if all food were sold through retail food stores. Much of this food is also sold through wholesale channels to restaurants, hotels, and other away-from-home food establishments and to schools, camps, hospitals, and other institutions. Food categories are defined as basic food commodities—for example, beef, wheat flour, and corn sweeteners. Few data are available for many further-processed products, such as bread and other bakery products, soups, and prepared foods in general. Because foods are measured before they are combined into their final form, only a small number of foods (approximately 400) need to be measured to account for all the different forms of food marketed in the United States (Gerrior and Zizza, 1994).

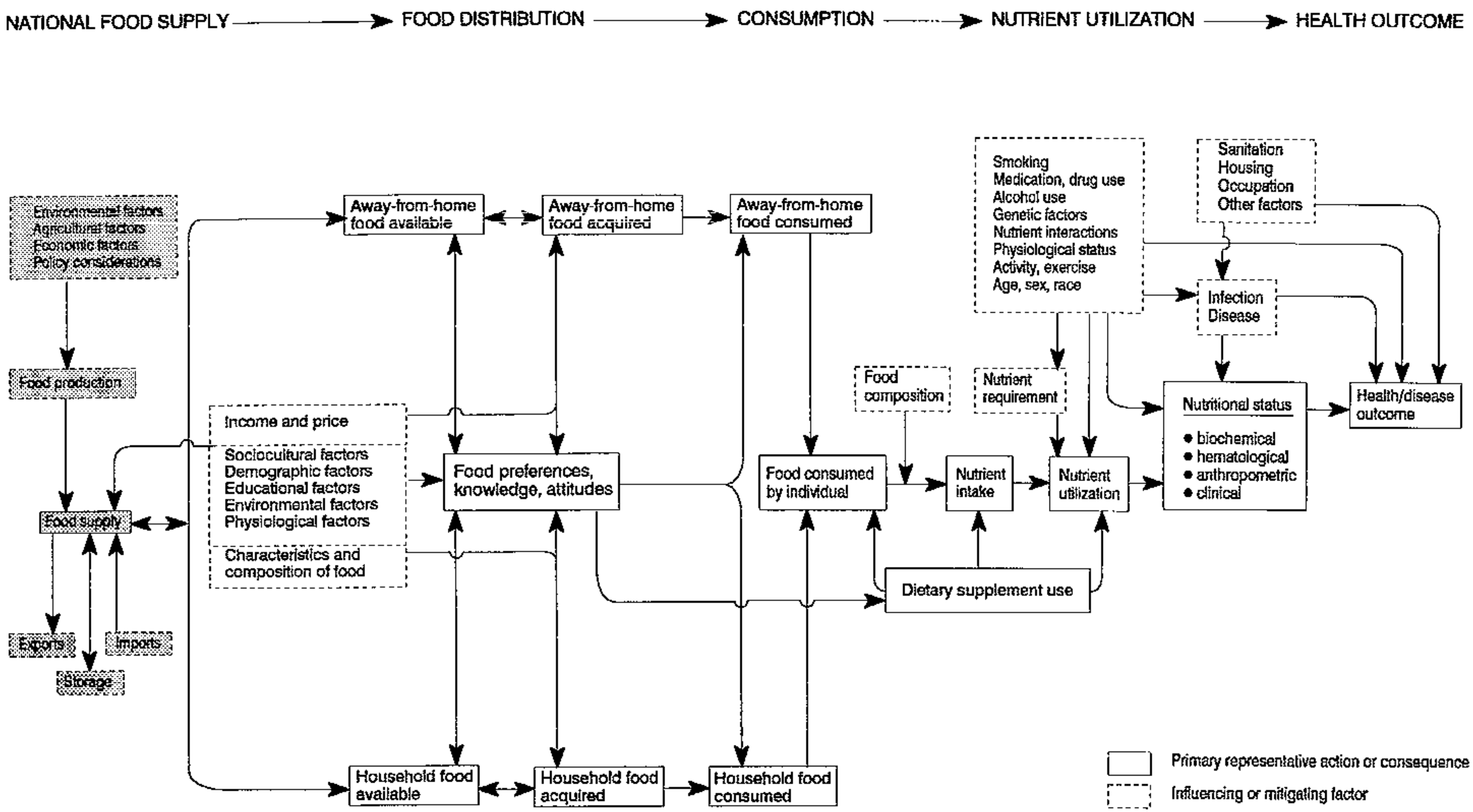

Figure 3-1. General conceptual model highlighting components of food supply (see text for explanation)

SOURCE: LSRO (1989).

Table 3-1. Types and sources of data on the food supply, disappearance, and nutrient availability used in chapter 3 of the *Third Report on Nutrition Monitoring*[1]

Type of data	Source of data
Annual total available supply of food commodities in the U.S. food supply	U.S. Food Supply, 1970-92 (USDA, ERS)
Annual per capita consumption (disappearance of food commodities in the U.S. food supply)	U.S. Food Supply, 1970-92 (USDA, ERS)
Daily per capita availability of nutrients in the U.S. food supply	Nutrient Content of the U.S. Food Supply, 1909-90 (USDA, ARS)[2]
Food sources of nutrients in the U.S. food supply	Nutrient Content of the U.S. Food Supply, 1909-90 (USDA, ARS)[2]

[1]USDA, U.S. Department of Agriculture; ERS, Economic Research Service; ARS, Agricultural Research Service.
[2]On Dec. 1, 1994, the U.S. Food Supply Series work conducted by ARS was transferred to the Center for Nutrition Policy and Promotion (USDA, CNPP).

SOURCE: LSRO, 1994.

Types and sources of data

The U.S. food-supply series is derived from records of commodity flows from production to end uses (Putnam and Allshouse, 1993). Supply and utilization balance sheets are developed for each major commodity from which human foods are produced. The total available supply of a food commodity is calculated as the sum of production, imports, and beginning-of-the-year inventories. For most food commodities, exports, industrial uses, farm inputs (seed and feed), and end-of-the-year inventories represent measurable nonfood uses (i.e., "utilization"). The amount of food that remains after subtracting these nonfood uses from the total available supply represents food that "disappears" into the marketing system and is thus available for human consumption. This residual component is often referred to as "food disappearance." Food disappearance data serve as a basis for estimating annual per capita consumption, which is done by dividing total food disappearance by the total U.S. population on July 1. Per capita per day nutrient availability is subsequently calculated from per capita consumption data. These key relationships are summarized below:

Total available food supply = production + imports + beginning-of-the-year inventories

Disappearance = total available food supply − utilization

Consumption is a function of disappearance, or
Consumption = f_1 (disappearance)

Per capita consumption = consumption/U.S. population

Per capita nutrient availability is a function of per capita consumption, or
Per capita nutrient availability = f_2 (per capita consumption)

For further information on the methodology used for calculating food-supply estimates, refer to the reports *Nutrient Content of the U.S. Food Supply, 1909-1990* (Gerrior and Zizza, 1994) and *Food Consumption, Prices, and Expenditures, 1970-92* (Putnam and Allshouse, 1993).

Total available food supply

The three components of the total available supply of a food commodity—production, imports, and beginning-of-the-year inventories—are directly measurable or estimated by various agencies of the Federal Government and private industry (Putnam and Allshouse, 1993). Information on farm production, inventories, and some processed products, including manufactured dairy products, comes from USDA's National Agricultural Statistics Services

(NASS). Data on fats and oils and flour production are obtained from the Current Industrial Reports of the Bureau of the Census. The Bureau of the Census also provides foreign-trade data and estimates of territorial shipments. Trade-association data are used when available and appropriate. ERS updates data on the total available supply of food commodities annually. The most recent update of data available at the time this report was prepared covers the period 1970-92 (Putnam and Allshouse, 1993).

Per capita consumption

ERS also updates data on per capita consumption of food commodities annually. The most recent update of such data that was available at the time this report was prepared is for 1970-92 (Putnam and Allshouse, 1993). These data represent the amount of food available for potential consumption rather than the amount of food ingested by individuals. Using food disappearance data to derive estimates of per capita consumption usually leads to overestimates because spoilage and waste accumulated through the marketing system and food that is thrown away at home or fed to pets are included in the estimates. In general, disappearance data are useful as indicators of trends in consumption over time rather than as measurements of absolute levels of food consumed. In other words, these data provide an indication of whether Americans, on average, are using more or less of various foods over time.

For food commodities such as fats and oils, disappearance data may not be reliable indicators of changes in consumption over time (Hunter and Applewhite, 1993). A further discussion of why food disappearance data may not be appropriate for monitoring trends in the use of fats and oils is presented under "Per Capita Consumption, 1972-92," below.

Per capita nutrient availability

Estimates of the nutrient content of the food supply are available for food energy; the three energy-yielding nutrients (protein, carbohydrate, and total fat); saturated, monounsaturated, and polyunsaturated fatty acids; cholesterol; 10 vitamins; and 7 minerals.

Nutrient per capita estimates are based on food disappearance; thus, these data represent the amount of nutrients available for consumption rather than the amount of nutrients ingested by individuals. Per capita nutrient estimates are computed by USDA's Center for Nutrition Policy and Promotion (CNPP). Because of a two-year time lag between release of per capita consumption and nutrient availability data, the most recent update on nutrient availability is for the period 1970 through 1990 (Gerrior and Zizza, 1994).

Nutrient availability estimates are derived from data on the annual amount of food available for consumption from ERS and from nutrient composition data from the Agricultural Research Service's Nutrient Data Laboratory (NDL). Nutrient availability is calculated by multiplying the amount (in pounds per capita per year) of each food used (disappearance) by the amount of each of the 24 nutrients or of food energy contained in the edible portion of the food (Gerrior and Zizza, 1994). The nutrient content from all foods is then totaled for each nutrient and converted to an amount per capita per day.

Nutrients that may be lost during the processing, marketing, and cooking of food or as plate wastes are included in per capita nutrient estimates. Nutrient estimates also include nutrients from parts of foods that are edible but not always eaten, such as separable fat on meat, but they exclude nutrients from the inedible parts of foods, such as bones, rinds, and seeds. Also excluded from per capita estimates are nutrients from ingredients, such as baking powder, baking soda, and yeast, and alcoholic beverages and the sugars and grains used in their production.

Per capita nutrient estimates reflect changes in the nutrient composition of food caused by improvements in laboratory analyses, technological advances in food processing, and marketing practices (Gerrior and Zizza, 1994). Also reflected in per capita nutrient estimates are changes occurring in fortification and enrichment practices. These data are obtained from periodic surveys of industry and are used to estimate the amounts of added nutrients in the food supply. Vitamins and minerals added to foods for their functional or flavoring properties or taken as supplements are not included in the estimates.

Trends in total available food supply, per capita consumption, and per capita nutrient availability

This section reviews and updates trends for the 20-year period from 1972 through 1992 of the annual total available supply and annual per capita consumption of food commodities. Discussion is geared toward food commodities that relate to public health and dietary guidance issues that were relevant during that period. Trends in total available food supply differ from trends in per capita consumption (disappearance) because the former reflects the total amount of a food commodity that is available for consumption before nonfood uses (exports, industrial uses, farm inputs (seed and feed), and end-of-the-year inventories) are deducted. Data from 1972 through 1992 were selected for the TRONM to update information from the second report on nutrition monitoring (LSRO, 1989), to provide information for the most recent 20-year period available at the time this report was prepared, and to be consistent with the time periods of other data presented in this report. For a detailed presentation of annual total available food supply and import data for each year from 1972 to 1992 and a more detailed discussion of changes in per capita consumption during that period, see the ERS publication *Food Consumption, Prices, and Expenditures, 1970-92* (Putnam and Allshouse, 1993) and review articles by Putnam (1993, 1994).

This section also provides a brief review of trends in nutrient availability for the 20-year period from 1970 to 1990 and updates data from the second report on nutrition monitoring. The percentage contributions that major food groups made to nutrient availability in 1990 are also reviewed in this section. For a more detailed presentation on the nutrient content of the U.S. food supply, see the ARS report *Nutrient Content of the U.S. Food Supply, 1909-1990* (Gerrior and Zizza, 1994).

Total available food supply, 1972-92

This section reviews and updates trends in the total available supply of food commodities. Also included is a review of food commodities that have shown noteworthy changes in imports and "import share" between 1972 and 1992. For the purposes of this chapter, import share is defined as the quantity of a food commodity that is imported into the United States, divided by the total available supply of the food commodity in the U.S. food supply. A discussion of the role of imports in stabilizing consumption in the face of unpredictable domestic production or the relationship of imports to agricultural implications of dietary change is beyond the scope of this chapter.

In most cases, the expansion in the total available supply of food commodities reflects population growth and increased consumer demand. Between 1972 and 1992, the total available supply of chicken and turkey (ready-to-cook weight), cheese, nuts other than peanuts and coconut, and fresh noncitrus fruits (farm-weight equivalent) more than doubled (table 3-2). During this time, increases of more than 40% were apparent in the total available supply of fish and shellfish (edible-meat weight), butter, shortening, salad and cooking oils, fresh apples (farm-weight equivalent), frozen fruit (product weight), fresh potatoes (retail-weight equivalent), wheat flour, rice (rough-equivalent basis), dried edible beans (farm-weight equivalent), peanuts, tea (leaf equivalent), and cocoa (cocoa bean equivalent).

Between 1972 and 1992, imports of fish and shellfish increased steadily in the United States, from 1,350 million lb in 1972 to 2,100 million lb in 1992; however, despite these increases, import share declined from 40% to 35%. In contrast, imports of fresh noncitrus fruits excluding apples and melons jumped 117% between 1972 and 1992 and maintained an import share of 50-60%.

During the late 1970s, rice imports reached an all-time low of 0.1 million hundredweight (Cwt) (1 hundredweight = 100 lb), with an import share of less than 1%. In 1992, imports of rice peaked at 5.3 million Cwt and commanded 3% of the total available rice supply in the United States. Between 1972 and 1982, imports of oats peaked at 3.5 million bushels in 1982, when import share was less than 1%. Oat imports jumped to 50 million bushels in 1992, with import share increasing to 11%. Increases in import share of oats were associated with declines in domestic production and in the total available supply of oats in the United States and with increased consumer demand for oat products (rolled oats, oat bran, and ready-to-eat cereals) because of the public perception that these foods help to reduce serum cholesterol levels. Import share of other food commodities varies greatly from commodity to commodity. Less than 1% of the total

Table 3-2. Total available supply of selected food commodities in the U.S. food supply and percent change, 1972-92, 1972-81, and 1982-92[1]

Food commodity	Year				Percent change		
	1972	1981	1982	1992	1972-81	1982-92	1972-92
Red meat (million pounds)[2]	41,303	42,251	40,860	44,932	2.3	10.0	8.8
Beef	24,739	24,564	24,811	25,944	–0.7	4.6	4.9
Pork	15,351	16,846	15,177	18,267	9.7	20.4	19.0
Veal	503	463	476	317	–8.0	–33.4	–37.0
Lamb	710	378	397	404	–46.8	1.8	–43.1
Poultry (million pounds)[3]							
Chicken	9,036	12,657	12,766	21,736	40.1	70.3	140.5
Turkey	2,132	2,734	2,711	5,042	28.2	86.0	136.5
Fish and shellfish (million pounds)	3,340	3,990	3,955	5,952	19.5	50.5	78.2
Eggs (million dozen)	5,801	5,849	5,822	5,900	0.8	1.3	1.7
Dairy products (million pounds)[4]	125,168	146,807	155,013	168,658	17.3	8.8	34.7
Whole milk, condensed/evaporated	1,526	1,081	1,083	933	–29.2	–13.8	–38.9
Nonfat dry milk	1,315	1,904	2,292	1,089	–44.8	–52.5	–17.2
Cheese	3,090	5,215	5,786	7,191	68.8	24.3	132.7
Fats and oils (million pounds)							
Butter	1,201	1,536	1,689	1,919	27.9	13.6	59.8
Margarine	2,421	2,651	2,657	2,908	9.5	9.4	20.1
Shortening	3,859	4,422	4,499	5,866	14.6	30.4	52.0
Salad and cooking oils	4,014	5,553	5,624	6,879	38.3	22.3	71.4
Fruit (million pounds)							
Fresh fruit[5]	17,524	23,294	23,240	29,972	32.9	29.0	71.0
Citrus	7,129	7,741	7,450	8,657	8.6	16.2	21.4
Apples	3,446	4,592	4,734	6,005	33.3	26.8	74.3
Other noncitrus	6,950	10,961	11,056	15,310	57.7	38.5	120.3
Frozen fruit[6]	1,373	1,265	1,363	2,085	–7.9	53.0	51.9
Vegetables (million pounds)							
Fresh potatoes[5]	44,572	49,156	52,430	62,666	10.3	19.5	40.6
Flour and cereal products							
Wheat (million bushels)[7]	2,531	3,777	3,932	3,001	49.2	–23.7	18.6
Wheat flour (1,000 hundredweight)	250,918	285,132	292,403	373,990	13.6	27.9	49.0
Rye (million bushels)[7]	83	23	26	18	–72.3	–30.8	–78.3
Rice (million hundredweight)[8]	106	172	200	187	62.3	–6.5	76.4
Corn (million bushels)[7]	10,284	9,511	10,772	10,583	–7.5	–1.8	2.9
Oats (million bushels)[7]	1,291	688	748	472	–46.7	–36.9	–63.4
Legumes and nuts							
Dry edible beans (million pounds)[5]	2,592	4,464	4,008	3,971	72.2	–0.9	53.2
Dry edible peas (million pounds)[5]	531	602	604	608	13.4	0.7	14.5
Tree nuts (thousand pounds)[9]	575,467	998,844	1,054,103	1,336,409	73.6	26.8	132.2
Peanuts (million pounds)[10]	3,669	4,397	4,199	5,341	19.8	27.2	45.6

Table 3-2. Total available supply of selected food commodities in the U.S. food supply and percent change, 1972-92, 1972-81, and 1982-92—continued

Food commodity	Year 1972	1981	1982	1992	Percent change 1972-81	1982-92	1972-92
Cane and beet sugar (1,000 short tons)	14,446	14,380	12,439	12,779	−0.5	2.7	−11.5
Coffee (million pounds)[11]	2,878	2,250	2,354	2,991	−21.8	27.1	3.9
Tea (million pounds)[12]	151	190	170	216	25.8	27.1	43.0
Cocoa (million pounds)[13]	933	944	849	1,638	1.2	92.9	75.6

[1]Total available supply data were rounded to the nearest whole number. A hundredweight equals 100 lb. A short ton equals 2,000 lb. Data for 1992 are preliminary except for frozen fruit, fresh potatoes, and dry edible beans. Preliminary data for veal from 1991 are presented because 1992 data were not available. Eggs include shell eggs and the shell-egg equivalent of dried and frozen eggs. The "other fresh noncitrus fruits" category includes apricots, avocados, bananas, cherries, cranberries, grapes, kiwi fruits, mangoes, nectarines, papayas, peaches, pears, pineapples, plums, prunes, strawberries, and melons. The "tree nuts" category includes almonds, filberts, pecans, walnuts, Brazil nuts, pignolias, pistachios, chestnuts, cashews, macademias, and miscellaneous nuts.
[2]Carcass weight.
[3]Ready-to-cook weight.
[4]Milk equivalent, estimated on a milk-fat basis. Individual dairy products are estimated on a product-weight basis.
[5]Farm weight.
[6]Product weight.
[7]Grain equivalent.
[8]Rough equivalent, which includes milled rice converted to rough basis at annual extraction rate.
[9]Shelled basis.
[10]Farmers' stock basis.
[11]Green bean equivalent.
[12]Leaf equivalent.
[13]Cocoa bean equivalent.

SOURCE: USDA, U.S. Food Supply, 1972-92 (Putnam and Allshouse, 1993).

available supply of eggs, butter, and iceberg lettuce in this country is imported, for example, whereas more than 99% of the total available supply of coffee, tea, cocoa, and tropical oils is imported.

Per capita consumption, 1972-92

Less red meat and more poultry and fish were available for consumption in 1992 than in 1972 (table 3-3). On a boneless, trimmed basis, per capita consumption in 1992 averaged 18 lb less beef, 25 lb more poultry, and 2 lb more fish and shellfish than it was in 1972 (fig. 3-2). Red meat accounted for 60% of total meat available for consumption in 1992, down from 69% in 1982 and 73% in 1972. Chicken and turkey accounted for 32% of total meat available for consumption, up from 24% in 1982 and 20% in 1972. Fish and shellfish accounted for 8% of total meat available for consumption in 1992, up from 7% in 1982 and in 1972.

Between 1972 and 1992, per capita consumption of beef dropped 22% (boneless, trimmed equivalent). Availability of beef reached a high of 89 lb per capita in 1976, dropped in the late 1970s, remained consistent until 1987, and has declined steadily since 1987. Despite yearly fluctuations, per capita availability of pork has been relatively stable over the years. Per capita consumption of veal, lamb, and mutton dropped by about one-half since 1972. In contrast, per capita consumption of poultry jumped 69% (boneless, trimmed equivalent) between 1972 and 1992. Per capita consumption of chicken increased 62% and per capita consumption of turkey doubled. Per capita consumption of fish and shellfish increased 18% (boneless, trimmed equivalent) between 1972 and 1992. Shellfish accounted for 29% of all fish available for consumption in 1992, up from 23% in 1972. The amount of shell eggs available for consumption declined 33% between 1972 and 1992, from 268 to 180 eggs per capita, while commercially processed egg products increased 54%, from 35 to 54 eggs per capita (fig. 3-3). In

Table 3-3. Annual per capita amount of selected food commodities available for consumption (per capita consumption) in the U.S. food supply and percent change, 1972-92, 1972-81, and 1982-92[1]

Food commodity	Year				Percent change		
	1972	1981	1982	1992	1972-81	1982-92	1972-92
Red meat (pounds)[2]	131.8	125.1	119.8	114.1	−5.1	−4.8	−13.4
Beef	80.3	72.8	72.5	62.8	−9.3	−13.4	−21.8
Pork	47.8	49.9	44.9	49.5	4.4	10.2	3.6
Veal	1.6	1.3	1.4	0.8	−18.8	−42.9	−50.0
Lamb and mutton	2.2	1.0	1.1	1.0	−54.5	−9.1	−54.5
Poultry (pounds)[2]	35.4	41.9	42.0	60.1	18.4	43.1	69.8
Chicken	28.3	33.5	33.7	45.9	18.4	36.2	62.2
Turkey	7.1	8.3	8.3	14.2	16.9	71.1	100.0
Fish and shellfish (pounds)[2]	12.5	12.6	12.4	14.7	0.8	18.5	17.6
Eggs (number)	303	264	264	234	−12.9	−11.4	−22.8
Shell	268	232	230	180	−13.4	−21.7	−32.8
Processed	35	32	34	54	−8.6	58.8	54.3
Dairy products (pounds)[3]	559.6	540.6	554.6	564.6	−3.4	1.8	0.9
Whole milk (plain)	200.4	136.3	130.3	81.4	−32.0	−37.5	−59.4
Low-fat milk (plain)	39.2	72.6	73.5	99.3	85.2	35.1	153.3
Skim milk (plain)	12.4	11.3	10.6	25.0	−8.9	135.8	101.6
Fluid-cream products	5.2	5.7	5.9	8.0	9.6	35.6	53.8
Yogurt	1.3	2.5	2.7	4.3	92.3	59.2	230.8
Cheese	13.0	18.2	19.9	26.0	40.0	30.6	100.0
Ice cream	17.6	17.4	17.6	16.4	−1.1	−6.8	−6.8
Ice milk	7.6	7.0	6.6	7.1	−7.9	7.6	−6.6
Sherbet	1.5	1.3	1.3	1.3	−13.3	0.0	−13.3
Other frozen dairy products	1.3	0.9	0.9	4.4	−30.8	388.9	238.5
Fats and oils (pounds)[4]	56.6	60.5	61.3	68.6	6.9	11.9	21.2
Butter	5.0	4.2	4.3	4.2	−16.0	−2.3	−16.0
Margarine	11.1	11.1	11.0	11.0	0.0	0.0	−0.9
Edible tallow	NA	1.0	1.3	2.4	—	84.6	—
Shortening	17.6	18.5	18.6	22.4	5.1	20.4	27.3
Salad and cooking oils	16.8	21.8	21.9	25.6	29.8	16.9	52.4
Fats and oils (pounds, fat-content basis)							
Animal fats	13.3	11.7	11.4	10.4	−12.0	−8.8	−21.8
Vegetable fats	40.0	45.7	46.8	55.2	14.2	17.9	38.0
Fruits (pounds)[4]	222.5	255.3	254.2	262.9	14.7	3.4	18.2
Fresh	94.3	103.7	107.3	122.7	10.0	14.4	30.1
Citrus	27.1	23.4	23.4	24.3	−13.6	3.8	−10.3
Noncitrus	67.1	80.2	83.9	98.4	19.5	17.3	46.6
For processing	128.2	151.6	146.9	140.2	18.2	−4.6	9.4
Vegetables excluding legumes (pounds)[5]	332.2	326.1	327.9	379.1	−1.8	15.6	14.1
Fresh	151.8	142.9	149.3	164.2	−5.9	10.0	8.2
For processing	180.4	183.2	178.6	214.9	1.6	20.3	19.1
Potatoes (pounds)[6]							
Fresh	55.5	44.0	45.2	46.8	−20.7	3.5	−15.7
For freezing	14.3	20.7	19.3	25.9	44.8	34.2	81.1

Table 3-3. Annual per capita amount of selected food commodities available for consumption (per capita consumption) in the U.S. food supply and percent change, 1972-92, 1972-81, and 1982-92—continued

	Year				Percent change		
Food commodity	1972	1981	1982	1992	1972-81	1982-92	1972-92
Flour and cereal products (pounds)	132.9	145.4	147.8	187.0	9.4	26.5	40.7
Wheat flour	109.8	115.8	116.9	138.3	5.5	18.3	26.0
Rice	7.0	10.9	11.8	16.8	55.7	42.4	140.0
Corn products	9.7	13.3	13.8	21.9	37.1	58.7	125.8
Oat products	4.4	3.6	3.6	8.5	–18.2	136.1	93.2
Breakfast cereals (ready-to-eat)[7]	8.6	9.8	9.9	11.3	14.0	14.1	31.4
Legumes and nuts (pounds)							
Dry edible beans[4]	6.0	5.4	6.5	7.5	–10.0	15.4	25.0
Dry field peas and lentils[4]	0.8	0.6	0.4	0.6	–25.0	50.0	–25.0
Tree nuts (shelled basis)	2.0	1.9	2.2	2.4	–5.0	9.1	20.0
Peanuts (kernel basis)	5.7	5.5	6.0	6.5	–3.5	8.3	14.0
Candy and other confectionery products (pounds)	19.1	16.2	16.9	20.7	–15.2	22.5	8.4
Total caloric and low-calorie sweeteners (pounds, dry basis)	130.0	132.3	132.7	166.0	1.8	25.1	27.7
Caloric sweeteners	124.9	124.1	123.2	143.3	–0.6	16.3	14.7
Refined sugar	102.3	79.4	73.7	64.5	–22.4	–12.5	–37.0
Corn sweeteners	21.1	43.5	48.2	77.4	106.2	60.6	266.8
Low-calorie sweeteners	5.1	8.2	9.5	24.3	60.8	155.8	376.5
Nonalcoholic beverages (gallons)							
Coffee	33.6	26.0	25.9	27.8	–22.6	7.3	–17.3
Tea	7.3	7.2	6.9	7.0	–1.4	1.4	–4.1
Soft drinks	26.2	35.4	35.3	44.1	35.1	24.9	68.3
Bottled water	NA	2.7	3.0	8.2	—	173.3	—
Milk	31.0	27.1	26.4	25.3	12.6	4.2	–18.4
Fruit juices	5.5	7.0	6.7	6.8	27.3	1.5	23.6
Alcoholic beverages (gallons)	37.2	43.1	42.3	37.4	15.9	–11.6	0.5
Beer	31.5	36.9	36.3	32.7	17.1	–9.9	3.8
Wine	2.6	3.3	3.3	2.7	26.9	–18.2	3.8
Distilled spirits	3.1	2.9	2.8	2.0	–6.4	–28.6	–35.5

[1]Data for 1992 are preliminary for all commodities except milk, fluid cream products, yogurt, fruits, vegetables, flour and cereal products, legumes, and nonalcoholic and alcoholic beverages. Data from 1991 are presented for peanuts, total caloric and low-calorie sweeteners, and low-calorie sweeteners because 1992 data were not available. "Fluid-cream products" includes half-and-half, light and heavy cream, sour cream, and eggnog. The "other frozen dairy products" category includes mellorine, frozen yogurt beginning in 1981, and other nonstandardized frozen dairy products. Total caloric sweeteners include refined sugar, corn sweeteners (high-fructose corn syrup, glucose, and dextrose), honey, and maple, cane, molasses, sorgo, and refiner's syrup. Data for low-calorie sweeteners (saccharin and aspartame) are based on sugar-sweetness equivalent, which assumes that saccharin is 300 times sweeter than sugar and that aspartame is 200 times sweeter than sugar. "Milk" in the "nonalcoholic beverages" category includes whole, lowfat, and skim milk and buttermilk. The "fruit juices" category includes orange, grapefruit, lemon, lime, apple, grape, and prune juices. Data for "alcoholic beverages" are based on an adult population 21 years of age and older. NA, not available.
[2]Boneless, trimmed.
[3]Milk-equivalent, estimated on a milk-fat basis. Individual dairy products are estimated on a product-weight basis.
[4]Product weight.
[5]Farm weight.
[6]Retail weight.
[7]"Breakfast cereals" is not an exclusive subcategory under "Flour and cereal products" (e.g., breakfast cereals made from wheat flour are included under "Wheat flour").

SOURCE: USDA, U.S. Food Supply, 1972-92 (Putnam and Allshouse, 1993).

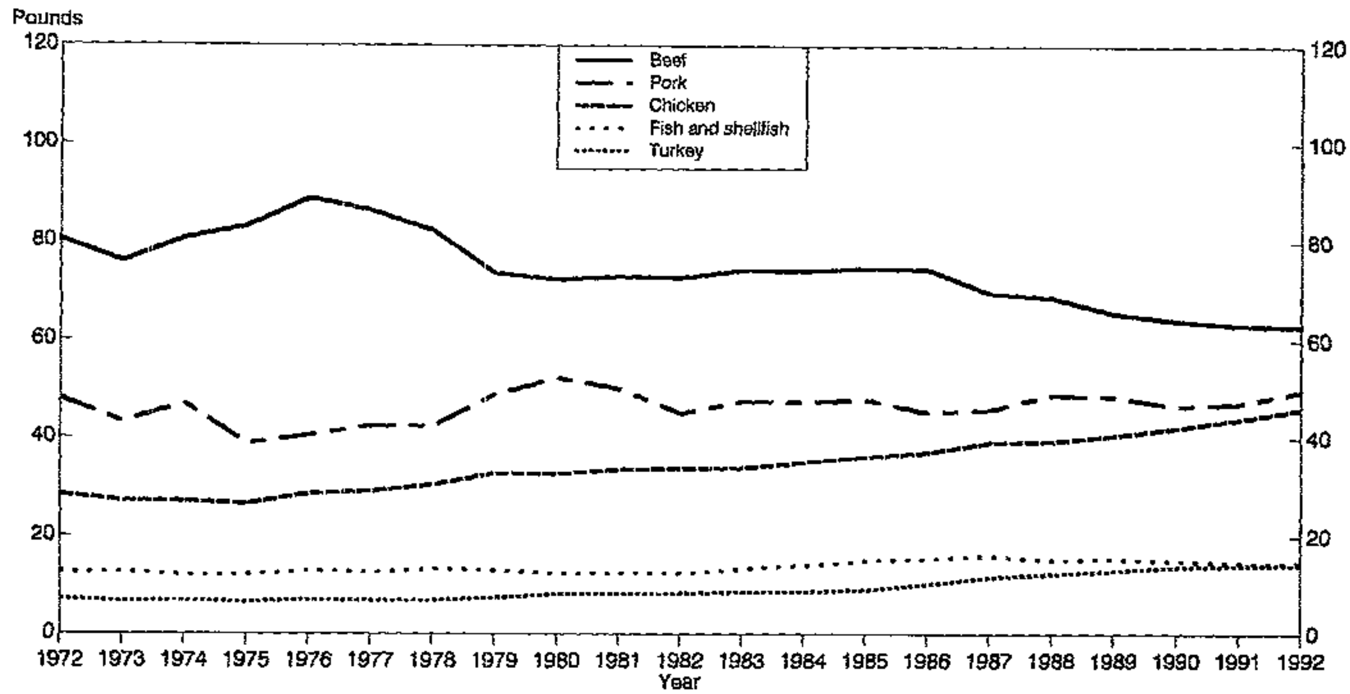

Figure 3-2. Annual per capita consumption of meat, poultry, and fish and shellfish, by year, 1972-92

NOTE: Data are based on boneless, trimmed equivalent.

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

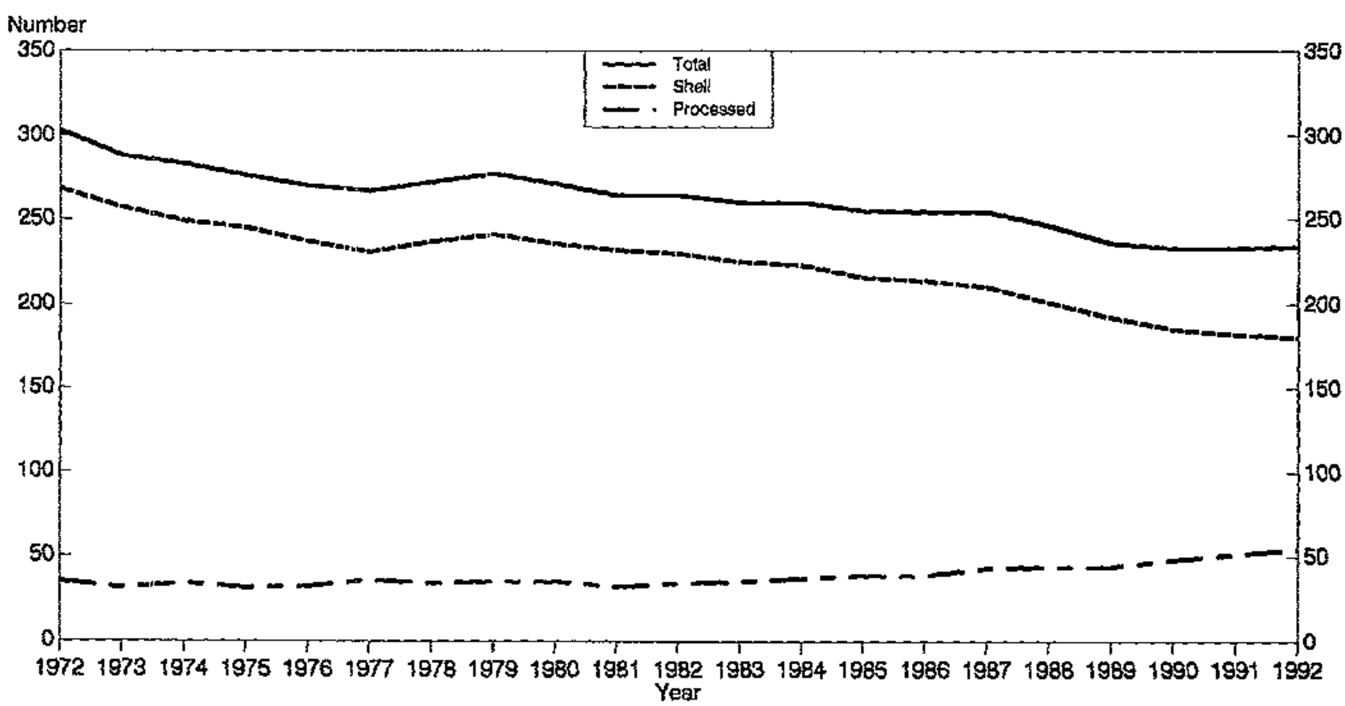

Figure 3-3. Annual per capita consumption of eggs, by year, 1972-92

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

1992, processed egg products accounted for 23% of total eggs available for consumption, up 13% from 1982 and 12% from 1972. Per capita availability of processed egg products jumped 59% between 1982 and 1992. This jump has been attributed largely to the more widespread use of processed egg products in fast-food restaurants and other food-service establishments and in food products, such as pasta and sweet baked goods (Putnam, 1993; Putnam and Allshouse, 1993).

Per capita consumption of all dairy products, including butter, was 565 lb in 1992, up 10 lb from 1982 and 5 lb from 1972, measured on a milk-equivalent, milk-fat basis. "Milk equivalent" is an estimate of the amount of raw milk needed to provide the amount of milk fat found in the product. While the annual consumption of all beverage milks (plain and flavored) declined by 49 lb per person between 1972 and 1992, use of lower-fat milk increased. During this time, per capita consumption of fluid whole milk (plain) dropped 59%, low-fat milk (plain and 1% and 2% milk fat) jumped 153%, and skim milk (plain) doubled (fig. 3-4). Yogurt consumption climbed dramatically between 1972 and 1992, up 231% from 1972 levels. Per capita consumption of frozen dairy products increased 11% between 1982 and 1992. Much of this increase can be explained by higher consumption of frozen yogurt (Putnam, 1993). In 1992, more than four times as much frozen yogurt was available for consumption than in 1982.

The apparent trend toward greater use of lower-fat milk is consistent with increased public concern about cholesterol and animal fat (Putnam, 1993). Price may also explain the shift toward lower-fat milk. Skim, 1%, and 2% milks are less expensive than whole milk. However, although per capita consumption of low-fat beverage milk is up, per capita consumption of fluid-cream products (half-and-half, light and heavy cream, sour cream, and eggnog) and cheese is up as well. About twice as much fluid-cream product and cheese (excluding cottage cheese) was available for consumption in 1992 as in 1972. Much of the increase in total cheese consumption can be attributed to increases in consumption of mozzarella and cheddar cheeses.

Although per capita use of fats and oils climbed 23% between 1972 and 1992, more vegetable fats and oils and less animal fats are being used today. This trend may reflect efforts by consumers to switch from saturated to unsaturated fatty acids (Putnam, 1993). In 1992, per capita consumption of fats and oils such as butter, margarine, shortening, and salad dressings was 66 lb, up 7 lb from 1982 and 12 lb from 1972

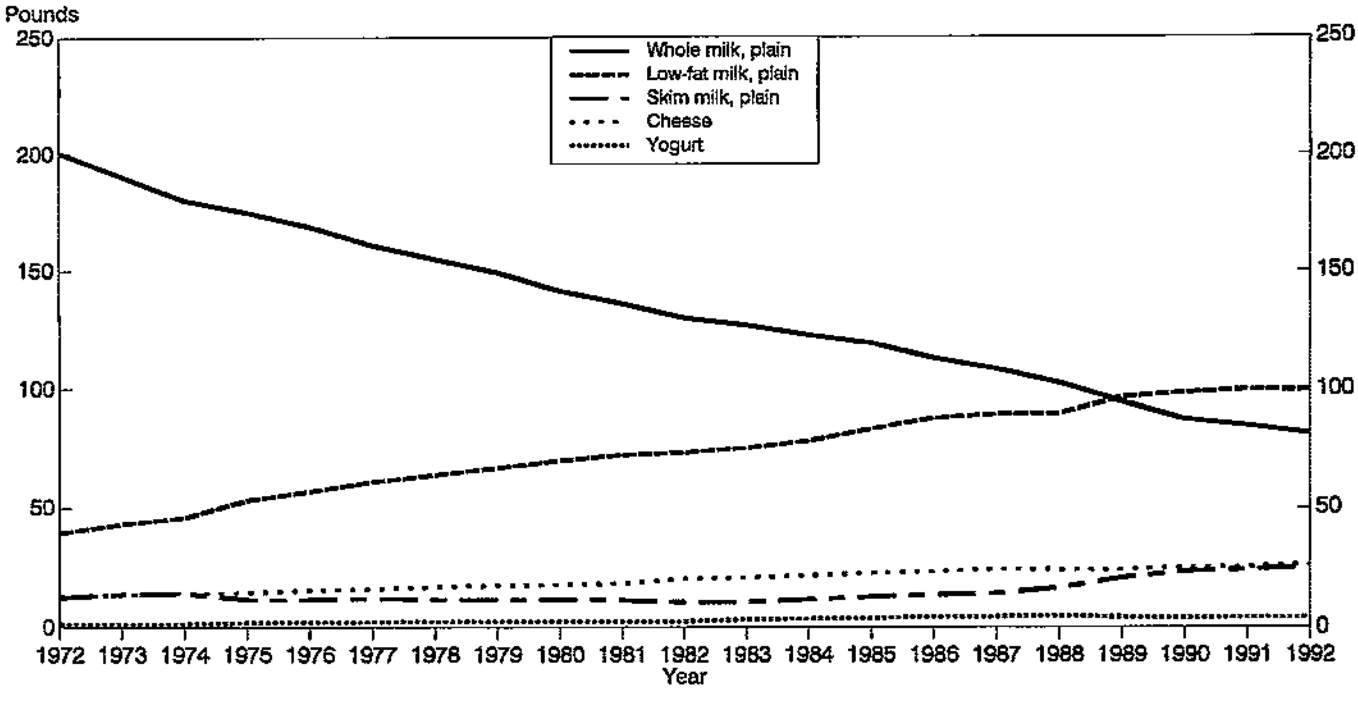

Figure 3-4. Annual per capita consumption of milk, yogurt, and cheese, by year, 1972-92

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

(fat-content basis, i.e., based on the proportion of fat in the product). Between 1972 and 1992, per capita use of butter declined 16% while use of margarine fell only slightly. In contrast, increases were seen for salad and cooking oils, up 52%, and shortening, up 27%.

The amount of edible beef tallow available for consumption was 2.4 lb per capita in 1992, 1 lb higher than in 1991. This dramatic increase is perplexing and requires further study (Putnam, 1993). According to data from the U.S. Department of Commerce, edible tallow production rose 26% between 1991 and 1992. This increase is attributed largely to changes in the amount of fat trimmed from cuts of beef. In response to lower beef consumption since 1985 and consumer concern about total fat, saturated fatty acids, and cholesterol, retailers have begun to trim fat from beef cuts more closely to the meat (Putnam and Allshouse, 1993). Another factor contributing to increases in per capita consumption of tallow is that the task of trimming excess fat from retail cuts of beef shifted from retailers in the late 1980s to large meatpackers in the 1990s. Trimming fat in large meatpacking plants permits a more efficient production of edible tallow. Thus, an increased supply of trimmed fat has led to an increase in the production of edible tallow.

As noted earlier in this chapter, the apparent increase in per capita use of fats and oils may not accurately reflect trends in actual use. A major factor behind the increasing trend in use of fats and oils is the growth of fast-food restaurants and other away-from-home eating establishments over the past two decades, where much of the food is prepared by deep-fat frying. A 1987 study by SRI, International, indicates that the quantity of used frying fat disposed of by restaurants and processed by renderers for use in animal feeds, pet foods, and industrial operations and for export now annually amounts to about 6 lb per capita, or about 9% of the 1992 total per capita disappearance of fats and oils (Putnam, 1993). A 1993 study estimated that about 50% (or more) of deep-frying fat used in food-service operations is discarded after use and is not available for consumption (Hunter and Applewhite, 1993). The difficulty in adjusting the food-supply estimates to reflect this wastage is the lack of data on the total quantity of deep-frying fat used by food-service operations.

Consumption of flour and cereal products jumped 54 lb per capita between 1972 and 1992, with consumption of rice up 140%; corn products (corn flour, cornmeal, hominy, grits, and starch) up 126%; oat products (rolled oats, oat flour, oat bran, and ready-to-eat cereals) up 93%; and wheat flour up 26%. Much of this growth is explained by the expansion of the fast-food industry and in-store bakeries and of offerings of grain-based products in the retail marketplace (Putnam, 1994). A growing preference for ethnic foods has also contributed to this increase. Large increases in per capita consumption of breakfast cereals (especially for ready-to-eat cereals) were also apparent between 1972 and 1992.

Per capita consumption of fruits and vegetables, excluding wine grapes, in 1992 was 650 lb (farm-weight equivalent), up 10% from 1982 and 16% from 1972 (fig. 3-5). Consumption of fresh fruit was 123 lb (farm-weight equivalent) per capita in 1992, up 14% from 1982 and 30% from 1972. Higher availability of fresh noncitrus fruits, such as bananas, grapes, and melons, accounted for much of this increase (Putnam, 1994). Consumption of fresh potatoes and other fresh vegetables excluding legumes was 164 lb (farm-weight equivalent) per capita in 1992, up from 152 lb in 1972. Largest per capita gains were seen for onions, bell peppers, broccoli, tomatoes, and garlic. Per capita availability of vegetables used for canning and freezing increased from 150 lb in 1972 to 182 lb in 1992. Between 1972 and 1992, per capita consumption of tomatoes used for canning rose 13%, whereas broccoli and sweet corn used for freezing climbed 130% and 67%, respectively. On a retail-weight basis, the per capita amount of fresh potatoes available for consumption decreased 16%, while per capita availability of frozen potatoes rose 81%. The growing popularity of ethnic foods, particularly Mexican and East Indian cuisine, over the past decade reflects increases in per capita consumption of beans and other legumes (Putnam, 1994). Between 1982 and 1992, use of dried field peas and lentils jumped 50%.

The amount of caloric sweeteners available for consumption reached a high of 143 lb per capita in 1992. While per capita consumption of refined sugars dropped nearly 40% between 1972 and 1992, per capita consumption of corn sweeteners, mainly high-fructose corn syrup (HFCS), increased more

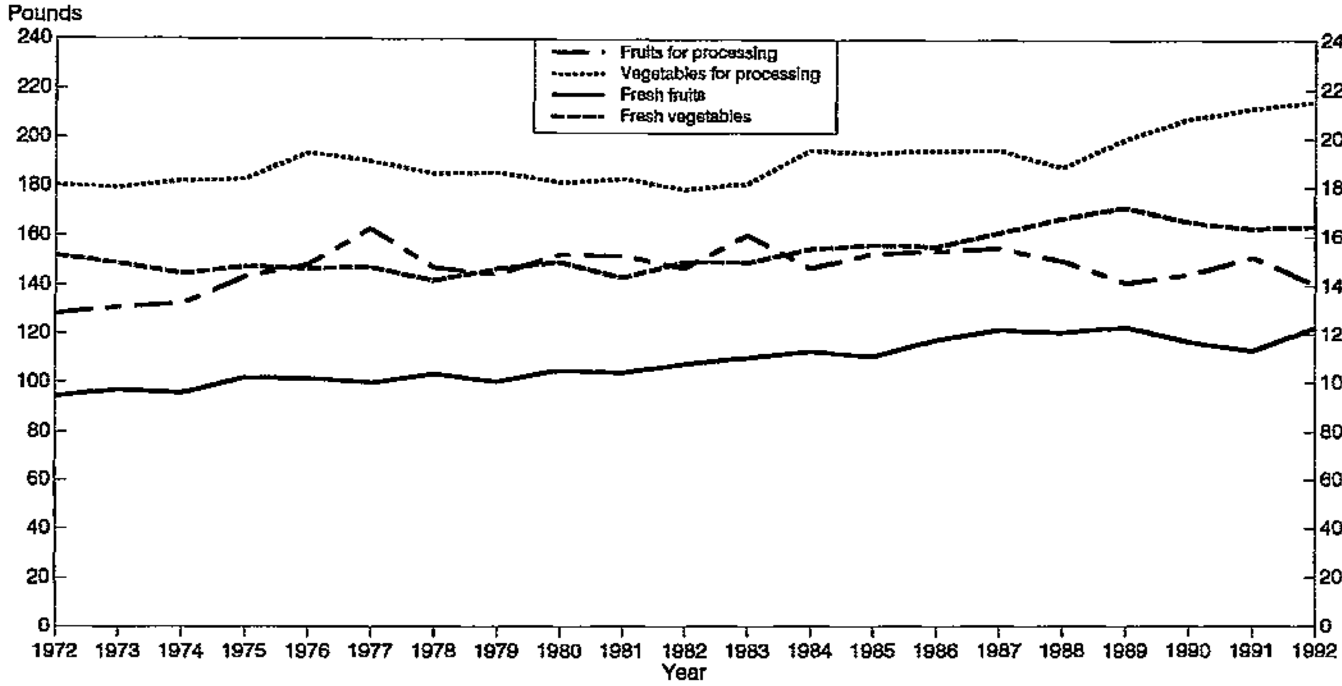

Figure 3-5. Annual per capita consumption of fruits and vegetables (fresh and for processing), by year, 1972-92

NOTE: Data are based on farm-weight equivalent. Fruits for processing includes fruit juices and fruits for canning, freezing, and drying. Vegetables for processing includes potatoes (but not legumes) and vegetables for canning, freezing, and drying.

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

than threefold. Per capita consumption of low-calorie sweeteners (aspartame and saccharin) more than tripled since 1980, largely from the introduction of aspartame on the market in the early 1980s. Much of the displacement of sucrose by HFCS and aspartame has been in soft drinks (Putnam, 1994). Between 1976 and 1992, per capita consumption of soft drinks was up 25%. Between 1976 and 1992, per capita consumption of soft drinks was greater than that of coffee, milk, fruit juices, and bottled water (fig. 3-6).

Between 1972 and 1992, per capita consumption of beer and wine among adults 21 years of age and older increased 4% while consumption of distilled spirits fell 36%. Per capita consumption of beer and spirits reached record highs in 1981 and has declined steadily since this time. Wine consumption peaked in 1985 and 1986 and has also declined steadily since then. Data on trends in per capita consumption of alcoholic beverages in a sample of people 14 years of age and older are available from the Alcohol Epidemiologic Data System (AEDS) (Williams et al., 1993). AEDS data are based on sales collected directly by AEDS or provided by beverage-industry sources. For 1991, AEDS received reports on beverage sales and/or tax receipts from the District of Columbia and from 30 States for beer, 31 States for wine, and 28 States for distilled spirits. For the remaining States, shipment data for major beverage-industry sources were used to estimate per capita consumption. AEDS converts gallons of sold or shipped beer, wine, and spirits into gallons of ethanol (pure alcohol). To estimate the ethanol content of alcoholic beverages, the following conversion coefficients, in use since 1977, were used: 0.045 for beer, 0.129 for wine, and 0.414 for spirits (Doernberg and Stinson, 1985).

AEDS data for the years 1985-1991, an update to the table that provided AEDS data for the years 1977-84 in the second nutrition monitoring report (LSRO, 1989), are shown in table 3-4. The decrease noted during the first 4 years of the 1980s continued through 1989. This resulted in a 12% decrease in overall per capita consumption of ethanol between 1981 and 1989. Between 1989 and 1990, per capita consumption increased by 1.2%. This increase reflected a surge in sales before the 1991 Federal

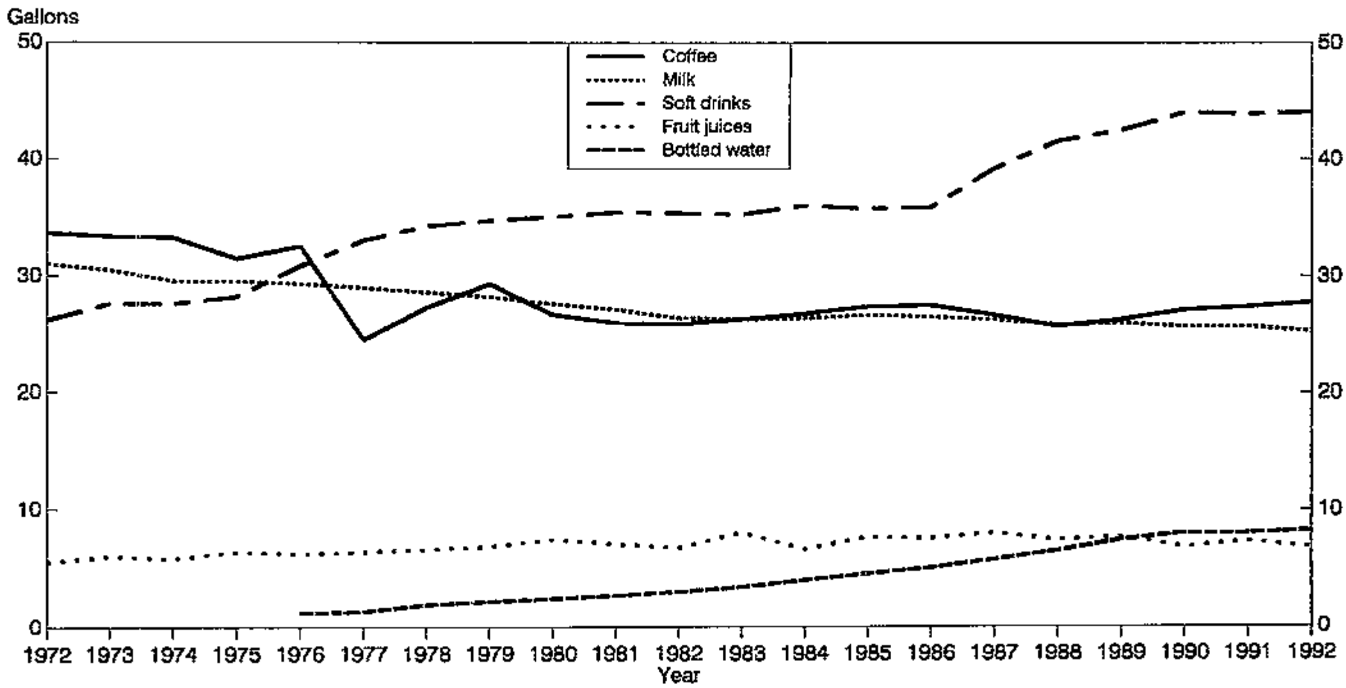

Figure 3-6. Annual per capita consumption of selected nonalcoholic beverages, by year, 1972-92

NOTE: "Fruit juices" includes citrus juices (orange, grapefruit, lemon, and lime) and noncitrus juices (apple, grape, and prune).

SOURCE: USDA, U.S. Food Supply, 1970-92 (Putnam and Allshouse, 1993).

Table 3-4. Per capita amounts of ethanol sold annually, based on the U.S. population 14 years of age and older, by year, 1985-91 (gal)

Year	Beer	Wine	Spirits	All alcoholic beverages
1985	1.33	0.38	0.90	2.62
1986	1.34	0.39	0.85	2.58
1987	1.34	0.38	0.83	2.54
1988	1.33	0.36	0.80	2.49
1989	1.31	0.34	0.78	2.43
1990	1.34	0.33	0.78	2.46
1991	1.29	0.30	0.72	2.31

SOURCE: Alcohol Epidemiologic Data System (Williams et al., 1993).

Excise Tax on alcoholic beverages. Between 1990 and 1991, a 6% decrease in per capita ethanol consumption was seen. Ethanol consumption from beer decreased 4%, whereas consumption from wine decreased 9% and consumption from spirits decreased 8%. These findings suggest a continuation of the 1980-89 trend of decreasing per capita ethanol consumption. It should be noted that per capita consumption values from the ERS and AEDS underestimate average alcohol consumption of drinkers because both drinkers and nondrinkers are included in the denominator.

Per capita nutrient availability, 1970-90

Per capita per day availability of food energy in the food supply increased from 3,300 calories in 1970 to 3,700 calories in 1990 (table 3-5). This 12% increase reflects higher levels of all three energy-yielding nutrients (protein, carbohydrate, and total fat). Between 1970 and 1990, the proportion of calories

Table 3-5. Daily per capita availability of food energy and 24 nutrients and food components in the U.S. food supply and percent change, 1970-90, 1970-80, and 1981-90

	Year				Percent change		
Nutrient or food component	1970	1980	1981	1990	1970-80	1981-90	1970-90
Food energy (kcal)	3,300	3,400	3,400	3,700	3.0	8.8	12.1
Protein (g)	99	98	98	105	–1.0	7.1	6.1
Carbohydrate (g)	383	404	393	452	5.5	15.0	18.0
Total fat (g)	159	161	161	165	1.3	2.5	3.8
Saturated fatty acids	61	60	59	59	–1.6	0.0	–3.3
Monounsaturated fatty acids	66	65	65	67	–1.5	3.1	1.5
Polyunsaturated fatty acids	27	31	31	32	14.8	3.2	18.5
Cholesterol (mg)	490	450	440	410	–8.2	–6.8	–16.3
Vitamins[1]							
Vitamin A (µg RE)	1,500	1,490	1,480	1,420	–0.7	–4.1	–5.3
Carotenes (µg RE)	500	570	570	620	14.0	8.8	24.0
Vitamin E (mg α-TE)	13.4	13.7	13.7	15.7	2.2	14.6	17.2
Vitamin C (mg)	108	112	108	110	3.7	1.8	1.8
Thiamin (mg)	2.0	2.4	2.4	2.5	20.0	4.2	25.0
Riboflavin (mg)	2.4	2.5	2.5	2.6	4.2	4.0	8.3
Niacin (mg)	23	26	26	28	13.0	7.7	21.7
Vitamin B_6 (mg)	2.1	2.0	2.0	2.2	–4.8	10.0	4.8
Folate (mg)	280	287	285	296	2.5	3.9	5.7
Vitamin B_{12} (mg)	10.4	9.4	9.5	8.7	–9.6	–8.4	–16.3
Minerals (mg)							
Calcium	870	850	840	920	–2.3	9.5	5.7
Phosphorus	1,470	1,490	1,480	1,600	1.4	8.1	8.8
Magnesium	320	320	320	350	0.0	9.4	9.4
Iron	15.5	15.9	15.9	19.3	2.6	21.4	24.5
Zinc	12.6	12.3	12.3	12.7	–2.4	3.3	0.8
Copper	1.6	1.6	1.6	1.7	0.0	6.2	6.2
Potassium	3,510	3,410	3,360	3,540	–2.8	5.4	0.8

[1]RE, retinol equivalents; α-TE, α-tocopherol equivalents.

SOURCE: USDA, Nutrient Content of the U.S. Food Supply, 1909-90 (Gerrior and Zizza, 1994).

from protein remained stable at about 12%, the proportion of calories from carbohydrate increased from 46% to 49%, and the proportion of calories from total fat decreased from 43% to 40%.

Between 1970 and 1990, availability of protein rose from 99 to 105 g per capita per day. This 6% rise reflects a greater use of grain products, cheese, yogurt, and low-fat milks. Availability of carbohydrate jumped 18%, from 383 g per capita per day in 1970 to 452 g per capita per day in 1990. This increase reflects an increased use of grain products, particularly rice and corn syrup sweeteners.

Availability of total fat in 1990 was 165 g per capita per day, up from 159 g in 1970. This 4% jump can be attributed to an increase in total fat from vegetable sources such as oils and shortening. Between 1970 and 1990, availability of polyunsaturated fatty acids increased 19%, of saturated fatty acids decreased 3%, of monounsaturated fatty acids remained about the same, and of cholesterol fell 16%. Changes in fatty acid availability reflect a shift from animal to vegetable sources of fat, whereas the decline in cholesterol availability may be explained by lower per capita consumption of red meat, fluid whole milk, and eggs.

Availability of vitamins C and B_6 remained about the same from 1970 to 1990. Per capita availability of all other vitamins (thiamin, riboflavin, niacin, vitamin E, and folate) increased over that period. Vitamin A availability decreased by 5%, which is accounted for by decreased availability of eggs and meats, particularly organ meats. Availability of carotenes increased from 500 to 620 retinol equivalents (RE) per day. This gain was attributed to the development of new varieties of deep-yellow vegetables that have more carotenes than other varieties. Increased availability of broccoli, green peppers, and carrots also contributed to higher levels of carotenes. Higher vitamin E availability reflects increased use of salad and cooking oils. Greater availability of grain products accounted for the higher folate levels. A 16% decline in vitamin B_{12} availability can be explained largely by the decreased use of meat, especially organ meats, and eggs. Availability of thiamin, riboflavin, niacin, and iron increased by 25%, 8%, 22%, and 25%, respectively, from 1970 to 1990. An increase in the enrichment levels of flour called for by revised Federal standards was primarily responsible for these increases.

Between 1970 and 1990, per capita availability of calcium, phosphorus, magnesium, copper, and potassium increased while per capita availability of zinc remained about the same. Increased use of low-fat milks and cheese was primarily responsible for the increased calcium and phosphorus levels. Higher magnesium levels can be explained by the increased use of low-fat milks, poultry, and grain products. The increased copper levels reflect the increased use of grain, soy, and nut products. The gain in potassium was accounted for by the increased availability of grain products and noncitrus fruits.

Food sources of nutrients, 1990

Table 3-6 presents the food groups that were primary contributors to availability of food energy and of various nutrients—that is, the groups that provided more than 15% of food energy or of each nutrient in the 1990 food supply. Major contributors of food energy, protein, carbohydrate, and total fat are shown in figures 3-7 through 3-10. Major sources of food energy in the food supply were meat, poultry, and fish; grain products; fats and oils; and sugars and sweeteners. In 1990, each of these food groups contributed more than 17% of the food energy available for consumption (fig. 3-7). In 1990, animal sources, consisting of the meat, poultry, and fish group and the dairy products group, contributed about two-thirds of total protein, with grain products also serving as an important source (fig. 3-8). Foods of plant origin have always been a major source of carbohydrate. In 1990, grain products and sugars and sweeteners each provided almost 40% of total carbohydrate (fig. 3-9). In 1990, the fats and oils group provided 48% of total fat, up from 41% in 1970 (fig. 3-10). The meat, poultry, and fish group also served as a major source of total fat in 1990. Major contributors of other nutrients are shown in figures A.3d through A.3g and A.3i through A.3y in appendix VA.

The primary source of saturated fatty acids and cholesterol in 1990 was the meat, poultry, and fish group, with meat accounting for the largest percentage contribution. The meat, poultry, and fish group was also the leading source of niacin, vitamin B_6, vitamin B_{12}, and zinc, as well as a major source of vitamin A, thiamin, riboflavin, iron, phosphorus, and potassium. The primary source of polyunsaturated and monounsaturated fatty acids and vitamin E was the fats and oils group. Eggs were one of the major sources of cholesterol, providing 33% of total cholesterol.

The leading source of riboflavin, calcium, and phosphorus was the dairy products group. In 1990, dairy products also served as an important source of vitamin A, vitamin B_{12}, magnesium, potassium, and zinc. In 1990, grain products were the leading source of thiamin, iron, magnesium, and copper and a major source of riboflavin, niacin, folate, phosphorus, and zinc. Vegetables were the leading source of vitamin A and carotenes in 1990, with dark-green and deep-yellow vegetables serving as major sources. Vegetables were also a major source of vitamin B_6, folate, potassium, and copper. The largest percentage contribution for vitamin C also came from the vegetable group, although the fruit group served as a major source of vitamin C, as well. The legumes, nuts, and soy group was an important source of folate and copper.

Table 3-6. Major sources of food energy and 24 food components in the U.S. food supply, 1990

Food component	Percent contribution
Food energy	
Grain products	23.3
Fats, oils	19.0
Sugars, sweeteners	17.9
Meat, poultry, fish	17.4
Protein	
Meat, poultry, fish	41.1
Grain products	22.3
Dairy products	19.8
Carbohydrate	
Grain products	39.5
Sugars, sweeteners	38.2
Total fat	
Fats, oils	47.6
Meat, poultry, fish	30.3
Saturated fatty acids	
Meat, poultry, fish	38.2
Fats, oils	33.0
Dairy products	20.8
Monounsaturated fatty acids	
Fats, oils	49.9
Meat, poultry, fish	32.7
Polyunsaturated fatty acids	
Fats, oils	67.9
Meat, poultry, fish	17.2
Cholesterol	
Meat, poultry, fish	47.3
Eggs	33.2
Dairy products	14.5
Vitamin A	
Vegetables	36.4
Meat, poultry, fish	22.9
Dairy products	18.4
Carotenes	
Vegetables	83.9
Vitamin E	
Fats, oils	62.5
Vitamin C	
Vegetables	52.2
Fruits	41.5
Thiamin	
Grain products	52.0
Meat, poultry, fish	21.1
Riboflavin	
Dairy products	30.9
Grain products	30.2
Meat, poultry, fish	19.8
Niacin	
Meat, poultry, fish	40.1
Grain products	38.0
Vitamin B_6	
Meat, poultry, fish	38.7
Vegetables	22.3
Folate	
Vegetables	26.4
Grain products	21.2
Legumes, nuts, soy	18.5
Vitamin B_{12}	
Meat, poultry, fish	74.8
Dairy products	19.7
Calcium	
Dairy products	74.5
Phosphorus	
Dairy products	33.7
Meat, poultry, fish	26.5
Grain products	19.0
Magnesium	
Grain products	23.7
Dairy products	17.6
Iron	
Grain products	48.9
Meat, poultry, fish	18.5
Zinc	
Meat, poultry, fish	43.7
Dairy products	19.0
Grain products	16.9
Copper	
Grain products	22.7
Vegetables	20.6
Legumes, nuts, soy	16.6
Meat, poultry, fish	15.6
Potassium	
Vegetables	26.5
Dairy products	19.7
Meat, poultry, fish	17.9

SOURCE: USDA, Nutrient Content of the U.S. Food Supply, 1909-90 (Gerrior and Zizza, 1994).

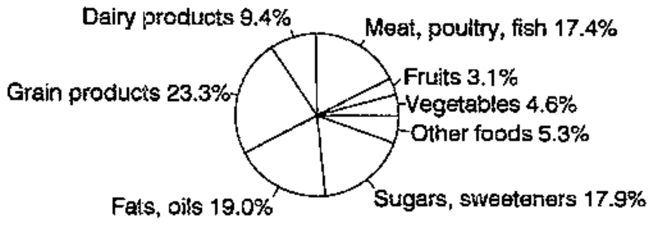

Figure 3-7. Food energy: percentage contribution of major food groups to the U.S. food supply, 1990

NOTE: The "other foods" category includes legumes, nuts, and soy (2.8%); eggs (1.3%); and miscellaneous foods (1.2%).

SOURCE: USDA, Nutrient Content of the U.S. Food Supply, 1990 (Gerrior and Zizza, 1994).

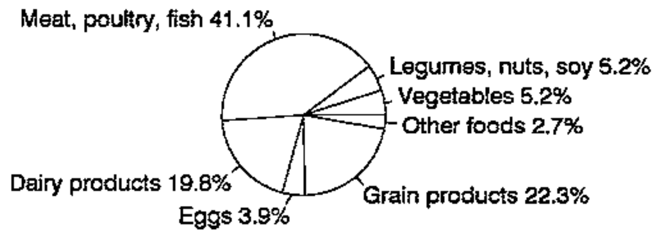

Figure 3-8. Protein: percentage contribution of major food groups to the U.S. food supply, 1990

NOTE: The "other foods" category includes fruits (1.2%); fats and oils (0.2%); and miscellaneous foods (1.3%).

SOURCE: USDA, Nutrient Content of the U.S. Food Supply, 1990 (Gerrior and Zizza, 1994).

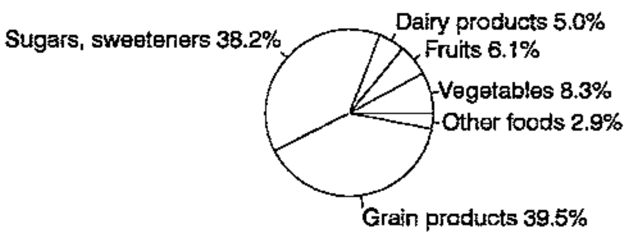

Figure 3-9. Carbohydrate: percentage contribution of major food groups to the U.S. food supply, 1990

NOTE: The "other foods" category includes legumes, nuts, and soy (1.8%); meat, poultry, and fish (0.1%); eggs (0.1%); and miscellaneous foods (0.9%).

SOURCE: USDA, Nutrient Content of the U.S. Food Supply, 1990 (Gerrior and Zizza, 1994).

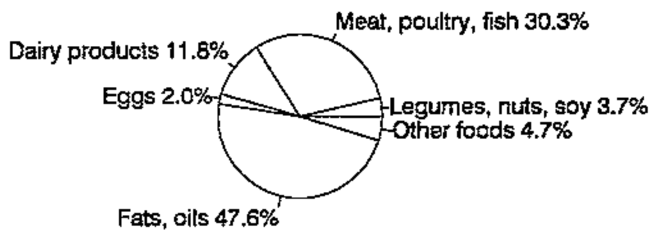

Figure 3-10. Total fat: percentage contribution of major food groups to the U.S. food supply, 1990

NOTE: The "other foods" category includes fruits (0.4%), vegetables (0.4%), grain products (1.8%), and miscellaneous foods (2.1%).

SOURCE: USDA, Nutrient Content of the U.S. Food Supply, 1990 (Gerrior and Zizza, 1994).

Summary of findings

Food disappearance data suggest that Americans, on a per capita basis, are slowly making changes in their eating patterns toward more healthful diets by using more low-fat and nonfat foods and leaner cuts of meat. A considerable gap, however, still exists between public health recommendations and consumer practices.

On a per capita basis, less red meat and more poultry and fish were available for consumption in 1992 than in 1972. Per capita consumption in 1992 averaged 18 lb less beef, 25 lb more poultry, and 2 lb more fish and shellfish than in 1972. Fewer shell eggs were available for consumption in 1992, down 33% from 1972. The decline in shell-egg and red-meat availability may be associated with public concerns about cholesterol.

There appears to be a trend toward using lower-fat milk. Between 1972 and 1992, average annual per capita consumption of fluid whole milk dropped 59%, whereas per capita consumption of fluid low-fat milk (1% and 2% milkfat) increased 153% and per capita consumption of fluid skim milk doubled. The trend toward using lower-fat milk is consistent with increased public concern about cholesterol and animal fats. However, this trend is offset by the growing availability of fluid-cream products and cheese. Between 1972 and 1992, per capita consumption of cheese doubled.

Although per capita consumption of fats and oils climbed 23% between 1972 and 1992, the data show that more vegetable fats and oils and less animal fats are being used today. This trend may reflect efforts by consumers to switch from saturated to unsaturated sources of dietary fat. Compared with 1972, Americans in 1992 used, on a per capita basis, 40 lb more fruits (farm-weight equivalent); 47 lb more vegetables excluding legumes (farm-weight equivalent); 9 lb fewer fresh potatoes (retail-weight equivalent); 12 lb more frozen potatoes (retail-weight equivalent); 54 lb more flour and cereal products; 1.3 lb more dried beans, peas, and lentils (farm-weight equivalent); 18 lb more sugar (mainly refined sugar and high-fructose corn syrup); and 18 gal more soft drinks.

Per capita availability of food energy in the food supply was higher in 1990 than in 1970. This increase reflects higher levels of all three energy-yielding nutrients (protein, carbohydrate, and total fat). Availability of saturated fatty acids decreased slightly between 1970 and 1990, whereas availability of polyunsaturated fatty acids increased and availability of monunsaturated fatty acids remained about the same. Cholesterol availability was lower in 1990 than in 1970. Between 1970 and 1990, availability of vitamins A and B_{12} decreased while levels of vitamins C and B_6 remained about the same. Per capita availability of all other vitamins and of calcium, phosphorus, magnesium, iron, copper, and potassium was higher in 1990 than in 1970. Availability of zinc remained about the same.

Gaps in knowledge

The food-supply time-series data do not permit a focus on changes in possible relationships between various socioeconomic factors and food use or an examination of changes occurring in the away-from-home market or in the use of preprepared foods (foods purchased in a ready-to-eat form and taken home for consumption). Disappearance data provide no information about a food's source, the form in which the food is consumed, or the safety or quality of the food.

Recommendations

- Awareness of the food-supply data and of their potential uses and limitations needs to be increased. Dissemination of food-supply estimates has not been as widespread as that from other components of the NNMRRP (HHS and USDA, 1993). Continued emphasis should be placed on documenting and interpreting food-supply data for researchers, policymakers, program managers, health professionals, and the media.

- Continue to collect reliable food-supply data from a variety of government and private sources and to calculate estimates of total available food supply, per capita consumption, and nutrient availability annually. Food-supply data provide unique and essential information on the amount of food and nutrients available for human consumption in this country. These data are crucial for monitoring the potential of the food supply to meet the nutritional needs of the U.S. population. In addition, food-supply data are useful for ascertaining population-based trends in food consumption over time.

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Chapter 4

Household-Based Estimates of Food Consumption and Expenditures

Introduction

Food consumption and expenditure patterns are influenced by many factors, including food prices and family income (Putnam and Allshouse, 1993). As consumers choose among foods available in the marketplace, demand for certain foods becomes more responsive to prices. As income increases and consumers demand greater convenience and quality, the amount of money spent on more expensive foods increases. Changes in the demographic structure of the U.S. population also may contribute to changes in consumption and spending patterns (Nayga and Capps, 1992). These changes include the growing number of women in the work force, of families living on two incomes, and of one-adult households and the shifting age distribution and growing ethnic diversity of the population. Changes in consumers' life-styles and attitudes about food convenience and food safety and increased concerns about health can also bring about changes in consumption and spending.

Studying food consumption and expenditure patterns in households of different sizes, races, income classes, geographic areas, and other socioeconomic and demographic characteristics is vital for many reasons. Comparing such patterns permits the effects of supply shifts, relative price changes, health concerns, and changing consumer life-styles and attitudes about household food consumption and purchases to be examined over time. This information is valuable to food marketers and processors, food program administrators, nutrition educators, health professionals, economists, and nutrition researchers because it helps them gain a better understanding of factors influencing food consumption and buying habits (Lutz et al., 1992; Smallwood et al., 1994). Data on food expenditures also can be used to assess existing market conditions, product-distribution patterns, and consumer buying habits and living conditions (Smallwood et al., 1994). When combined with demographic and income projections, food-expenditure information can be used to predict future consumption trends. Furthermore, information about household food-use and food-expenditure patterns is useful for developing typical market baskets of foods for certain populations, such as elderly people. In turn, these market baskets can be used to develop price indices that are tailored to the consumption patterns of these population groups. Lastly, information about these patterns is essential for budgeting food program expenditures. Over $40 billion are spent by USDA each year on food assistance and nutrition programs.

This chapter provides a review of information about household food use and expenditures from two surveys of the NNMRRP: the Consumer Expenditure Survey (CES) 1980-92 and the Nationwide Food Consumption Surveys (NFCS) 1977-78 and 1987-88. Figure 4-1 highlights the interrelationships of various components of household-based food consumption and expenditures with the other components of the conceptual model.

Types and sources of data

The CES is an annual survey of household food expenditures conducted by the U.S. Department of Labor's Bureau of Labor Statistics (BLS). USDA also conducts comprehensive household surveys of food use about every 10 years from the household component of the NFCS. The most recent NFCS surveys were conducted in 1977-78 and 1987-88. In the NFCS, data are also collected on household food consumption patterns. The types of data collected in

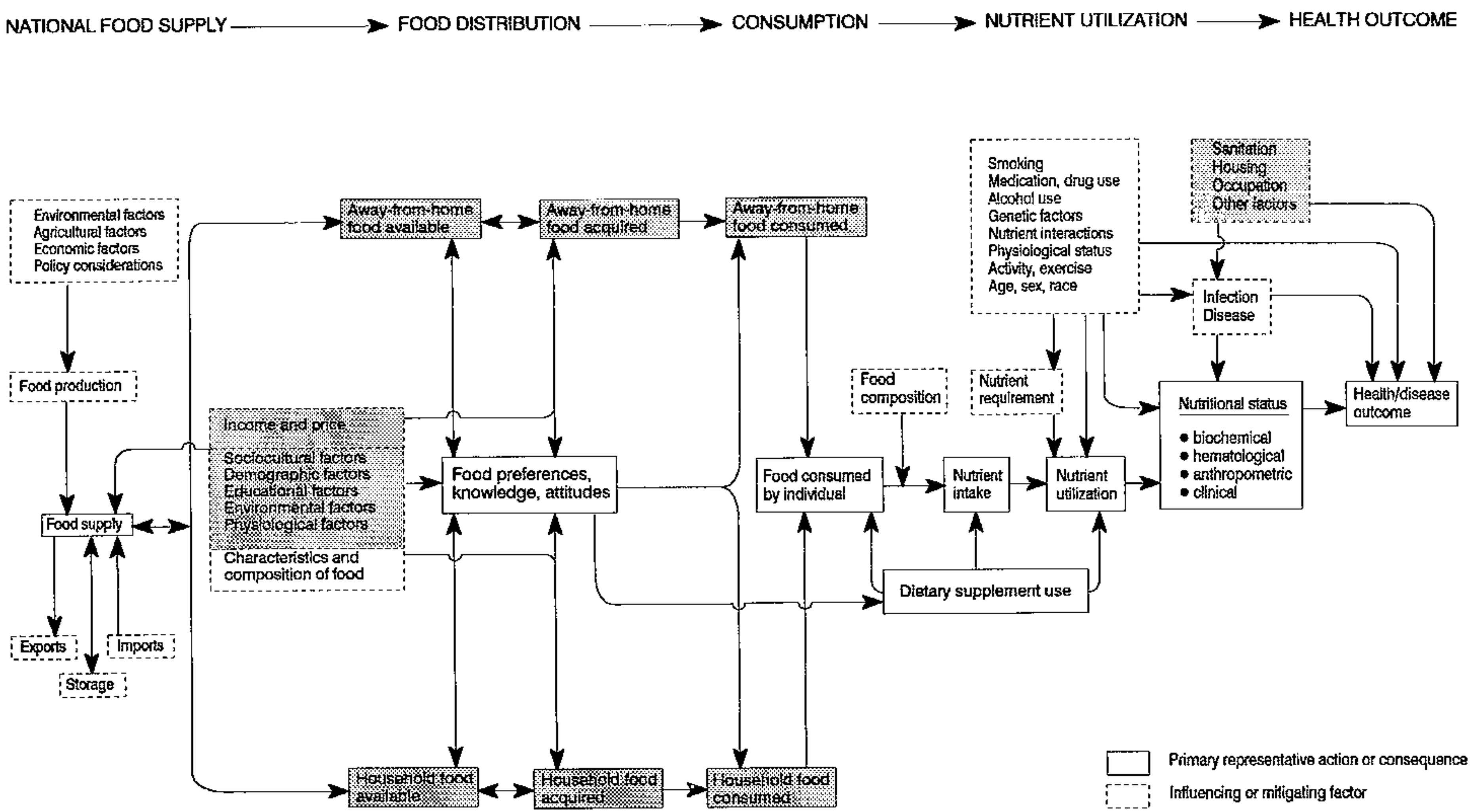

Figure 4-1. General conceptual model highlighting components of household-based food expenditures (see text for explanation)

SOURCE: LSRO (1989).

the CES and NFCS surveys and the sources of these data are shown in table 4-1.

The CES provides the most recent and comprehensive data available on the annual amount of money spent on food by American households. Using CES data, USDA's Economic Research Service (ERS) has compiled tables on annual per person expenditures for at-home and away-from-home food for urban households for the years 1980 through 1992 (Smallwood et al., 1994). Annual per capita expenditures are reported for approximately 100 foods and food groups. Rural sampling units were dropped from the CES sample between 1981 and 1983 because of budgetary limitations, but they were reinstated in 1984. Because of this exclusion, comparisons of food expenditures for all households cannot be made between 1980 and 1992. To allow comparisons to be made across all 13 survey years, only data from urban households are presented in this chapter.

In the CES, at-home food expenditures are recorded by participants in a diary. Information on away-from-home food spending is collected in a separate interview portion of the CES. Expenditures for food purchased at restaurants, carryouts, and other types of eating establishments and taken home for consumption are included in away-from-home expenditures. Expenditures are the transaction costs, including excise and sales taxes, of foods purchased during the diary-keeping period. Data are collected throughout the year, with increased data collection during the last 6 weeks of the year to account for increased buying activity during the holiday season.

The NFCS household data provide a snapshot of the type, quantity, and "money value" of foods used in households in 1977-78 and 1987-88. "Money value" is based on the expenditures for purchased foods and on assigned values for home-produced food and food received free of cost as gifts or as pay. Household interviews were conducted throughout the year to account for seasonal variations in food consumption and buying habits. The term "food consumption" is used to describe the quantity of food used in the household rather than actual ingestion of food. Expenditures for purchased food are based on prices reported as paid, excluding sales tax. Food bought and eaten away from home is not included, but food bought away from home and brought into the home for consumption is included. Although not presented in this chapter, data on the nutritive value of food used in the household during the 7-day survey period are also available from the household portion of the NFCS.

For the NFCS, ERS calculates annual household food use and money-value estimates for 64 food groups and expresses them on a 21-meal-equivalent-person (21-MEP) basis (Lutz et al., 1992). The 21-MEP conversion assumes that a person eats 3 meals a day over the 7-day period of the survey and accounts for differences in the number of household members and guests eating from home food supplies and in the number of meals eaten at home and away from home. By using the 21-MEP conversion, household variation in at-home food use is controlled, thereby facilitating comparisons across households that have different sizes and different at-home eating patterns. Household-food-use and money-value data represent

Table 4-1. Types and sources of data on household-based food consumption and expenditures used in chapter 4 of the *Third Report on Nutrition Monitoring*

Type of data	Source of data[1]
Average annual per person expenditures of urban households for food at home and food away from home	Consumer Expenditure Survey (DOL, BLS)
Average annual money value of food used at home and away from home (per 21-meal-equivalent person)[2]	Household component of NFCS 1977-78 (USDA, ARS) and NFCS 1987-88 (USDA, HNIS)
Average annual household food use (per 21-meal-equivalent person)	Household component of NFCS 1977-78 (USDA, ARS) and NFCS 1987-88 (USDA, HNIS)

[1]DOL, U.S. Department of Labor; BLS, Bureau of Labor Statistics; USDA, U.S. Department of Agriculture; ARS, Agricultural Research Service; HNIS, Human Nutrition Information Service.
[2]"Money value" is based on the expenditures for purchased food and on assigned values for home-produced food and food received free of cost. Expenditures for purchased food are based on prices reported as paid, excluding sales tax.

SOURCE: LSRO, 1994.

per person averages of the amount of food used and the amount of money spent for food for the population as a whole. These data do account for differences in the distribution among people of foods in different categories, but they do not allow direct observation of the distribution nor do they account for within-household variation.

Criteria for assessment

The criteria used for assessing data on household-based food consumption and expenditures include type of sample design, level of participation of the sample population, and weighting procedures. The choice of which populations to sample (i.e., the sampling frame) for the CES was based on procedures and information from the Bureau of the Census (Smallwood et al., 1994). Revisions to the sampling frame in 1986 created some difficulty when population estimates in 1986 were being compared with estimates from previous years; however, these revisions have little effect on the population averages for food expenditures from the CES presented in this chapter. Response rates for, or levels of participation in, the CES have not been problematic; about 85% of the eligible sample participated in 1987 and 1988. The weighting procedures used in the CES (Smallwood et al., 1994) did not raise concerns among the Expert Consultants and LSRO.

NFCS 1977-78 and NFCS 1987-88 were both based on self-weighting, multistage, stratified selection procedures for selecting samples from private households in the 48 contiguous States. NFCS 1977-78 provided a sample of 15,000 households, whereas NFCS 1987-88 provided a sample of 6,000 households. The level of household participation—that is, the number of usable questionnaires collected—was 61% for NFCS 1977-78 and 37% for NFCS 1987-88.

Independent evaluations of the effect of nonresponse on the individual intake portion of the NFCS 1987-88 were conducted by LSRO (1991) and the U.S. General Accounting Office (GAO, 1991). On the basis of these evaluations, it was concluded that it is not possible to determine the extent to which nonresponse bias might influence interpretation of analyses that use data from the individual-intake portion of the survey, particularly when subgroup sizes are small. A similar evaluation was not conducted for the household portion of NFCS 1987-88; however, when the household data were compared with the CES and ERS food-supply data to investigate the validity of the NFCS data, data from the three sources were found to be fairly consistent with each other in most cases. Except for households headed by a person who was neither white nor black, the NFCS subgroups that were examined all had sample sizes of over 400 households (Lutz et al., 1992).

Although NFCS 1977-78 and 1987-88 were designed to be self-weighting, weights that could be used to determine population estimates had to be calculated because of the statistically significant nonresponse rates for both time periods. Because of differences in response rates between the two NFCSs, different weighting procedures were applied to the two surveys. To account for nonresponse, the weights for the samples were calculated after the sample was collected. In NFCS 1977-78, the weights were calculated to be proportional to the ratio of the actual number of households in the sample to the number of completed questionnaires (Lutz et al., 1992). The weights were calculated for each primary sampling unit after each quarter of the survey (i.e., each 4-month period) and then scaled to produce equal response across the four quarters of the survey. Construction of weights for NFCS 1987-88 included adjustments for underrepresentation of certain subpopulations. In light of comparisons of NFCS household data with data from other sources and application of weighting factors, the Expert Consultants and LSRO concluded that the bias introduced by nonresponse in NFCS 1987-88 did not unduly compromise the estimates included in this chapter. A further discussion of procedures used to adjust for nonresponse in NFCS 1987-88 is presented in chapter 2.

Appropriate uses and limitations of the data

In the CES and the NFCS, household food consumption and expenditure data represent per person averages of the quantity of food used and the amount of money spent for food by households, regardless of whether or not a particular household purchased a specific food item during the record-keeping period. Thus, the average expenditure may be considerably below the actual expenditures reported by households that purchased the food item, especially for infrequently purchased foods. For items frequently used by most households, average expenditures for all households may not differ greatly from expenditures for households that actually use the item.

In household-based expenditure surveys, as in all surveys, errors may arise from several sources. Errors in the selection of households and the recording and interpretation of information may result in sampling biases. Random variation occurs because of the inherent variability in the population. Measurement error occurs when respondents and interviewers make mistakes during the recording and/or processing of data. In the CES, failure of respondents to complete questionnaires may introduce a potential source of bias. Because respondents in the CES are required to report only food items actually purchased, it becomes difficult to identify incomplete expenditure reporting (Smallwood et al., 1994). Distinguishing between an incomplete expenditure diary and a complete one that lists only a few food purchases is difficult. Incomplete reporting on other sections of the CES diary—for example, mortgage status—may be associated with incomplete food-expenditure reporting. Homeowners who do not report a mortgage status are about half as likely to report most food purchases as are homeowners who report a mortgage status. Similar patterns of underreporting are observed when income reporting is incomplete. Thus, caution is advised when CES data from these two subgroups are used.

The CES differs from the NFCS in several respects (table 4-2). The most notable difference is that the CES measures food purchases, whereas the NFCS measures the money value of food used in the household (Lutz et al., 1992; Smallwood et al., 1994). As a result, differences in reported food-expenditure values may occur between the surveys because of conceptual issues related to measurements. For example, the value of nonpurchased food, such as home-produced food and food received as gifts or as pay, is included in the NFCS but not in the CES. The surveys also vary because of differences in the timing of consumption and purchase. The CES does not measure consumption from household food stocks; thus, expenditures may include purchases used to build up inventories of staple foods such as flour and sugar. However, disparities among households due to inventory changes tend to average out over large groups of consumers (Smallwood et al., 1994).

Another difference between the two surveys is their unit of observation (Smallwood et al., 1994). The consumer unit is used for the CES, whereas the household is used as the observational unit for the NFCS. In the CES, "consumer unit" is defined as all members of a particular household who are related by blood, marriage, adoption, or other legal arrangement; a financially independent person living alone or sharing a household with others, living as a roomer in a private home or lodging house, or living in permanent quarters in a hotel or motel; or two or more people living together who pool their incomes to make joint expenditure decisions. In the NFCS, "household" is defined as all people who regularly share a house, apartment, room, or group of rooms used as separate living quarters. People who live in the household but who are away temporarily—for example, in the hospital or on travel—are included in the NFCS, whereas people living away in group quarters, such as college dormitories, rooming houses, military barracks, and institutions, are excluded. Residences with nine or more people unrelated to each other were not eligible to participate in the survey.

Differences in reporting are also apparent between the CES and the NFCS. In the CES, annual expenditures per person are reported. CES food-expenditure data are combined with food-price information from the BLS food-item price indices for detailed food categories. In the NFCS, the quantity and money value of food used in the household are calculated in terms of the 21-MEP.

The two surveys differ in several other ways. The CES data are collected over two consecutive 1-week periods, whereas the NFCS data are collected over one 1-week period. Data from the two surveys are annualized (i.e., converted to an expenditures-per-year basis) by their respective agencies and presented on a per person basis when reported. Describing data on a similar per person basis allows the data from the two surveys to be compared with each other and with other data. The CES includes college students living in dormitories, and the NFCS excludes them. The CES has collected data consistently only for urban households, whereas the NFCS data include three levels of urbanization (central cities, suburban areas, and nonmetropolitan areas). The NFCS data include foods purchased at restaurants, carryouts, and similar

Table 4-2. Comparison of measurement techniques used in the CES 1980-92 and NFCS 1977-78, 1987-88 surveys

CES 1980-92	NFCS 1977-78, 1987-88
Conducted by the U.S. Department of Labor, Bureau of Labor Statistics, every year since 1980.	Conducted by U.S. Department of Agriculture every 10 years since 1977-78.
Household-based cross-sectional survey.	Household-based cross-sectional survey.
Measures food purchases made by households.	Measures money value and quantity of food used by households.
Excludes value of nonpurchased foods (homegrown foods and food received as gifts or as pay) in food expenditures.	Includes nonpurchased foods in food expenditures.
Does not measure consumption out of household food stocks; expenditures may include purchases used to build up inventories.	May measure consumption out of household food stock.
Unit of observation: consumer unit.	Unit of observation: household.
Consumer unit includes college students living in dormitories.	Household excludes college students living in dormitories.
Calculations of annual food expenditures per person are reported.	Calculations of annual food use and money value are reported in terms of a 21-meal-equivalent person.
Includes price indices for foods and food groups; no quantity data are reported.	Excludes price data for foods and food groups, but price data may be derived by dividing money value of food by the quantity of food.
Food purchased at restaurants, carryouts, and other eating establishments and brought home for consumption are considered away-from-home expenditures.	Food purchased at restaurants, carryouts, and other eating establishments and brought home for consumption are considered at-home expenditures.
Households report information over two consecutive, 1-week periods.	Households report information over a 1-week period.
Urban households only.	Three levels of urbanization (central cities, suburban areas, and nonmetropolitan areas).

SOURCE: Lutz et al. (1992); Smallwood et al. (1994).

types of establishments and brought home to eat as part of at-home expenditures. In the CES, these expenditures are included in away-from-home food spending.

Consistency within and between data sources in assessing change over time

The methodologies of data collection in CES 1980-92 and in NFCS 1977-78 and 1987-88 have remained relatively consistent over time. In the CES, some changes have occurred in the sampling frame and weighting procedures (Smallwood et al., 1994); however, these changes should not affect the comparisons of food expenditures over time. For the most part, the two NFCSs were designed in the same manner. Both NFCS 1977-78 and 1987-88 used a 7-day list-recall method for the household-data questionnaire. In NFCS 1977-78, a pencil-and-paper questionnaire was used to interview respondents, whereas computer-assisted personal-interviewing technology was used in NFCS 1987-88 (Lutz et al., 1992). Because of the large nonresponse rate in NFCS 1987-88, the weighting procedures used for the data from that survey differed from those used for NFCS 1977-78. This weighting of the data from the two surveys made the data more comparable for time-trend analysis.

Current data on household-based food expenditures

This section summarizes CES data on food spending in 1992 in American urban households by selected socioeconomic and demographic characteristics. Data for 1992 were used because they were the most recent CES data available at the time this report was prepared. All data are presented in 1992 dollars. For further information on 1992 CES data, refer to the report *Food Spending in American Households, 1980-92* (Smallwood et al., 1994).

In 1992, white households spent more money per person on food than did black households and households of other races (fig. 4-2). Food spending was higher in households with higher incomes. Households in the lowest 20% of the income distribution spent nearly 60% less money per person than did households in the highest 20% of the income distribution. Per person food spending increased with age of the household head up to 64 years of age and then declined. Households in the South spent the least amount of money on food, and those in the Northeast spent the most.

In 1992, white households spent a larger share of total food expenditures on food away from home (FAFH) than did black households and households of other races. FAFH spending, as a share of total food expenditures, increased as household income increased. Households in the highest 20% of the income distribution spent 39% of total food expenditures on FAFH, whereas households in the lowest 20% of the income distribution spent 24% of total food expenditures on FAFH. The share of the food budget spent on FAFH tended to drop as the age of the household head increased. In households headed by a person (nonstudent) less than 25 years of age, 40% of total food expenditures were spent on FAFH, whereas 28% was spent on FAFH in households headed by a person over 64 years of age. Households in the South spent the highest share of food expenditures on FAFH (36%) and households in the Northeast spent the lowest share on FAFH (32%).

Food expenditures in relation to income

Disposable income is a key factor influencing demand for food. According to 1992 CES data, per capita disposable income was $17,346 (1992 dollars), up from $3,521 (1970 dollars) in 1970 (Putnam and Allshouse, 1993). When adjusted for inflation, real per capita disposable income in 1992 was 36% higher than it was in 1970. Although food expenditures have increased considerably over the years, the percentage of disposable personal (i.e., after-tax)

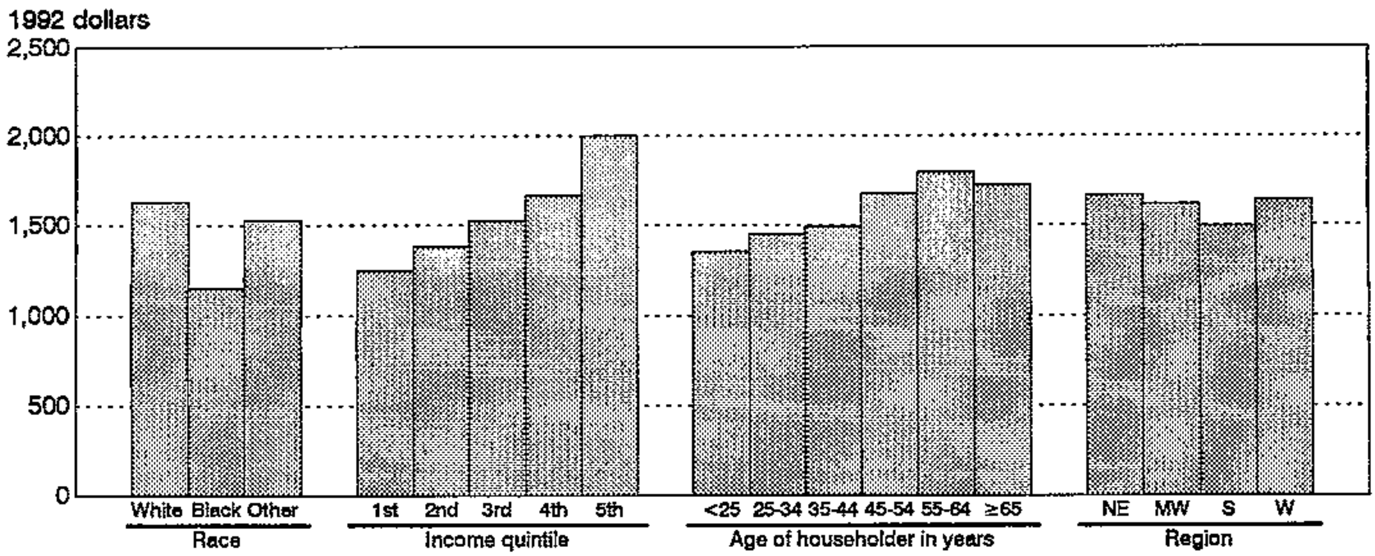

Figure 4-2. Average annual food expenditures per person in urban households, by selected demographics, 1992

NOTE: NE, Northeast; MW, Midwest; S, South; W, West.

SOURCE: DOL, CES, 1992 (Smallwood et al., 1994).

income spent for food has fallen over time. In 1992, families and individuals spent 12% of their disposable personal income on food, down from 14% in 1970. This result is consistent with Engel's Law, that is, as the wealth of a nation increases, the proportion of income spent for food declines. As a smaller share of income is spent on food, more money is available to purchase personal services and other discretionary items.

Data from the CES showed that the proportion of income spent for food in 1992 varied widely among households of different incomes. In 1992, approximately 14% of disposable income was spent for food in households with annual incomes of $40,000-$49,999. In households with annual incomes greater than $50,000, the percentage decreased to about 10%. In contrast, in households with incomes of $5,000-$9,999 per year, about one-third of disposable income was spent on food.

Trends in household-based food consumption and expenditures

This section begins with a review of CES data on food spending in urban households from 1980 through 1992. Trends in food expenditures (in terms of money value) and the quantity of food used in households from NFCS 1977-78 and 1987-88 are then summarized by selected socioeconomic and demographic characteristics. All food-expenditure data from the CES (see table A.T4-3,F4-3,4,5,6,7,8 in app. VA) and money-value data from the NFCS were adjusted for inflation to 1988 dollars to allow comparisons to be made on a common-dollar basis between the two surveys and across years of each survey. Trends in food spending in 1980 and 1988 from CES data were, when possible, compared with money-value data from NFCS 1977-78 and 1987-88. These trends are summarized in table 4-3. Because the two surveys differed in their definition of food groups, comparisons were made only for food groups that were common to both surveys. Also, because of differences in conceptual issues related to measurements used in the two surveys, food-expenditure values from the surveys differ (see table 4-2).

Further details on NFCS 1977-78 and 1987-88 household food-use and money-value data are provided in the reports *Changes in Food Consumption and Expenditures in American Households During the 1980's* (Lutz et al., 1992) and *Food Consumption and Dietary Levels of Households in the United States, 1987-88* (USDA, 1994). For further information on CES 1980-92 data, consult the report *Food Spending in American Households, 1980-92* (Smallwood et al., 1994).

CES 1980-92

Although there were some yearly fluctuations, average annual total food expenditures (excluding expenditures for alcoholic beverages) and average annual expenditures for FAFH, when adjusted for inflation, remained about the same in urban households between 1980 and 1992. The share of spending for FAFH peaked in 1990, when almost 40% of average annual total food expenditures was for FAFH (fig. 4-3). By 1992, the share of spending for FAFH as a percentage of average annual total food expenditures had gradually declined to 34%. A main reason for this drop in FAFH spending was the recession during the early 1990s (Manchester, 1993). During recessions, people cut back on food expenses by eating out less often.

Between 1980 and 1988, average annual expenditures for beef, pork, and poultry in urban households decreased (fig. 4-4). Between 1988 and 1992, per person spending for beef continued to decrease while spending for pork and poultry began to rise. Yearly fluctuations in spending were seen for fish and seafood.

Per person spending for all dairy products decreased slightly between 1980 and 1992. During that time, overall spending for fresh milk and cream dropped 18% (fig. 4-5), with spending for fresh whole milk dropping by one-half and spending for other types of fresh milk and cream increasing by almost 40%. Spending for cheese fell by nearly 10%, while spending for ice cream and other frozen dairy products increased by about one-third. Between 1980 and 1992, average annual per person expenditures for eggs declined by about one-third (fig. 4-5).

Per person spending for fresh fruits and vegetables dropped between 1980 and 1992; however, declines for vegetables were not as dramatic as those for fresh fruits (fig. 4-6). Spending for bananas climbed 45% during these years, whereas spending for oranges fell by nearly 50%, for apples, by 14%, and for other fresh fruits, by 30%. Spending for lettuce, tomatoes, and other fresh vegetables (excluding potatoes) also

Table 4-3. Average annual household expenditures per person for selected foods and percent change for selected years[1]

	CES					NFCS		
	Expenditures (1988 dollars)			Percent change		Expenditures (1988 dollars)		
	1980	1988	1992	1980-88	1980-92	1977-78	1987-88	Percent change
Total food	1341	1349	1343	0.6	0.1	2093	2059	−1.6
Food at home	879	824	879	−6.3	0.0	1534	1348	−12.1
Food away from home	464	511	464	10.1	0.0	559	711	27.2
Meat	203.86	146.64	155.99	−28.1	−23.5	392.73	267.96	−31.8
Beef	103.06	71.76	71.49	−30.4	−30.6	219.68	141.61	−35.5
Pork	65.73	42.12	53.16	−35.9	−19.1	103.90	77.81	−25.1
Poultry	38.18	33.80	45.69	−11.5	19.7	60.45	71.41	18.1
Fish and shellfish	31.02	26.00	28.45	−16.2	−8.3	61.44	60.16	−2.1
Eggs	13.73	10.92	9.58	−20.5	−30.2	19.23	14.48	−24.7
Dairy products	100.41	102.96	97.40	2.5	−3.0	164.35	159.72	−2.8
Fresh milk	52.85	50.96	43.17	−3.6	−18.3	81.53	72.89	−10.6
Cheese	30.09	30.68	27.36	2.0	−9.1	48.25	48.28	0.1
Frozen desserts	12.95	15.60	17.26	20.5	33.3	19.30	20.78	7.7
Fruits	85.62	81.12	74.80	−5.3	−12.6	148.30	117.09	−21.0
Fresh	50.85	47.32	39.74	−6.9	−21.8	94.52	66.88	−29.2
Processed	34.77	33.80	35.06	−2.8	0.8	53.78	50.21	−6.6
Vegetables	72.94	66.04	67.74	−9.5	−7.1	152.28	115.45	−24.2
Fresh	47.67	43.68	42.25	−8.4	−11.4	102.08	73.89	−27.6
Processed	25.27	22.36	25.49	−11.5	0.9	50.20	41.56	−17.2
Cereal and bakery products	122.57	121.16	131.10	−1.2	7.0	166.61	154.09	−7.5
Flour and flour mixes	7.53	5.20	6.58	−30.9	−12.6	14.15	7.61	−46.2
Cereals	22.65	28.08	26.05	24.0	15.0	54.37	62.73	15.4
Bread	29.44	24.96	24.56	−15.2	−16.6	42.37	34.98	−7.4
Other baked goods	55.98	53.56	62.07	−4.3	10.9	79.00	78.53	−0.6
Fats and oils	27.97	24.44	29.23	−12.6	4.5	42.56	34.58	−18.8
Prepared food, including baby food	34.77	49.92	65.16	43.6	87.4	27.34	64.10	134.5
Sugar and sweets	31.45	30.16	34.07	−4.1	8.3	50.71	39.63	−21.8
Selected nonalcoholic beverages								
Coffee	21.96	15.60	15.74	−29.0	−28.3	31.28	25.41	−18.8
Soft drinks	36.83	47.84	44.53	29.9	20.9	33.05	51.94	57.2
Alcoholic beverages	145.65	106.08	92.82	−27.2	−36.3	55.43	48.56	−12.4

[1]Data are from table A.T4-3,F4-3,4,5,6,7,8 in appendix VA. Food-expenditure data from the CES and NFCS surveys differ because of differences in several conceptual (measurement) issues between the two surveys. These differences are summarized in table 4-2. Subcategory values do not add up to category totals because only subcategories common to both surveys were included here.

SOURCE: DOL, CES, 1980-92; USDA, NFCS, 1977-78 and 1987-88.

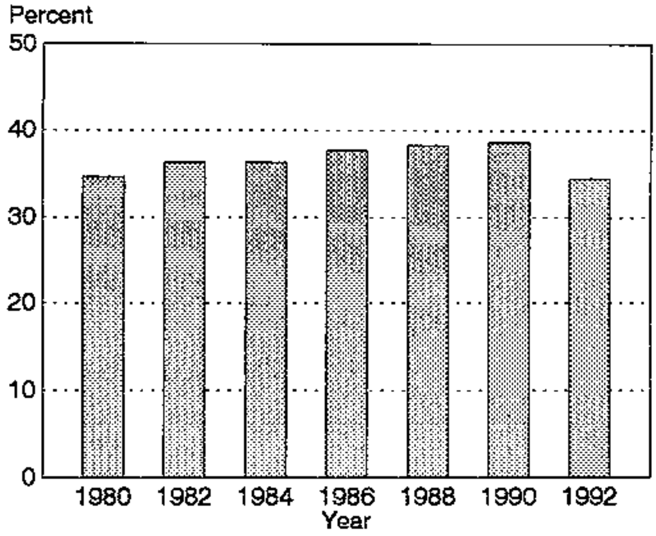

Figure 4-3. Share of spending per person in urban households for food away from home, as a percentage of total food expenditures, 1980-92

NOTE: Data are from table A.T4-3,F4-3,4,5,6,7,8 in appendix VA. Expenditures did not include food expenditures for alcohol.

SOURCE: DOL, CES, 1980-92 (Smallwood et al, 1994).

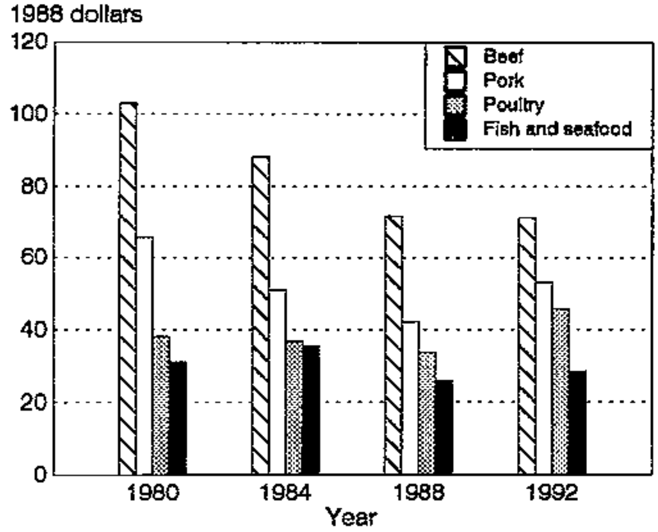

Figure 4-4. Average annual expenditures per person in urban households for beef, pork, poultry, and fish and seafood, 1980, 1984, 1988, and 1992

NOTE: Data are from table A.T4-3,F4-3,4,5,6,7,8 in appendix VA.

SOURCE: DOL, CES, 1980-92 (Smallwood et al., 1994).

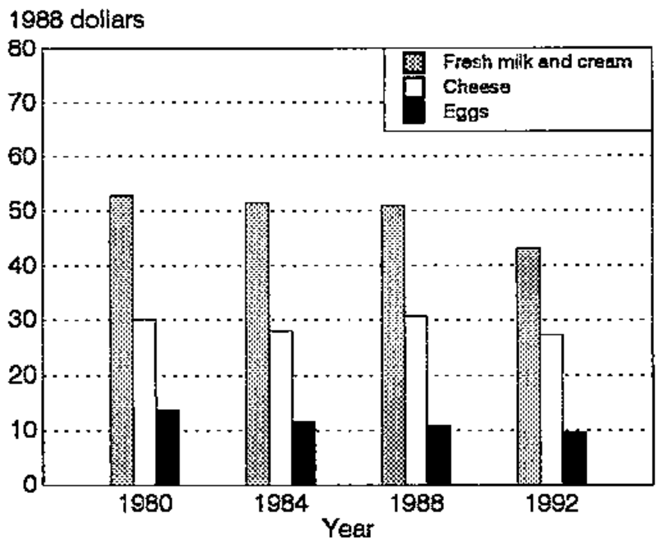

Figure 4-5. Average annual expenditures per person in urban households for fresh milk and cream, cheese, and eggs, 1980, 1984, 1988, and 1992

NOTE: Data are from table A.T4-3,F4-3,4,5,6,7,8 in appendix VA.

SOURCE: DOL, CES, 1980-92 (Smallwood et al., 1994).

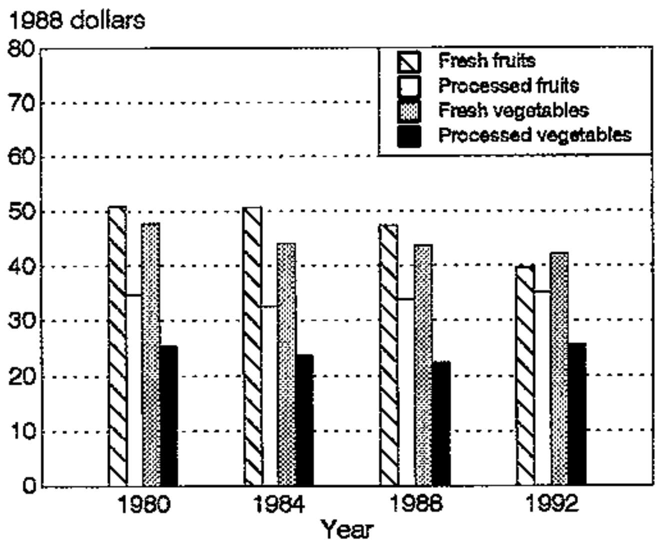

Figure 4-6. Average annual expenditures per person in urban households for fresh and processed fruits and vegetables, 1980, 1984, 1988, and 1992

NOTE: Data are from table A.T4-3,F4-3,4,5,6,7,8 in appendix VA. Processed fruits included canned, frozen, and dried fruits and fresh, canned, and frozen fruit juices. Processed vegetables included frozen vegetables, canned beans and corn, and other types of processed vegetables.

SOURCE: DOL, CES, 1980-92 (Smallwood et al., 1994).

decreased between 1980 and 1992. Spending for processed fruits and vegetables remained relatively unchanged.

Between 1980 and 1992, per person spending for cereal and bakery products increased 7%. Purchases of cereal climbed 15%, whereas purchases of rice, pasta, and cornmeal rose by about one-third. Spending for white bread decreased by 45%, while spending for other types of bread more than doubled. Much of the growth in spending on nonwhite breads was product-driven, as consumers gained appreciation for different varieties of breads and supermarkets began offering in-store bakeries and a wider variety of bread products (Putnam, 1994).

Food expenditures for fats and oils followed a downward trend between 1980 and 1987 and have since edged upward. Between 1980 and 1988, per person spending for butter decreased 36%, steadily climbed until 1991, and declined slightly in 1992. Spending for margarine followed a similar downward trend during the 1980s but increased gradually from 1990 through 1992. Gradual increases in spending for salad dressing and other fats and oils were noted between 1986 and 1992.

Between 1980 and 1992, spending for frozen prepared foods and other miscellaneous prepared foods, including baby foods, nearly doubled (fig. 4-7). During this time, purchases of potato chips, nuts, and similar types of snack foods jumped nearly 60%, and purchases of candy and chewing gum increased 32%. Purchases of carbonated and noncarbonated beverages rose by 21% and 34%, respectively, while purchases of coffee and of fresh milk and cream fell by 28% and 18%, respectively (fig. 4-8). Spending for alcoholic beverages used at home and away from home decreased by more than one-third between 1980 and 1992. Spending for alcoholic beverages is expected to continue to be low (Putnam, 1994).

NFCS 1977-78 and 1987-88

Average annual total food expenditures in 1987-88 were down slightly from 1977-78 (table 4-3). In 1977-78 and 1987-88, white households spent more money on food than did black households and households of other races. White and black households spent more on food in 1977-78 than in 1987-88, whereas other-race households spent more

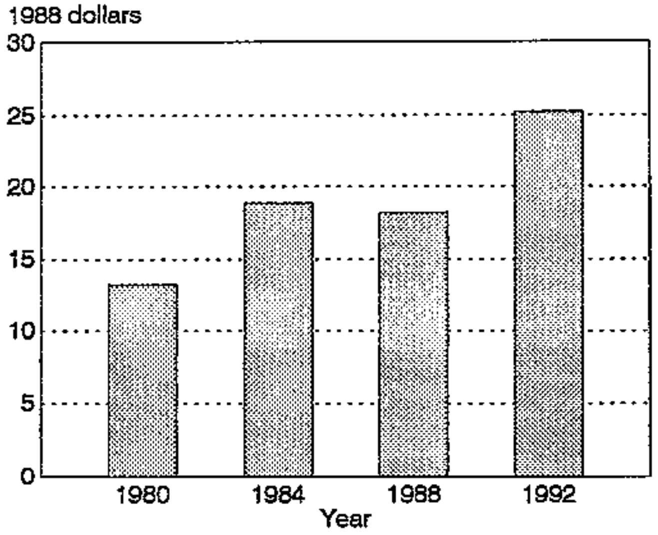

Figure 4-7. Average annual expenditures per person in urban households for frozen prepared foods, 1980, 1984, 1988, and 1992

NOTE: Data are from table A.T4-3,F4-3,4,5,6,7,8 in appendix VA.

SOURCE: DOL, CES, 1980-92 (Smallwood et al., 1994).

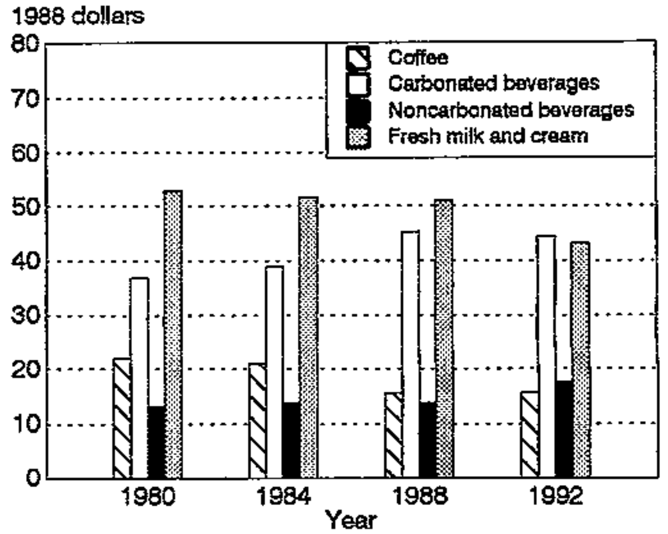

Figure 4-8. Average annual expenditures per person in urban households for selected nonalcoholic beverages, 1980, 1984, 1988, and 1992

NOTE: Data are from table A.T4-3,F4-3,4,5,6,7,8 in appendix VA.

SOURCE: DOL, CES, 1980-92 (Smallwood et al., 1994).

money for food in 1987-88 than in 1977-78. In both 1977-78 and 1987-88, households in the highest 20% of the income distribution spent about twice as much money for food as those in the lowest 20% and households in the Northeast and West spent more money on food than did households in the Midwest and South. Many of the differences in household food expenditures seen across regions can be explained by price variations (Lutz et al., 1992).

Between 1977-78 and 1987-88, FAFH spending increased from 27% to 35% of total food expenditures. During this time, the percentage of total food expenditures spent on FAFH increased across all racial groups (fig. 4-9), income classes (fig. 4-10), and regions of the country. White households spent a larger share of total food expenditures on FAFH than did black households and households of other races. In 1987-88, white households spent 36% of total food spending on FAFH, up from 28% in 1987-88. In comparison, FAFH spending in black households was 27% of total food expenditures in 1987-88, up from 20% in 1977-78, and FAFH spending in other-race households was 30% of total food expenditures, up from 21% in 1977-78. The wealthiest households spent 45% of total food expenditures on FAFH in 1987-88, up from 38% in 1977-78, whereas the poorest households spent 21% of total food expenditures on FAFH in 1987-88, up from 14% in 1977-78.

Compared with households in the Northeast, Midwest, and South, households in the West spent the greatest share of total food expenditures on FAFH, 36% in 1987-88 and 30% in 1977-78.

Between 1977-78 and 1987-88, per person consumption of beef and pork declined while consumption of poultry and fish and shellfish increased. In 1977-78 and 1987-88, black households consumed more pork, lunch meat, poultry, and fish and shellfish than did white and other-race households. In 1977-78, beef consumption rose sharply with income. In contrast, consumption declined in 1987-88 across all income classes, with the largest decreases occurring in the wealthier households (fig. 4-11). In 1987-88, per person consumption of fish and shellfish was generally higher in households with higher incomes, whereas per person consumption of pork and lunch meat was generally higher in households with lower incomes. The largest declines in per person consumption of beef were in the West, and the smallest declines were in the South. Households in the Northeast used the most poultry and fish, whereas those in the South used the most pork. Between 1977-78 and 1987-88, per person spending declined for all types of red meat and lunch meat across all racial groups, income classes, and regions of the country. Spending for poultry increased except in black households and in

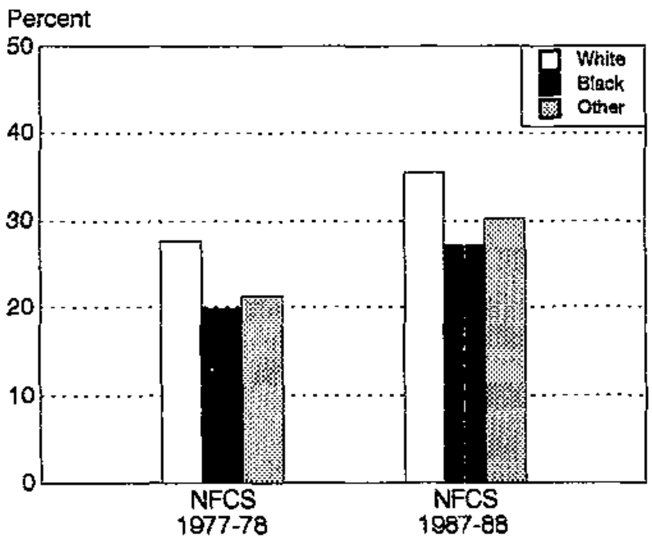

Figure 4-9. Percentage of total food expenditures spent on food away from home, by race, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

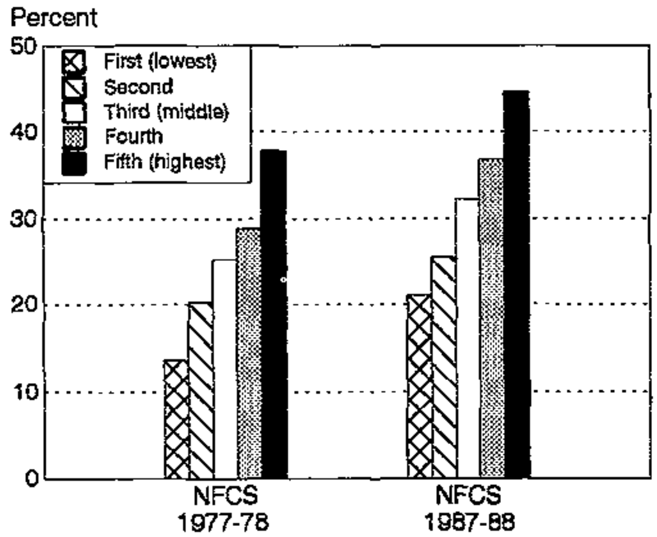

Figure 4-10. Percentage of total food expenditures spent on food away from home, by income quintile, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

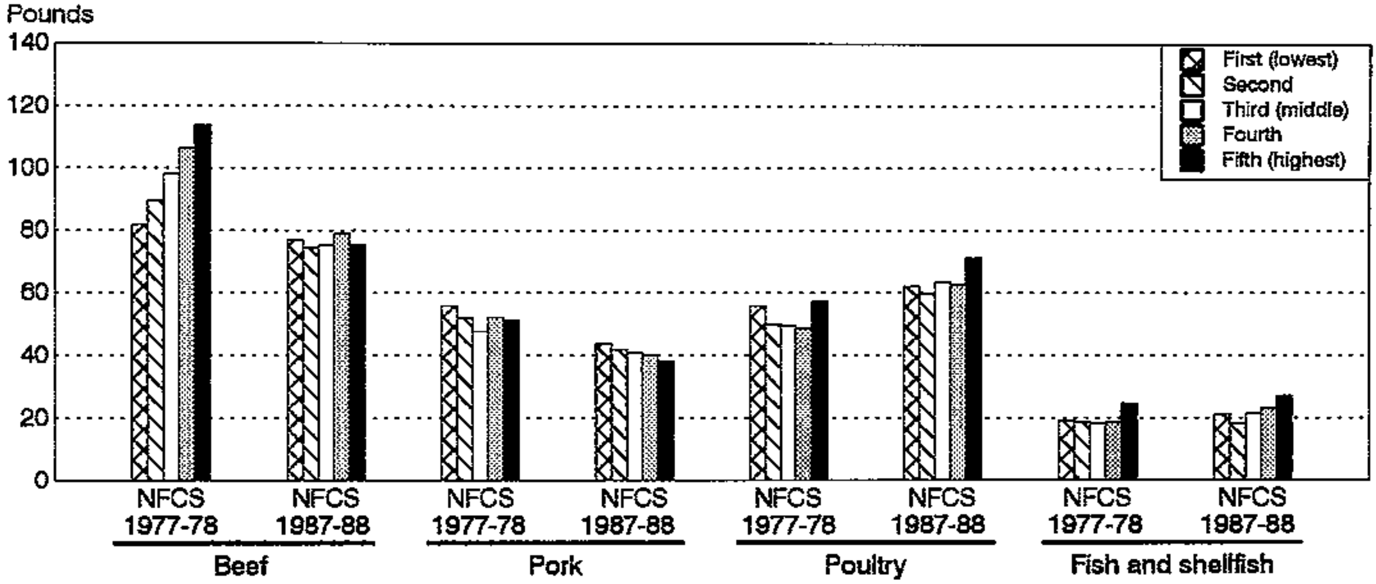

Figure 4-11. Average annual household use of beef, pork, poultry, and fish and shellfish in pounds per 21-meal-equivalent person, by income quintile, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

the poorest households, and it increased in all regions in the country. Spending for fish and shellfish increased in white and other-race households, in households at higher income levels, and in the Northeast.

Per person consumption of eggs fell 25% between 1977-78 and 1987-88. Declines in consumption were highest in other-race households, in the wealthiest households (fig. 4-12), and in the South and West. Egg consumption and spending for eggs decreased in all racial and income groups and in every region of the country during that period.

Between 1977-78 and 1987-88, small declines were seen in per person consumption of and spending for dairy products (fresh equivalent). Consumption of fresh fluid milk decreased across racial and income groups and all regions of the country except the Midwest, with the largest decreases seen in black and other-race households, in higher income households (fig. 4-12), and in the West. Purchases of fresh fluid milk decreased across all racial and income groups and regions of the country. In 1977-78 and 1987-88, consumption and purchases of fresh fluid milk and cheese were highest in white households and increased with income (fig. 4-12). Between 1977-78 and 1987-88, cheese consumption increased in white and other-race households, across income classes, and in the Northeast, Midwest, and South.

Northeasterners spent the most money on fresh fluid milk and cheese, whereas Southerners spent the least amount on these foods. Use of frozen-milk desserts declined slightly across all racial and income groups and regions of the country. Spending for frozen-milk desserts rose in all households except black and other-race households, the poorest households, and households in the Northeast.

Consumption and purchases of fresh and canned fruits and vegetables and frozen fruits declined between 1977-78 and 1987-88, and consumption and purchases of fruit juices and frozen vegetables increased. In 1977-78 and 1987-88, white households consumed more fresh fruits and vegetables per person than did black households. In 1987-88, other-race households consumed more fresh vegetables but less canned and frozen fruits and vegetables than did white and black households. Consumption and purchases of fresh and frozen fruits and vegetables and fruit juices tended to increase with income (fig. 4-13). Households in the West used the most fresh fruits and vegetables, Northeastern households used the most frozen fruits and vegetables and the most fruit juices, Midwestern households used the most canned fruits, and Southern households used the most canned vegetables.

Between 1977-78 and 1987-88, per person consumption of breakfast cereals climbed 12% and

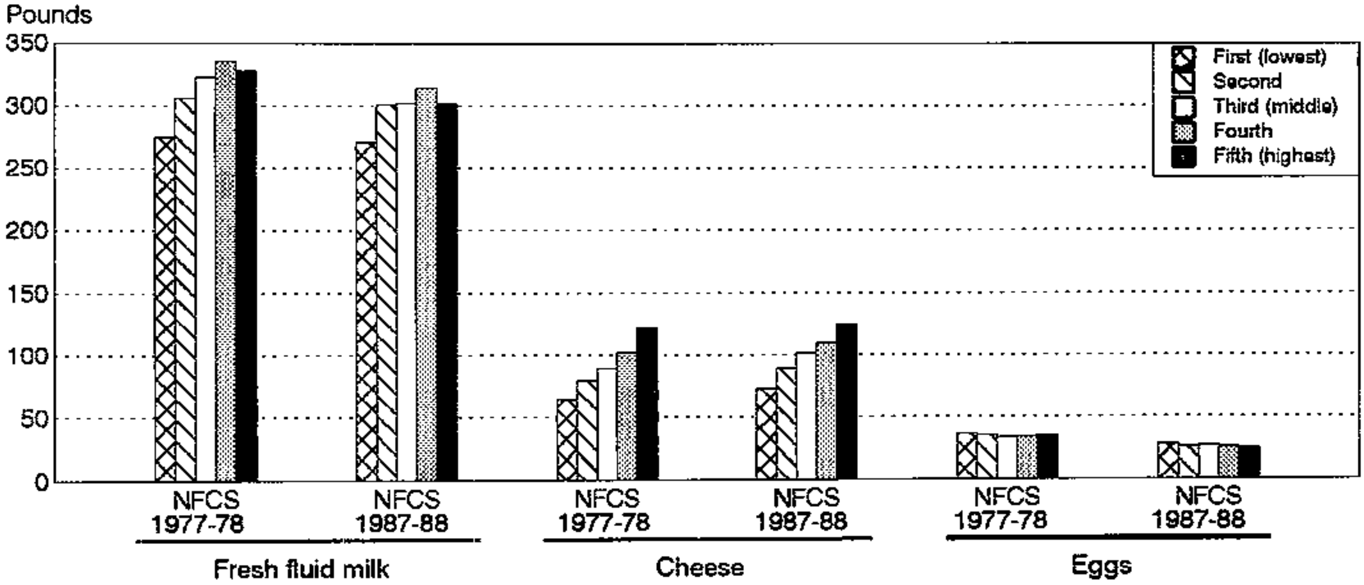

Figure 4-12. Average annual household use of fresh fluid milk, cheese, and eggs in pounds per 21-meal-equivalent person, by income quintile, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

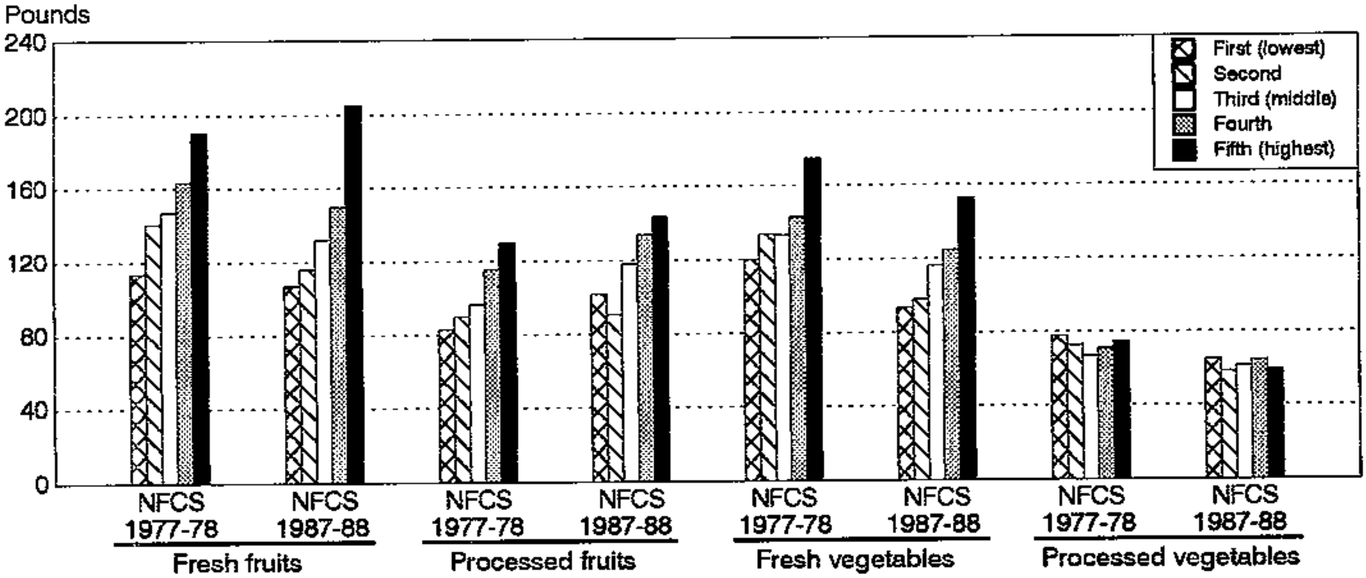

Figure 4-13. Average annual household use of fresh and processed fruits and vegetables in pounds per 21-meal-equivalent person, by income quintile, 1977-78 and 1987-88

NOTE: Processed fruits included canned, frozen, and dried fruits and fresh, canned, and frozen fruit juices. Processed vegetables included canned, frozen, and dried vegetables and vegetable juices.

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

baked goods increased 6% while consumption of bread dropped 13%. In 1977-78 and 1987-88, white households consumed more breakfast cereals and baked goods than did black and other-race households; higher-income households tended to use more baked goods and less cereals other than breakfast cereals than did lower-income households; and households in the Northeast used the most baked goods. Average annual per person spending for breakfast cereals climbed 27% between the two surveys, while purchases for other types of cereals decreased 6%. Spending for bread dropped 17%, while spending for other baked goods decreased only slightly.

Consumption of and spending for fats and oils declined across all racial and income groups and regions of the country between 1977-78 and 1987-88. In 1977-78 and 1987-88, white households used more and spent more money on fats and oils than did black and other-race households. Consumption of and expenditures for table fats, shortening, and salad and cooking oils decreased, whereas consumption of and spending for salad dressings increased. Spending for table fats and salad dressings was highest among white households and increased with income, spending for shortening was highest in black and lower-income households, and spending for salad and cooking oils was highest in other-race households.

Per person consumption of mixtures and dinners (canned, frozen, dried, and already cooked) nearly doubled between 1977-78 and 1987-88. In 1977-78 and 1987-88, white households consumed the most mixtures and dinners and black households consumed the least. Household use nearly doubled across all racial groups, was higher as income level increased (fig. 4-14), and increased the most in the Midwest. Spending climbed dramatically between 1977-78 and 1987-88; purchases of mixtures and dinners increased nearly 150%.

Overall use of sugars and sweets dropped 9 lb per person between 1977-78 and 1987-88. In 1977-78, black households consumed about the same amount of sugars and sweets as white households and more than other-race households, whereas in 1987-88, black households consumed more sugars and sweets than white and other-race households. Use of sugars and sweets tended to decrease as income level increased. Use was highest in the South and lowest in the Northeast and West.

Consumption of soft drinks increased the most of all the nonalcoholic beverages between 1977-78 and 1987-88 (52%). Per person consumption increased across all racial and income groups and regions of the country. As shown in figure 4-15, in 1977-78 and 1987-88, consumption was highest in white

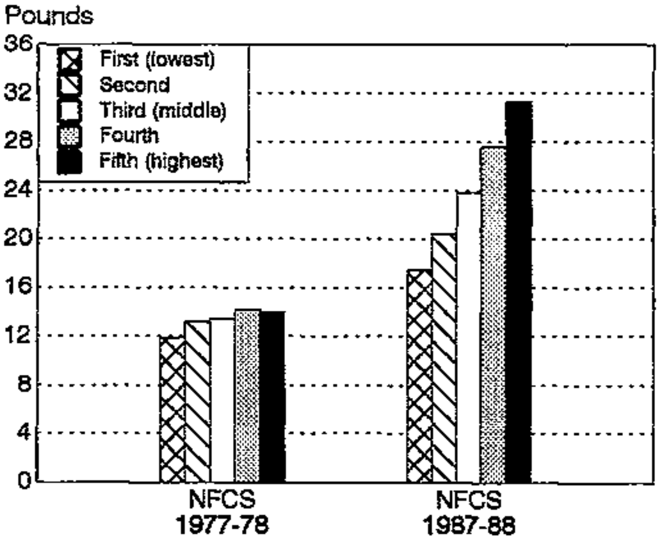

Figure 4-14. Average annual household use of mixtures and dinners (canned, frozen, dried, and already cooked) in pounds per 21-meal-equivalent person, by income quintile, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

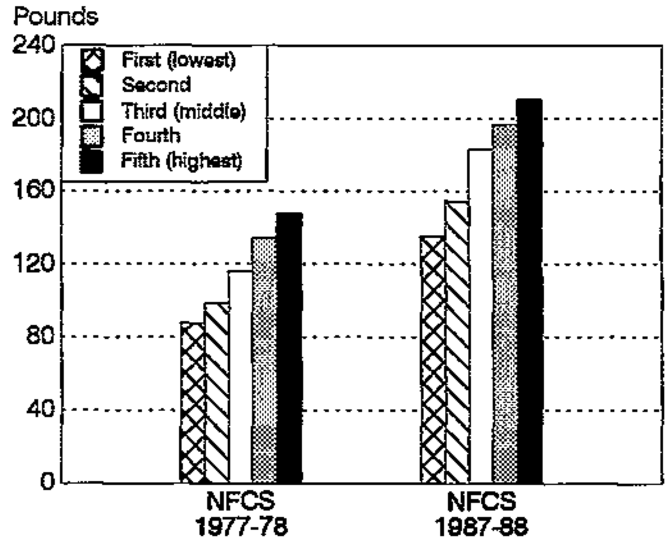

Figure 4-15. Average annual household use of soft drinks in pounds per 21-meal-equivalent person, by income quintile, 1977-78 and 1987-88

SOURCE: USDA, NFCS, 1977-78 and 1987-88 (Lutz et al., 1992).

households and lowest in black households and was higher at higher incomes. Between 1977-78 and 1987-88, consumption of alcoholic beverages increased in white and other-race households and in the South and West. Households at the lowest and highest ends of the income distribution increased consumption of alcoholic beverages, and middle-income households decreased use of alcoholic beverages.

Summary of findings

The types and variety of foods eaten, the methods and extent of food preparation, and away-from-home eating patterns have changed considerably since the 1970s. Besides changes in traditional demand determinants, such as food prices, family income, and population structure, notable changes have occurred in nontraditional factors that affect the demand for food. These include changes in consumer life-styles and socioeconomic and demographic characteristics, changes in technological forces, and heightened consumer concern about diet and nutrition.

Despite differences between the CES and the NFCS, trends in food spending during the 1980s were fairly consistent between the surveys in most cases. When adjusted for inflation, data from CES 1980 and 1988 and from NFCS 1977-78 and 1987-88 showed that total food spending remained relatively unchanged and that FAFH spending, as a proportion of total food expenditures, increased. Subsequent data from CES 1989-92 found that FAFH spending, as a share of total food expenditures, continued to climb until 1990 and then began to decrease in 1991 and continued to decrease in 1992.

During the 1980s, noteworthy trends in household spending occurred for certain foods. Per person spending, adjusted for inflation, increased for prepared foods, soft drinks, cheese, frozen desserts, and cereals and decreased for beef, pork, eggs, fish and shellfish, fresh milk, flour and flour mixes, breads and other baked goods, fresh and processed fruits and vegetables, fats and oils, sugars and sweets, coffee, and alcoholic beverages. Little change was found for purchases of dairy products as a group. Per person spending for poultry decreased.

Consistent with these findings are household-food-use patterns from the NFCS. Between 1977-78 and 1987-88, annual per person consumption of prepared foods, soft drinks, cheese, and cereals, particularly breakfast cereals, increased, while consumption of beef, pork, eggs, fresh milk, flour and flour mixes, breads, fats and oils, and sugars and sweets declined. Declines in consumption were also seen for fresh fruits and vegetables. Consumption of frozen fruits and canned fruits and vegetables decreased, while consumption of fruit juices and frozen vegetables increased.

Data from CES 1989-92 showed continued upward trends in spending for prepared foods and continued downward trends in spending for eggs, fresh milk, fresh fruits and vegetables, and alcoholic beverages. Between 1989 and 1992, purchases for beef, poultry, pork, processed fruits and vegetables, fats and oils, sugars and sweets, and coffee showed signs of increasing, while purchases for soft drinks and total dairy products, including cheese, showed signs of decreasing.

Gaps in knowledge

A great deal of data is reported in the CES and the NFCS for some foods and food groupings. However, data for certain types of foods, for example, specific types of milk (whole milk, low-fat milk, and skim milk), yogurt, low-fat and nonfat frozen dairy products, and processed eggs, are collected but not reported in commonly available published tables. Data on specific types of foods may be found in other reports and are available on data tapes, which are less accessible than published material.

A limitation of the data from the two surveys is that the surveys' reporting practices for foods and food groups differ, thus making comparisons across surveys difficult. Furthermore, in some cases, unrelated foods are grouped together in ways that make it difficult to identify trends for specific foods included in a food grouping. For example, in the CES, data are reported for the milk groupings "fresh whole milk" and "other fresh milk and cream," whereas in the NFCS, data are reported only for "fresh fluid milk." When data are reported in this manner, specific trends in consumption and expenditures for whole milk, low-fat milk, and skim milk cannot be identified. When unrelated foods are grouped together, actual changes over time for the food grouping become diluted. This effect becomes especially pronounced if trends for two foods in the same grouping are in opposite directions.

Another limitation of the CES and NFCS data is that they do not capture information for FAFH by type of food item and by food facility (school cafeteria, restaurant with counter service, restaurant with waiter-waitress service, vending machine, etc.). Also, little detail is provided on preprepared food.

Recommendations

- Continue collecting annual CES food-expenditure data at the household level for food at home and FAFH. These data provide an invaluable source of information on household food expenditures every year.

- Continue collecting NFCS household data for food at home and FAFH. These data are the only available source of collective information about household food use and expenditures, and they permit the analysis of food use and expenditures according to several sociodemographic categories, including race, region, urbanization, and household size. Because these data provide vital information needed for food policy decisions, NFCS household data should be collected at shorter intervals, perhaps every 5 years rather than every 10 years, which will allow better descriptions of trends in a rapidly changing marketplace.

- Expand efforts to capture FAFH information by type of food item and by type of food facility (school cafeteria, restaurant with counter service, restaurant with waiter-waitress service, vending machine, etc.) where foods are eaten away from home.

- Consider collecting and analyzing household food expenditure data in the CES and household food use and expenditure data in the NFCS for preprepared foods because of the increase in household use of preprepared foods.

- Make data-collection and analytical methodologies more consistent between the CES and the NFCS. For example, the CES reports food expenditures on a per person basis, whereas the NFCS reports the money value of food on a 21-MEP basis. A further limitation of the surveys is that the reporting categories for food groupings differ in commonly available published tables. Addressing these two limitations would permit greater comparison of data between the two surveys.

- Modify current food-grouping reporting practices for the CES and the NFCS to better capture changes in the types of foods available to consumers. This will permit greater understanding of changes in current and future patterns in household food use and purchasing. Over the past decade, the types of foods that American households are using have changed considerably. For example, more lower-fat versions of foods—such as frozen entrees, frozen dairy products, and cakes, cookies, and crackers—are and will continue to become available. Rather than purchasing food commodities, many people now purchase foods in mixtures, such as frozen entrees and pizza, and as preprepared foods (foods purchased in a ready-to-eat form and taken home for consumption), such as foods from carryout restaurants and salads from supermarkets.

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Chapter 5

Food Composition and Survey Nutrient Data Bases

Introduction

Accurate food composition data are a prerequisite for the assessment of nutrient intake and nutritional adequacy of diets as well as for the identification and evaluation of nutrition-related health conditions. This chapter provides an update of information on food composition data in the research data bases of the National Nutrient Data Bank and the survey nutrient data bases that are developed from it. The role of food composition information in the diet-health relationship is shown in figure 5-1.

The sources of food composition data considered in this chapter are shown in table 5-1. These data are available as handbooks and in electronic formats. The food components considered in this report are substances that have been associated with nutrition-related health status. The National Nutrient Data Bank does not include data on the composition of dietary supplements except those used as meal replacements.

Research data bases on food composition

After a food is analyzed in the laboratory, its composition data, along with the quality-assurance procedures described below, are incorporated into the research data bases on food composition. (For further information on the research data bases for the National Nutrient Data Bank, see Haytowitz (1995).)

The USDA Nutrient Data Base for Standard Reference, a computer file for *Agriculture Handbook No. 8* (e.g., USDA, 1992), is produced from the National Nutrient Data Bank and is the main source of data for the USDA Nutrient Data Base for Individual Food Intake Surveys (Survey Nutrient Data Base). The USDA Nutrient Data Base for Standard Reference contains nutrient profiles for about 5,200 food items, with values for the "proximate" components (i.e., water, food energy, protein, total lipid (fat), total carbohydrates, total dietary fiber, and ash), 9 mineral elements, 9 vitamins, individual fatty acids (saturated, monounsaturated, and polyunsaturated), cholesterol, total phytosterols, and 18 amino acids (table 5-2). Refuse values, which are used to calculate the weight of the edible part of a food item that contains refuse, are also listed for each food item in the data base.

Information in this data base includes the mean or weighted mean, the number of samples on which the values are based, and the standard error of the mean so that the variability in the nutrient data can be estimated. Analytical data incorporated into the data base are derived from several sources, including the food industry; Agricultural Research Service (ARS) contracts; government laboratories, including the USDA Food Composition Laboratory (FCL); and the scientific literature. Approximately 85% of the food composition data in the National Nutrient Data Bank are from sources outside USDA (Perloff, 1994). In some cases, values not available from these sources are imputed and included in the data base; in other cases, the missing values are not imputed. Supporting files include the data base format, a list of food descriptors and identification numbers, and a file that links the food identification numbers used in the 1963 edition of *Agriculture Handbook No. 8* to the food identification numbers used in the revised sections of that handbook.

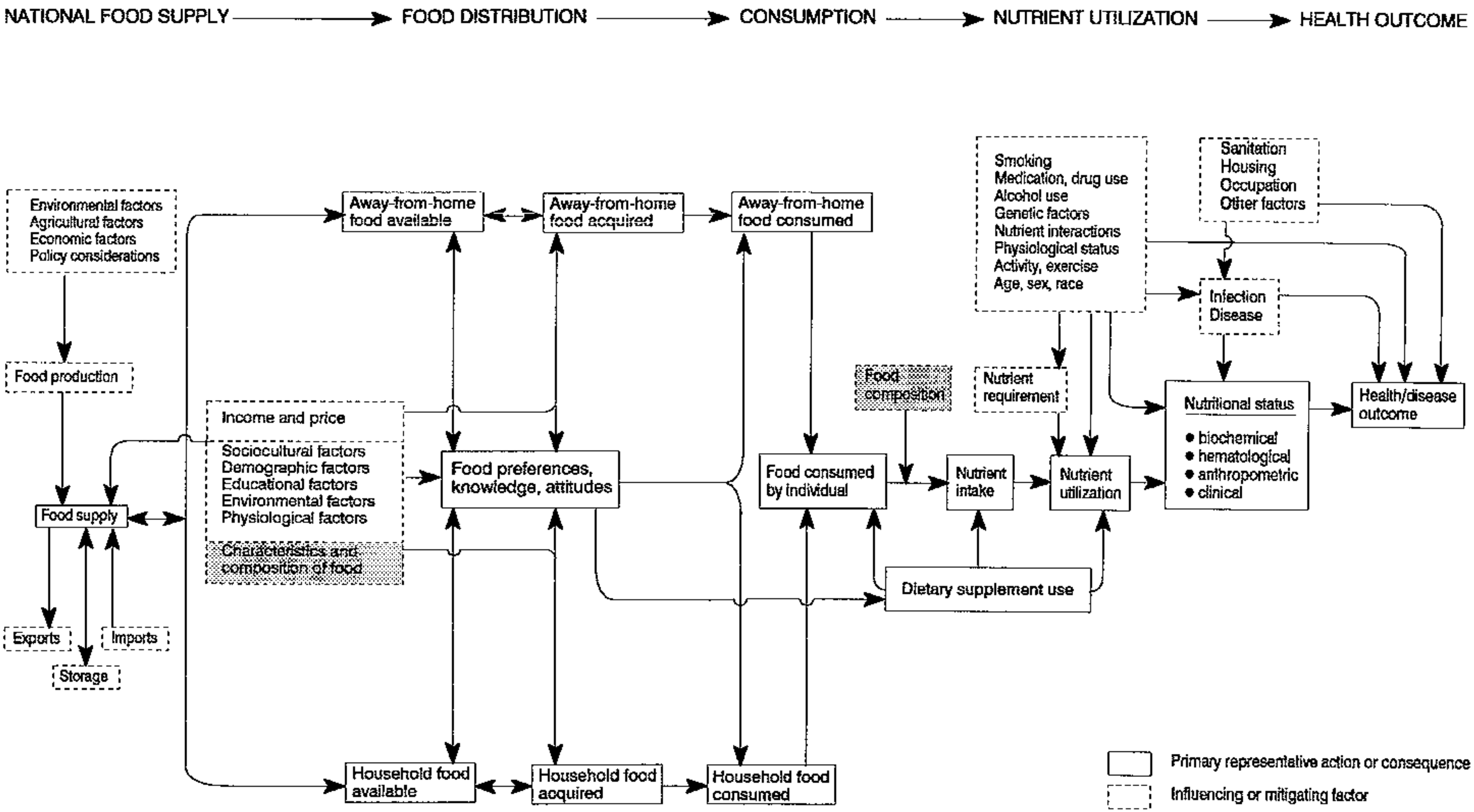

Figure 5-1. General conceptual model highlighting food composition in the relationship of food to health (see text for explanation)

SOURCE: LSRO (1989).

Table 5-1. Types and sources of data on food composition used in chapter 5 of the *Third Report on Nutrition Monitoring*

Type of data	Source of data[1]
Food composition data from provisional tables on concentrations of selenium and vitamins D and K in foods	USDA, ARS
USDA Nutrient Data Base for Individual Food Intake Surveys (Survey Nutrient Data Base)[2]	USDA, ARS and HNIS[3]
USDA Nutrient Data Base for Standard Reference	USDA, ARS

[1]USDA, U.S. Department of Agriculture; ARS, Agricultural Research Service; HNIS, Human Nutrition Information Service.
[2]The Survey Nutrient Data Base appropriate for the years of the following surveys was used: NFCS 1977-78, HHANES 1982-84, CSFII 1985-86, NFCS 1987-88, NHANES III 1988-91, CSFII 1989-91, and the Strong Heart Dietary Survey 1989-91. The sponsoring agency was ARS (USDA) for 1977-81 and HNIS (USDA) for 1981-91.
[3]Legislation passed on Feb. 20, 1994, transferred the functions and staff of USDA's Human Nutrition Information Service (HNIS) to the existing Agricultural Research Service (ARS) of that department.

SOURCE: LSRO, 1994.

Table 5-2. Food components in the USDA Nutrient Data Base for Standard Reference

Proximate	Minerals	Vitamins	Lipids	Amino acids
Water	Calcium	Vitamin C	Fatty acids	Tryptophan
Food energy	Iron	Thiamin	Saturated, total (C_4-C_{18})	Threonine
Protein	Magnesium	Riboflavin	Monounsaturated, total ($C_{16:1}$-$C_{22:1}$)	Isoleucine
Total lipid (fat)	Phosphorus	Niacin	Polyunsaturated, total ($C_{18:2}$-$C_{22:6}$)	Leucine
Total carbohydrate	Potassium	Pantothenic acid	Cholesterol	Lysine
Total dietary fiber	Sodium	Vitamin B_6	Phytosterols	Methionine
Ash	Zinc	Folate		Cystine
	Copper	Vitamin B_{12}		Phenylalanine
	Manganese	Vitamin A		Tyrosine
				Valine
				Arginine
				Histidine
				Alanine
				Aspartic acid
				Glutamic acid
				Glycine
				Proline
				Serine

SOURCE: USDA, ARS, 1994.

Tables 5-3, 5-4, and 5-5 summarize the current state of knowledge about food composition data for carbohydrates, protein, lipids, vitamins, and minerals. These tables provide an indication of the quantity of data available for various food groups in the USDA Nutrient Data Base for Standard Reference as of 1990. (The quantity of data for some nutrients, such as dietary fiber and selenium, has increased since then.) The tables do not address the quality of data for specified foods or sources. USDA periodically revises the data base to include new data for foods or food components and assigns a release number to each revision of the data base to allow data base users to identify the version of the data base they used.

Survey data bases for nutrient intakes

The Survey Nutrient Data Base is actually a series of data bases derived from several sources and developed for use in the NFCS and the CSFII. It has also been used in analyses of nutrient intakes for HHANES 1982-84 and NHANES III 1988-91 data. The data bases in this series contain mean values for food energy and 28 other food components (shown in table 5-6).

The data do not correspond to any published set of food composition values. Each release of the Survey Nutrient Data Base is developed using analytical and imputed data from the USDA Nutrient Data Base for Standard Reference and other current data. For example, some data for highly processed foods, such as baked products and snack foods, frozen meals and entrees, and fast foods, are provided by the food industry on a voluntary basis to supplement the data in the USDA Nutrient Data Base for Standard Reference. The Survey Nutrient Data Base currently contains food composition data for about 7,100 food items.

As shown in figure 5-2, the components of the data base system include a primary nutrient data set, a recipe file, and a file of nutrient retention factors that are linked together by a recipe-calculation program. A description of each of these components is included below (see "Developing Survey Nutrient Data Bases").

Generating food composition data and evaluating data quality

Analytical data

Generating food composition data is costly. The cost of analyzing one sample for all of the nutrients reported in the USDA Nutrient Data Base for Standard Reference can range from about $1,600 to $2,000. Analyzing six samples, as recommended by the U.S. General Accounting Office (GAO, 1993), may cost about $10,000 to $12,000 per food. Such funds are rarely available. Therefore, for the systematic improvement of food composition data, priorities must be set for analyzing food components and foods.

Selecting food components and foods for analysis

Food components.— As discussed by Beecher and Matthews (1990), factors that have been considered by USDA in establishing priorities for the analysis of food components include 1) the adequacy of the composition data for the food component, 2) the adequacy of the analytic methodology, and 3) the association of the nutrient or food component with a current public health problem in the United States. Food components that meet all three criteria are given the highest priority for analysis. For food components for which data are inadequate and a public health problem is known or suspected but for which good analytic methodology is lacking, the measurement system must be improved before high-quality data can be generated.

Food components that have been associated with nutrition-related health problems and that were considered current public health issues in 1989 are food energy, total fat, saturated fatty acids, cholesterol, alcohol, iron, calcium, and sodium (LSRO, 1989). These food components qualify for highest priority in terms of assessing the adequacy of analytic methodology and food composition data (Beecher and Matthews, 1990). A second group of nutrients that were considered potential public health issues requiring further study in 1989 included dietary fiber, vitamin A, carotenes, folate, vitamin B_6,

Table 5-3. State of knowledge of the carbohydrate, protein, and lipid composition of foods[1]

Food type	Individual sugars	Starch	Dietary fiber	Total protein	Total fat	Fatty acids	Choles-terol	Other sterols	*Trans* fatty acids
Baby foods	○	○	□	●	●	□	□	○	○
Baked products									
Bread	○	□	□	●	●	□	○	○	□
Sweet goods	○	□	□	●	●	□	○	○	□
Cookies and crackers	○	□	□	●	●	□	○	○	□
Beverages	□	*	*	*	○	○	*	*	*
Breakfast cereals	●	□	●	●	●	□	○	○	○
Candies	□	○	○	○	□	□	□	□	□
Cereal grains									
Whole	□	□	□	●	□	●	*	□	*
Flour	□	□	□	●	□	●	*	□	*
Pasta	□	□	□	●	□	□	*	○	*
Dairy products	●	*	*	●	●	●	●	*	*
Eggs and egg products	*	*	*	●	●	●	●	*	*
Fast foods	○	○	□	●	●	□	□	□	□
Fats and oils	*	*	*	*	●	●	●	□	●
Fish and shellfish									
Raw	*	*	*	●	●	●	●	□	○
Cooked	*	*	*	□	●	●	●	○	○
Frozen dinners	○	○	□	□	□	□	□	○	○
Fruits									
Raw	●	○	□	●	●	□	*	□	*
Cooked	□	○	□	□	○	○	*	○	*
Frozen or canned	□	○	□	●	●	○	*	○	*
Infant formula	○	○	○	●	□	□	○	○	○
Institutional food	□	□	□	○	□	□	□	□	○
Legumes									
Raw	□	□	□	●	●	□	*	□	*
Cooked	□	□	□	●	●	□	*	○	*
Processed	□	□	□	●	□	□	*	○	*
Meat									
Beef	*	*	*	●	□	●	●	*	*
Lamb	*	*	*	●	□	●	●	*	*
Pork	*	*	*	●	●	●	●	*	*
Sausage	*	*	*	●	●	●	●	*	*
Veal	*	*	*	●	●	●	□	*	*
Mixed dishes									
Commercial	○	○	□	●	□	□	□	□	○
Home prepared	○	○	□	□	□	□	□	○	○
Nuts and seeds	□	□	□	●	●	●	*	□	*
Poultry	*	*	*	●	●	●	●	*	*
Restaurant food	□	□	□	○	○	○	○	○	○
Snack foods	□	○	□	□	●	□	□	○	□
Soups	○	○	○	●	●	□	□	□	○
Vegetables									
Raw	□	●	□	●	□	□	*	□	*
Cooked	□	□	□	●	□	○	*	○	*
Frozen	□	□	□	●	●	○	*	○	*
Canned	□	□	□	●	●	○	*	○	*

[1]● Substantial data, □ inadequate data, ○ few or no data, and * not applicable.

SOURCE: Adapted from Beecher and Matthews (1990).

Table 5-4. State of knowledge of the vitamin composition of foods[1]

Food type	Vitamin A	Thiamin	Riboflavin	Vitamin B_6	Vitamin C	Niacin	Vitamin B_{12}	Folate	Vitamin D	Vitamin E
Baby foods	●	●	●	□	●	●	□	□	*	□
Baked products										
Bread	*	●	●	●	*	●	*	□	*	□
Sweet goods	□	●	●	□	*	●	□	□	*	□
Cookies and crackers	□	●	●	●	*	●	□	□	*	□
Beverages	□	□	□	□	□	□	*	□	*	*
Breakfast cereals	□	□	□	□	□	□	□	□	□	□
Candies	□	□	□	□	□	□	○	□	*	○
Cereal grains										
Whole	□	●	●	●	*	●	*	●	*	□
Flour	*	●	●	●	*	●	*	●	*	□
Pasta	*	●	●	●	*	●	*	●	*	○
Dairy products	●	●	●	●	●	●	●	□	●	□
Eggs and egg products	□	●	●	●	*	●	●	□	□	□
Fast foods	●	●	●	□	□	●	□	○	○	□
Fats and oils	□	*	*	*	*	*	*	*	□	□
Fish and shellfish										
Raw	□	□	□	□	*	□	□	□	□	□
Cooked	○	○	○	○	*	○	○	□	□	□
Frozen dinners	□	●	●	○	□	●	○	○	*	○
Fruits										
Raw	●	●	●	●	●	●	*	□	*	○
Cooked	□	□	□	□	□	□	*	□	*	○
Frozen or canned	●	●	*	□	●	●	*	□	*	○
Infant formula	○	○	○	○	○	○	○	○	○	○
Institutional food	○	○	○	○	○	○	○	○	○	□
Legumes										
Raw	□	●	●	□	*	●	*	●	*	●
Cooked	○	●	●	□	*	●	*	●	*	●
Processed	□	□	□	○	□	□	*	○	*	□
Meat										
Beef	●	●	●	●	*	●	●	□	□	□
Lamb	□	●	●	□	*	●	●	□	□	□
Pork	□	●	●	●	*	●	●	□	□	□
Sausage	□	●	●	●	●	●	●	□	□	○
Veal	□	●	●	●	*	●	●	●	□	□
Mixed dishes										
Commercial	□	●	●	□	□	●	□	□	○	□
Home prepared	□	□	□	□	□	□	□	○	○	○
Nuts and seeds	□	□	□	□	□	□	*	*	□	□
Poultry	□	●	●	□	*	●	□	□	□	□
Restaurant food	○	○	○	○	○	○	○	○	○	○
Snack foods	□	□	□	□	○	□	*	□	□	□
Soups	●	●	●	□	●	●	□	○	*	○
Vegetables										
Raw	●	●	●	□	●	●	*	□	*	□
Cooked	□	□	□	□	□	□	*	□	*	□
Frozen	●	●	●	○	●	●	*	□	*	○
Canned	●	●	●	○	●	●	*	□	*	○

[1]● Substantial data, □ inadequate data, * not applicable, and ○ few or no data.

SOURCE: Adapted from Beecher and Matthews (1990).

Table 5-5. State of knowledge of the mineral composition of foods[1]

Food type	Calcium	Iron	Phos-phorus	Sodium	Mag-nesium	Potas-sium	Zinc	Copper	Man-ganese	Boron, chromium, fluoride, iodine, and selenium
Baby foods	●	●	●	●	□	●	□	□	○	○
Baked products										
Bread	●	●	●	●	●	●	●	●	□	○
Sweet goods	●	●	●	●	●	●	●	□	□	○
Cookies and crackers	●	●	●	●	●	●	●	●	□	○
Beverages	□	□	□	□	□	□	□	□	○	○
Breakfast cereals	●	□	●	●	●	●	●	●	□	○
Candies	□	□	□	□	□	□	□	□	○	○
Cereal grains										
Whole	●	●	●	●	●	●	●	●	●	○
Flour	●	●	●	●	●	●	●	●	●	○
Pasta	●	●	●	●	●	●	●	●	●	○
Dairy products	●	●	●	●	●	●	●	●	□	○
Eggs and egg products	●	●	●	●	□	●	●	□	□	○
Fast foods	●	●	●	●	●	●	●	●	□	○
Fats and oils	○	○	○	○	○	○	□	□	*	*
Fish and shellfish										
Raw	●	●	●	●	●	●	●	●	●	○
Cooked	○	○	○	○	○	○	○	○	○	○
Frozen dinners	□	□	□	□	□	□	□	□	○	○
Fruits										
Raw	●	●	●	●	●	●	□	□	□	○
Cooked	□	○	○	○	○	□	○	○	○	○
Frozen or canned	●	●	●	●	●	●	□	□	○	○
Infant formula	□	□	□	□	□	□	○	○	○	○
Institutional food	○	○	○	○	○	○	○	○	○	○
Legumes										
Raw	●	●	●	●	●	●	●	●	●	○
Cooked	●	●	●	●	●	●	●	●	●	○
Processed	□	□	□	□	□	□	○	○	○	○
Meat										
Beef	●	●	□	●	●	●	●	●	●	○
Lamb	●	●	●	●	●	●	●	●	□	○
Pork	●	●	●	●	●	●	●	●	●	○
Sausage	●	●	●	●	●	●	●	●	□	○
Veal	●	●	●	●	●	●	●	●	□	○
Mixed dishes										
Commercial	●	●	●	●	●	●	□	□	○	○
Home prepared	□	□	□	□	□	□	○	○	○	○
Nuts and seeds	●	●	●	●	●	●	●	●	●	○
Poultry	●	●	●	●	●	●	●	●	●	○
Restaurant food	○	○	○	○	○	○	○	○	○	○
Snack foods	□	□	○	●	○	○	○	○	○	○
Soups	●	●	●	●	●	●	●	●	○	○
Vegetables										
Raw	□	□	□	□	□	□	□	□	□	○
Cooked	□	□	□	□	□	□	○	○	○	○
Frozen	●	●	●	●	●	●	●	●	○	○
Canned	●	●	●	●	●	●	●	●	○	○

[1] ● Substantial data, □ inadequate data, ○ few or no data, and * not applicable.

SOURCE: Adapted from Beecher and Matthews (1990).

Table 5-6. Food components in the USDA Nutrient Data Base for Individual Food Intake Surveys

Proximate	Minerals	Vitamins	Lipids	Other
Food energy	Calcium	Vitamin A	Fatty acids	Alcohol
Moisture	Phosphorus	Carotenes	Saturated	
Protein	Magnesium	Vitamin E	Monounsaturated	
Total lipid (fat)	Iron	Vitamin C	Polyunsaturated	
Total carbohydrate	Zinc	Thiamin	Cholesterol	
Total dietary fiber	Copper	Riboflavin		
	Sodium	Niacin		
	Potassium	Vitamin B_6		
		Folate		
		Vitamin B_{12}		

SOURCE: USDA, ARS, 1994.

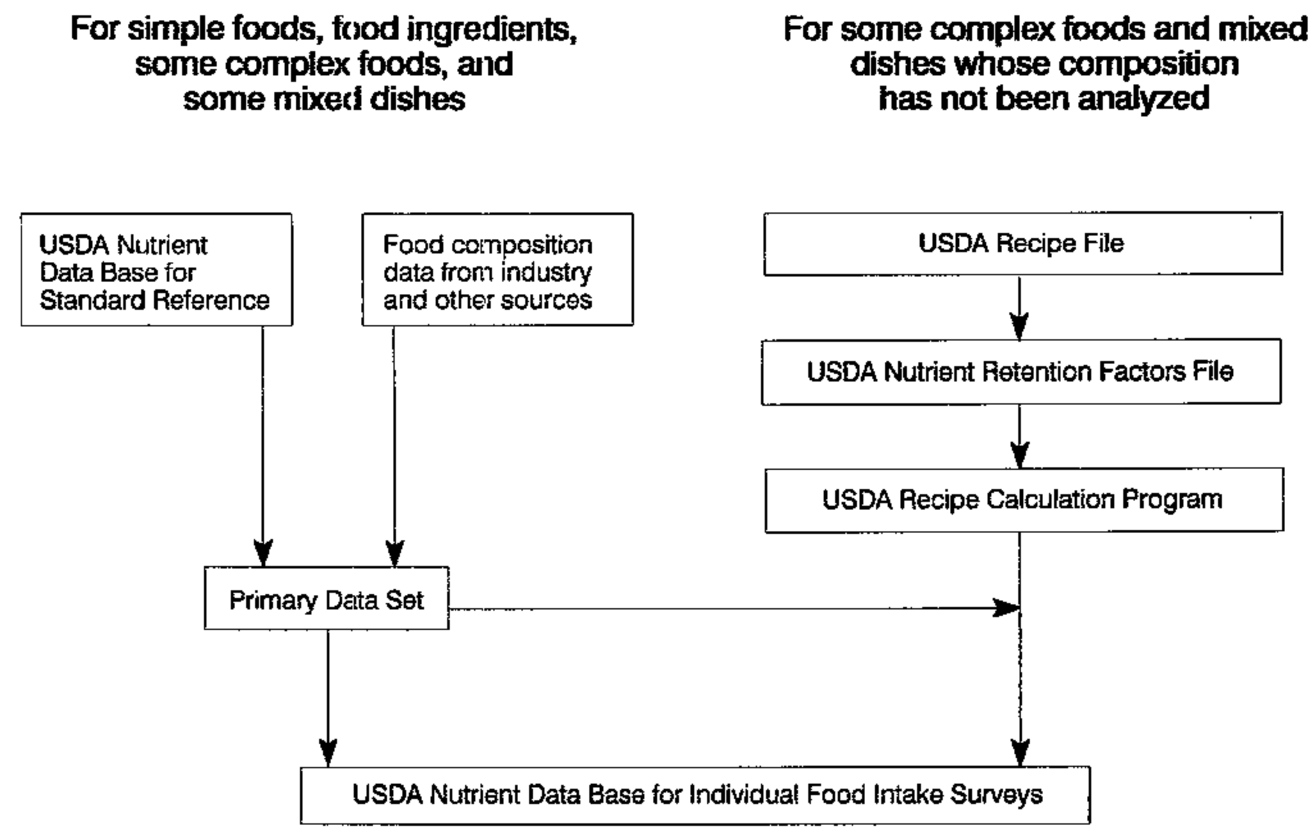

Figure 5-2. Sources of information and components of the USDA Nutrient Data Base for Individual Food Intake Surveys

SOURCE: LSRO, 1994.

vitamin C, potassium, zinc, and fluoride. Because acceptable analytic methods are not available to measure concentrations of many of these components in foods, improvement of the analytic methodology is the highest priority for these food components (Beecher and Matthews, 1990).

Foods.— A conceptual approach used by USDA to establish priorities for selecting foods for analysis was also described by Beecher and Matthews (1990). The three factors USDA considers in establishing priorities are 1) whether the food composition data are absent or inadequate, 2) whether the nutrient in the food makes a significant contribution to the diet, and 3) whether the data are available for the food as eaten. Foods that are major contributors of nutrients to the diet and for which data are lacking or imputed are given highest priority for analysis (see "Imputed Values," below). Foods that are major contributors of a nutrient and foods for which data are inadequate or unreliable are given next priority. USDA recommends that the analysis of foods in other categories be conducted only if there is an overriding reason and if resources are sufficient to conduct the sampling and analysis. Matthews (1992) described the procedure for using major contributors of nutrients to prioritize and select foods for analysis.

Developing and validating methodology

Accurate and precise analytic procedures must be developed and validated before foods can be analyzed reliably. The FCL of USDA designs and develops new and/or improved measurement systems for analyzing food components, which are made available for field use by government, industrial, and academic laboratories. The current state of development of field methods for analyzing nutrients in foods is compiled in table 5-7.

If the state of development is "adequate" or "substantial," the methodologies are considered acceptable, and if the state of development is "conflicting" or "lacking," the methodologies are considered unacceptable. If appropriate methods are used by trained analysts, accurate values will be obtained for nutritionally significant levels of those nutrients listed as having "adequate" or "substantial" methodologies. For a few of the nutrients in the "conflicting" and "lacking" categories, reliable values may be obtained if extreme care is exercised by the analyst. However, for most of the nutrients in those two categories, it is unlikely that valid results can be obtained during routine assays.

The criteria used to evaluate the state of methods development are accuracy, speed of analysis, cost per analysis, and development needs (table 5-8). Of these, the accuracy of the method is the criterion considered most critical for generating high-quality data (Beecher and Matthews, 1990).

After a method is developed that provides results with reasonable accuracy, precision, and speed for a given food, it must be validated with a standard reference material (SRM). SRMs for such foods as wheat flour, rice flour, bovine liver, and even a "total diet" are produced and distributed by the National Institute of Standards and Technology (NIST). NIST measures the amount of certain proximate components and the concentrations of certain minerals in an SRM by using highly accurate and precise techniques (Wolf, 1993). Research is under way to develop and use the SRMs with matrices similar to those found in foods as they are actually eaten. This should greatly reduce the many problems associated with analyzing nutrients and other substances in complex food matrices. Secondary quality-control materials should be used regularly by laboratories to ensure the accuracy of measurements and must be linked with the values obtained by the analysis of the SRMs.

Reliable food component data can be generated only after a field method has been validated and an ongoing analytical quality-control program has been established (Beecher and Matthews, 1990). To be most useful for evaluation of data quality, quality-control procedures should involve careful monitoring of the accuracy and precision of the method along with complete documentation of all aspects of the analysis (Mangels et al., 1993). The use of internal standards with every analytical sample, as appropriate to the method, should be required to ensure the accuracy of the data generated.

Sampling strategies and sample-handling procedures

In addition to the development and validation of analytical methods and the implementation of quality-control procedures, obtaining high-quality food composition data requires the design, implementation, and evaluation of sampling strategies and sample-

Table 5-7. State of development of methods for analysis of nutrients in foods

Nutrient category	Adequate	Substantial	Conflicting	Lacking
Carbohydrates	—	Individual sugars Total dietary fiber (AOAC)[1] Starch	Other fiber components	Resistant starch
Energy	Bomb calorimetry	—	Calculated	—
Lipids	—	Cholesterol Fatty acids (common, C_{12}-C_{20})	Fat (total) Sterols Fatty acids (*trans*, ω3 short-chain, C_8-C_{10})	—
Mineral nutrients	Calcium Copper Magnesium Phosphorus Potassium Sodium Zinc	Iron Selenium Manganese	Arsenic Chromium Fluoride Iodine	Boron Cobalt Molybdenum Silicon Tin Vanadium Organic species
Protein and amino acids	Nitrogen (total)	Amino acids (most)	Amino acids (some) Protein (total)	—
Vitamins	—	Niacin Riboflavin Thiamin Vitamin B_6	Carotenoids (provitamin A) Vitamin A Folate Vitamin B_{12} Vitamin C Vitamin D Vitamin E Pantothenic acid Vitamin K	Biotin Choline
Other	—	—	Phytate Carotenoids (nonvitamin A) Phytosterols Tocotrienols	Flavonoids Lignins Saponins

[1]AOAC, Association of Official Analytical Chemists.

SOURCE: USDA, Food Composition Laboratory, 1994.

Table 5-8. Classification factors for evaluating the state of methods for analyzing food composition

State of methodology	Accuracy	Speed of analysis	Cost per analysis	Development needs: Methodology	Development needs: Applications	Development needs: Other
Adequate	Excellent	Fast	Modest (<$100)	Increase sample throughput	—	Reduce cost
Substantial	Good	Moderate	Modest to high	Modify methods	Develop applications (needs adaptation to specific food matrices)	Improve extraction procedure
Conflicting	Fair	Slow	High	Modify and/or develop methods	Develop applications (needs adaptation to specific food matrices)	Improve extraction procedure
Lacking	Poor	Slow	Unknown	Develop methods	Develop applications (needs adaptation to specific food matrices)	Improve extraction procedure

SOURCE: USDA, Food Composition Laboratory, 1994.

handling procedures. Strategies for representative sampling of foods for compositional analyses have centered on generating accurate estimates of the mean composition of foods that provide the majority of a nutrient or nutrients in the diet of the U.S. population. Comprehensive analytical studies of an individual food should include assessment of nationwide sampling studies to identify the major sources of variation in nutrient composition for that food, including region of the country, commercial brand, recipe for preparation, and differences among food samples (Beecher and Matthews, 1990). Sampling designs for collecting representative samples of foods were described by Holden et al. (1986), Li et al. (1987), McClure and Lee (1993), and Savell et al. (1988).

Handling and storage of food samples prior to laboratory analysis may greatly affect the nutrient content of foods, particularly of trace minerals, such as chromium, that are present in very small concentrations in foods. Use of inappropriate procedures in sample preparation may introduce elements from the environment or from food-contact surfaces, leading to large errors in the subsequent laboratory analysis. Beecher (1993) described this and other difficulties involved in homogenization and treatment of foods before analysis. Complete documentation of procedures—including how the edible portion was prepared for analysis, how the homogenization method was validated, how the food was prepared (e.g., broiled at 550 °F to an internal temperature of 150 °F), and how storage and moisture changes were monitored—and of how storage and moisture conditions changed is essential.

Evaluating data quality

A system for evaluating the quality of food composition data has been developed through a collaborative effort involving USDA, NIST, and FDA. The system includes criteria in five general categories that represent the major determinants of data quality for inclusion in food composition data bases, plus data-quality criteria ratings ranging from 3 (highly acceptable) to 0 (unacceptable) for each category. The categories are sampling plan, number of samples, sample handling procedures, analytic method, and analytic quality control. The mean of the five data-quality criteria ratings for each source of data is termed the Quality Index. These criteria, together with category-specific decision trees that simulate the human decision-making process that occurs in evaluating data quality, have been incorporated into artificial-intelligence software. Data-quality criteria used for evaluating carotenoid content of fruits and vegetables were summarized by Mangels et al. (1993). Other examples of the use of this system to provide consistent and objective evaluation of published data on the selenium and copper contents of foods were reported by Lurie et al.

(1989) and Schubert et al. (1987). Food composition data produced by laboratories under contract to ARS include information on all five of the data-quality categories.

The sum of Quality Index ratings greater than or equal to 1.0 is used to develop "confidence codes," which provide an indication of the confidence the data user can have in the grand mean nutrient concentration for a given food. (See Mangels et al. (1993) for the criteria for assigning confidence codes and their meanings.) Confidence codes have been included for data compiled from published sources on selenium (Bigwood et al., 1987; Schubert et al., 1987), copper (Lurie et al., 1989), and carotenoids (Mangels et al., 1993).

Nutrition labeling values

Nutrient concentrations for some foods, often highly processed foods and frozen meals and entrees, may be taken from nutrition labels if no other information is available. These values are derived to ensure that products are in compliance with labeling regulations. Although food companies may determine and then use the mean concentrations of nutrients in their own food product for labeling purposes, the mean value may not be in compliance with FDA regulations. FDA's review of the quality of nutrient composition data bases for individual foods and ingredient data base systems includes nutrient variability of foods, sampling design, analytical methods, and statistical treatment of data (McClure and Lee, 1993). USDA generally uses mean nutrient values for the foods it regulates.

FDA requires that nutrition labeling values be based on compliance algorithms derived from the lower or upper limit of a prediction interval that will include the mean value of analyses of any number of samples of the same product in the future. Although the use of nutrient values derived through that approach may be necessary and desirable for nutrition labeling purposes, errors may be introduced into nutrient intakes calculated from these nutrient values in food consumption surveys. The following paragraphs explain how labeling values are calculated to be in compliance with FDA regulations.

Compliance evaluation of nutrition labeling values depends on using the nutrient classification defined specifically for compliance purposes. Added nutrients in fortified or fabricated foods (vitamins, minerals, protein, dietary fiber, and potassium) are classified as Class I nutrients. For Class I substances, the nutrient content must be 100% or more of the label value. Naturally occurring nutrients over which producers or manufacturers have little control (vitamins, minerals, protein, total carbohydrate, other carbohydrate, dietary fiber, unsaturated fatty acids, and potassium) are classified as Class II substances. To be in compliance, the nutrient content of Class II substances must be at least 80% of the label value. A third group of nutrients not given a formal classification, which includes food energy, sugars, total fat, saturated fatty acids, cholesterol, and sodium, must be present at no more than 120% of the label value to be in compliance. Because of these compliance considerations, compliance algorithms based on one-sided 95% prediction intervals are calculated with no adjustment for Class I nutrients and with adjustment factors of 5/4 (125%) for Class II substances and 5/6 (83%) for the third group of nutrients. The approaches used to calculate prediction intervals and to select either the mean concentration or the appropriate limit of the prediction interval were detailed by McClure and Lee (1993).

For Class I and Class II substances, use of the lower limit of the prediction interval results in a bias toward values lower than the mean for these nutrients. For the third group of nutrients, use of the upper limit of the prediction interval results in a bias toward values higher than the mean. Thus, using nutrition labeling values to calculate nutrient intakes from food consumption data may lead to underestimates of intakes of Class I and Class II substances contributed by foods for which nutrition labeling values were used and to overestimates of nutrients in the third group. Because food energy values based on nutrition labeling values may be biased upwards by using upper limits for the prediction intervals, macronutrient concentrations expressed as percent of calories may also be biased. For total fat and saturated fatty acids, composition data that are based on the percentage of total calories and that are biased in the same direction as food energy values may lead to overestimates of the contents of these nutrients. The overestimates of total fat and saturated fatty acids based on percentages of total calories may lead to underestimates of total carbohydrate, protein, and unsaturated fatty acids when expressed as percent of calories.

Rounding of mean values may also introduce error into the calculation of nutrient intakes from nutrition labeling data. Because rounding may be either up or down, it may either increase or decrease the bias introduced by the use of the upper or lower limit of the prediction interval values.

Imputed values

In addition to analytical data, the USDA Nutrient Data Base for Standard Reference also contains imputed values that fill in missing values for foods for which some analyzed values are not available. The data from which the imputed values are derived are often from another form of the food. For example, instant coffee has been used to impute protein values for brewed coffee. If an alternate form of the food is not appropriate or not available, analytic values from "similar" counterparts are used as the surrogate for imputation. For example, raw, mature navy beans are used to impute total dietary fiber values for raw, mature black beans, and turkey leg meat without skin is used to impute zinc values for turkey ham made with cured turkey thigh meat. In a few instances, literature summaries, data from other countries, enrichment standards, and formulations or recipes have been used to impute nutrient values.

Zero values

Zero values in food composition tables may have different meanings. In some cases, a zero value indicates that a substance is not present in a food. For example, cholesterol is not present in plant products. For other substances, such as carotenoids, zero values in food composition tables represent values reported as not detected at a detection limit specified in acceptable references for a given nutrient (Mangels et al., 1993).

Developing survey nutrient data bases

Most of the analytic values in the USDA Nutrient Data Base for Standard Reference are for food ingredients or for simple food items consumed as such. Although some analytic data are available for complex foods (foods composed of several food ingredients) and mixed dishes, recipe calculation and imputation procedures provide most of the food composition data for these categories of foods. Table 5-9 summarizes the sources of composition data for each of these food categories in order of predominance. Analytic values for nutrients in dietary supplements, except those used as meal replacements, are not included in the data base.

Many of the foods reported in food consumption surveys fall into the complex foods and mixed dishes categories. Because it is not possible to analyze all of the foods that people report in surveys, a recipe-calculation approach was used to develop the Survey Nutrient Data Base. The components of the Survey Nutrient Data Base are shown in figure 5-2, and their roles in constructing the data base are described below.

Primary Data Set

The Primary Data Set (PDS) contains food composition data from the USDA Nutrient Data Base for Standard Reference for food items and for items used only for calculating the nutrient content of mixed foods from recipe components. It provides the nutrient values used for calculating the nutrient intakes from each food reported by each individual participating in a food consumption survey. Most of the data in the PDS are from the most recent version of the USDA Nutrient Data Base for Standard Reference. Nutrient values for products identified as enriched, such as flour, or with added vitamin C, such as many juice drinks, include nutrients added through enrichment or fortification. Values are added

Table 5-9. Sources of food composition data for types of foods

Food type	Source of data in descending order of predominance
Simple foods and food ingredients (e.g., apples, carrots, flour, sugar)	Analytic Imputed
Complex foods (e.g., bread, pudding, salad dressing)	Analytic Imputed Calculated
Mixed dishes (e.g., pizza, sushi, casseroles, frozen entrees)	Calculated Imputed Analytic

SOURCE: LSRO, 1994.

to the PDS for the nutrients missing from the USDA Nutrient Data Base for Standard Reference, such as carotenes. Nutrient profiles are also imputed for missing food items that are needed for the Survey Nutrient Data Base to provide a single, common value for nutrient concentrations for all users of the data base. The date of entry into the PDS (if not from the USDA Nutrient Data Base for Standard Reference), mean nutrient values, and a "source" code specifying whether the nutrient values are analytical or imputed are given. The analytical values may vary in quality. The PDS currently used contains data with values for food energy and 28 other components for 3,351 food items. Information on the quality evaluation of data in the PDS is included below (see "Quality Evaluation").

The total number of key foods in the PDS contributing 80% of total nutrient intake to the CSFII 1989-91 together with the number of analytical, imputed, and nutrition labeling values is shown in table 5-10. The procedure used to identify foods that are key contributors of a nutrient is based on the amount of a nutrient in a food and the grams of food consumed as described by Hepburn (1987) and Matthews (1992).

The PDS can be used to generate tables of data sources organized by food group for specific categories of food in the Survey Nutrient Data Base. Such tables would be useful to researchers for identifying the type and, to some extent, the quality of food composition data for a particular group of products. An example of how the tables could be structured is shown in table 5-11, which summarizes the percentages of baby-food and baby-formula data identified as analytical, imputed, nutrition labeling, or assumed to be zero (i.e., actually not present or below the limit of detection for accepted methods).

Table 5-10. Total number of food items in the Primary Data Set that contribute 80% of nutrient intake and the source of their values (analytical, imputed, or nutrition labeling) for CSFII 1989-91

		Source of value		
Nutrient	Total items	Analytical	Imputed	Nutrition labeling
Protein	188	177	11	0
Total dietary fiber	135	116	18	1
Total fat	127	119	8	0
Cholesterol	72	61	11	0
Vitamin C	68	61	1	6
Vitamin B_6	204	158	12	34
Thiamin	177	147	5	25
Riboflavin	178	148	7	23
Niacin	197	158	13	26
Folate	146	96	19	31
Vitamin E	116	60	47	9
Vitamin A	62	47	1	14
Vitamin B_{12}	96	77	11	8
Carotenes	31	31	0	0
Calcium	72	68	3	1
Iron	236	190	12	34
Copper	241	220	21	0
Magnesium	201	186	13	2
Phosphorus	197	188	9	0
Zinc	213	188	15	10
Potassium	178	169	9	0
Sodium	104	100	4	0

SOURCE: USDA, ARS, 1994.

Recipe File

The Recipe File links each survey food identification number to one or more PDS items through a set of recipe codes. About one-half of the recipes are linked directly to the PDS. For example, the survey food identification number for whole milk is linked to the PDS item for whole milk. The rest of the recipes link food item identification numbers to PDS items by a recipe code. For example, the survey food identification number for apple and cabbage salad is linked to the PDS items for cabbage, apples, and mayonnaise. Recipes contain information about changes in moisture or fat that occur during cooking as well as information about the recipe ingredients (i.e., names, identification numbers, weights, and codes for accessing retention factors, if applicable). The Recipe File contains about 7,100 recipes (one for each item in the Survey Nutrient Data Base). Recipes are usually selected from popular cookbooks, and they are chosen to most closely represent the mixed dish as typically consumed. Some of the recipes are for commercial products, such as frozen dinners or entrees, although these are not identified by brand name.

Nutrient Retention Factors File

The Nutrient Retention Factors File is a data set of adjustment factors to use in calculating the retention of the following vitamins and minerals during cooking and food preparation: vitamins C, B_6, B_{12}, and A; thiamin; riboflavin; niacin; folate; carotenes; calcium; magnesium; iron; phosphorus; potassium; sodium; zinc; and copper. Retention factors for those nutrients are determined from paired samples of foods analyzed in raw and cooked forms. Protocols for the analyses are controlled to protect samples from contamination or unintentional nutrient loss, ensure that identical cooking procedures are followed for each analysis, and minimize handling losses during preparation. The factors are then used to calculate the nutrient content of foods prepared by similar methods.

Table 5-11. Percentage of data for baby foods and baby formulas in the Survey Nutrient Data Base identified as analytical, imputed, or nutrition labeling or assumed to be zero (%)[1]

Nutrient	Analytical	Imputed	Nutrition labeling	Assumed zero
Protein	94	5	1	0
Total dietary fiber	5	82	0	13
Total fat	94	5	1	0
Cholesterol	8	48	1	44
Vitamin C	95	4	2	0
Vitamin B_6	87	12	1	0
Thiamin	96	3	1	0
Riboflavin	96	3	1	0
Niacin	96	3	1	0
Folate	69	31	0.4	0
Vitamin E	63	36	1	0
Vitamin A	71	29	0.4	0
Vitamin B_{12}	31	58	0.4	11
Carotenes	50	43	0	7
Calcium	95	4	1	0
Iron	94	5	1	0
Copper	57	43	0.4	0
Magnesium	65	35	0	0
Phosphorus	87	12	1	0
Zinc	78	21	1	0
Potassium	93	6	1	0
Sodium	94	5	1	0

[1]The sum of the percentages of data (analytical, imputed, label, and assumed zero) may not add up to 100% because of rounding.

SOURCE: USDA, ARS, 1994.

The accuracy of the nutrient retention factors is obviously important to the ultimate accuracy of the calculated nutrient content of foods. However, the documentation of the development of the nutrient retention factors and the quality control for that development are not generally available in the published scientific literature, and thus the Expert Consultants and LSRO were unable to evaluate the accuracy of the nutrient retention factors used in the Recipe Calculation Program.

Recipe Calculation Program

The Recipe Calculation Program is a computer program that determines which items will appear in the Survey Nutrient Data Base and which sets of nutrient values from the PDS will be used for each item. For single-component recipes, nutrient values are moved directly from the PDS to the Survey Nutrient Data Base. For multicomponent recipes, the values are calculated from the data for each ingredient. The recipe-calculation procedure is identical to the one used for the USDA Nutrient Data Base for Standard Reference. Nutrient retention factors are used in the calculations when appropriate. The procedure permits calculations to be done with or without addition of salt and with different fat sources. The recipe-calculation approach was used to generate data bases that were used for CSFII 1985-86, NFCS 1987-88, CSFII 1989-91, HHANES 1982-84, and NHANES III 1988-91.

The most recent release of the Survey Nutrient Data Base contains composition data for about 7,100 food items and is currently being used for CSFII 1994-96 and NHANES III. Of these 7,100 items, data for about one-half are derived from recipe calculations for foods with multiple ingredients using a mixture of analytical, imputed, and nutrition labeling information on food composition. When fortification levels are changed, nutrient values are updated in the PDS and the recipes are recalculated.

Quality evaluation

Monitoring and verifying nutrient data in key foods have been emphasized as ways of maintaining the quality of food composition data in the PDS. Key foods are those foods in the PDS that cumulatively provided 80% of the intake of a given nutrient for the U.S. population in CSFII 1989-91. Values currently in the PDS are improved by replacing calculated values with analytical values, increasing the number of samples on which estimates are based, updating "old" values, and generating data by newer or more accurate methods (Matthews, in press). For example, new data were incorporated into the Survey Nutrient Data Base when improved methodologies led to more accurate values for the concentration of iron in beef and of cholesterol in eggs.

Approximately 85% of the food composition data in the National Nutrient Data Bank today is from sources outside USDA, such as the food industry and the scientific literature. The documentation for these data varies widely, with only about 10-15% containing documentation for all five criteria for data-quality evaluation developed by the FCL and recommended for use in the National Nutrient Data Bank by GAO (1993). Data-evaluation criteria and a scoring system are needed for nutrient values that are incorporated into the USDA Nutrient Data Base for Standard Reference. Current models of evaluation systems that cover a limited number of nutrients might be used to develop a more complex model within the structure of a large data base management system (Perloff, 1994).

Appropriate uses and limitations of the data

For many foods, estimates of mean concentrations of food components are reported in the Survey Nutrient Data Base. No indicators of the variation in nutrient content of a food are included in the data base. Thus, the variation in nutrient intake estimates for survey participants reflects the variation in food consumption patterns, not the variation of nutrients in foods. Although mean concentrations of food components may be used for evaluating nutrient intakes of large populations, the variation about the mean intake of a nutrient may be underestimated because the variation in nutrient content of foods is not included. Of greater concern is the uncertainty involved in assessing low or high intakes of nutrients. Failure to account for the variability in concentrations of nutrients in foods may have a greater impact on estimating intakes at the extremes of distributions because the range of nutrient contents of foods is not taken into consideration. When information on several samples and standard errors is in the USDA Nutrient Data Base for Standard Reference, estimates of variation may be made. However, about one-half of the items in the Survey Nutrient Data Base are based on recipe calculations, and estimating the variance of the nutrient content for these items would be extremely difficult.

The actual impact of the variability in food composition on the variability of nutrient intakes in surveys has not been calculated. Beaton (1986) assessed the impact of the precision of food composition data on the variability of the content of a 1-day diet from 1,000 theoretical 1-day diets. Coefficients of variation (CVs) for food composition data were as high as 30%, but when these data were used to calculate 1,000 theoretical 1-day diets, assuming random variation, the error term in a 1-day intake estimate was low (generally $\leq$10% CV). If the CVs for food composition data are assumed to be random, then statistical theory suggests that the variance of the nutrient content of the mixed diet will decrease as more food items are included in the diet. Beaton (1986) cautioned that this approach is not adequate for the accurate calculation of nutrient intakes of individuals, although it provides valid assessments of nutrient intakes of large groups. These observations suggest that systematic bias in food composition data may be of much greater concern than random variation (Beecher and Matthews, 1990).

The data in the USDA Nutrient Data Base for Standard Reference, even those with incomplete documentation, are used as common values for nutrient concentrations by all investigators who use the Survey Nutrient Data Base. This practice allows comparisons to be made across studies. Although this practice reduces the number of different values used by investigators, efforts need to be maintained to replace these data with more reliable estimates as they become available.

The quality of analytical data varies among nutrients. For example, the quality of data on calcium concentrations in foods is considered to be good. The state of the development of methodology for analyzing calcium in foods is rated as adequate, and data in the PDS for 68 of the 72 food items contributing 80% of calcium intake in CSFII 1989-91 are analytical data. In contrast, the quality of data on folate concentrations in foods is generally considered to be less than adequate. Although analytical data are available in the PDS for 96 of the 146 food items thought to contribute 80% of folate intake, an acceptable methodology for analyzing folate in foods is lacking. When there is serious concern about high or low intakes of a particular nutrient, the quality of food composition data for that nutrient should be examined. If the data are considered to be of good quality, then greater confidence can be placed in the intake estimate. If the quality of the data is considered less reliable, then less confidence can be placed on the estimate. When data quality is in serious doubt, estimates of nutrient intake should be accompanied by cautions about confidence in the accuracy of the estimates until improvements are made in data quality.

As improvements are made in the quality of food composition data, the development and use of appropriate factors for correction of "old" data become critical. This situation was clearly illustrated for cholesterol concentrations in food by comparing the results from gas-liquid chromatography (GLC), the method of choice, with those from colorimetry. These comparisons indicated that the GLC values were about 68% of the colorimetric values and ranged from 84% to 89% of the values calculated from food composition tables (Marshall et al., 1989a,b). In some cases, values for total sterols determined by GLC were less than cholesterol values determined colorimetrically.

The differences in the results obtained from analyzing a mixture by a particular method and from calculating the concentrations of the individual components in that mixture based on values obtained by the same analytical method were described by Matthews (1988). GLC values for cholesterol in composite diets were reported to be about 25% lower than the computed values (Marshall and Judd, 1982; Marshall et al., 1989a,b). Because of the variable relationship between the GLC values and the older data, Marshall et al. (1989b) concluded, "The differences between GLC and colorimetrically analyzed cholesterol, and also between calculated and GLC-analyzed cholesterol, are not likely to be fixed percentages which could be applied for correction purposes; instead they will vary depending upon food selection." In a situation such as this, when a single correction factor cannot be applied, the method used to generate the data should be documented.

The interpretation of data on nutrient intakes requires knowledge of the forms of the nutrient measured. Because nutrients occur in foods in different forms (e.g., folates in monomer and polymer forms), analytical methods may or may not include all biologically active forms of a nutrient. Likewise, other analytical methods may include forms of the nutrient that are not utilized by humans. If the methods used for an assessment of nutrient intake include nonactive forms of the nutrient, actual intake is likely to be overestimated. Conversely, if the methods do not include all active forms, estimated intakes are likely to be lower than actual intakes.

Update of food composition data

Since the EPONM report was published, data on the selenium, vitamin D, and vitamin K contents of selected foods have been compiled (Gebhardt and Holden, 1992; Weihrauch and Chatra, 1994; Weihrauch and Tamaki, 1991). Intakes of these nutrients were not evaluated in CSFII 1989-91 or NHANES III 1988-91; however, this information is included in this report because of its timeliness for nutrition researchers.

Mean nutrient contents of some foods that are high in selenium, vitamin D, and vitamin K are shown in figures 5-3, 5-4, and 5-5. Concentrations of selenium tend to be high in meats, poultry, fish and seafood, grain products, and some seeds and very low in fruits and vegetables. Canned fish products such as pink salmon, sardines, and tuna contain the highest concentrations of vitamin D, and lower concentrations are found in milk and margarine fortified with vitamin D, eggs, and some cheeses. Although not illustrated in figure 5-4, breakfast cereals fortified with vitamin D contain about 2.7-3.8 µg of vitamin D per 100 g of cereal; unfortified cereals contain negligible levels of the vitamin (Weihrauch and Tamaki, 1991). Vitamin K concentrations are highest in leafy and cruciferous dark-green vegetables (fig. 5-5).

Data on the contents of individual carotenoids (including carotenes) in fruits and vegetables have

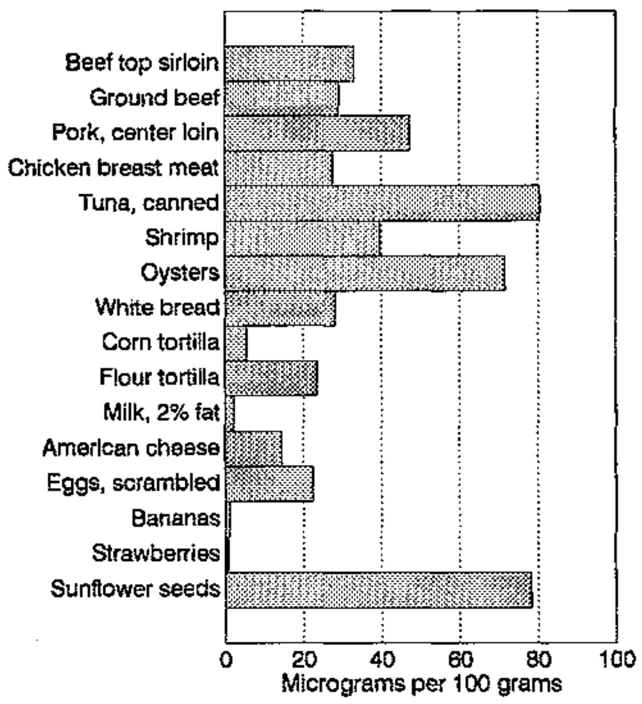

Figure 5-3. Mean selenium content of selected foods

NOTE: Beef, pork, chicken, fish, and seafood values are for cooked meat. The value for tuna is for drained, light-meat tuna canned in water.

SOURCE: USDA, Provisional Table on Selenium Content of Foods (Gebhardt and Holden, 1992).

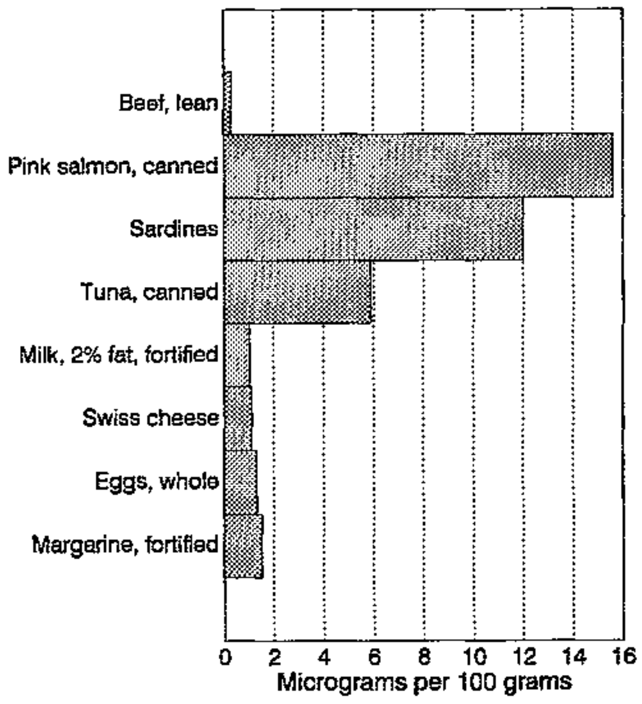

Figure 5-4. Mean vitamin D content of selected foods

NOTE: The value for sardines is for unspecified sardines canned in tomato sauce. The value for tuna is for drained, light meat tuna canned in oil. The value for margarine is based on label information.

SOURCE: USDA, Provisional Table on Vitamin D Content of Foods (Weihrauch and Tamaki, 1991).

also been published since 1989 (Mangels et al., 1993). An example of the use of the system for evaluating the quality of food composition data described above is included with those data (Mangels et al.,1993). A data base for carotenoids in 2,458 fruits, vegetables, and selected multicomponent foods containing fruits and vegetables has also been developed for use with food consumption data from surveys (Chug-Ahuja et al., 1993).

Evaluating food composition data for use in assessing current nutritional status in the NNMRRP

As discussed above, the quality of data available for incorporation into the Survey Nutrient Data Base varies among nutrients. The Expert Consultants and LSRO used information on the state of development of analytical methods (table 5-7), the quantity of data available on nutrient composition of foods (tables 5-3, 5-4, and 5-5), the fraction of analytical data in the PDS for food items contributing 80% of the total intake for nutrients (table 5-10), and their own experience and judgment to evaluate food composition data for use in assessing current nutritional status. Table 5-12 summarizes this evaluation.

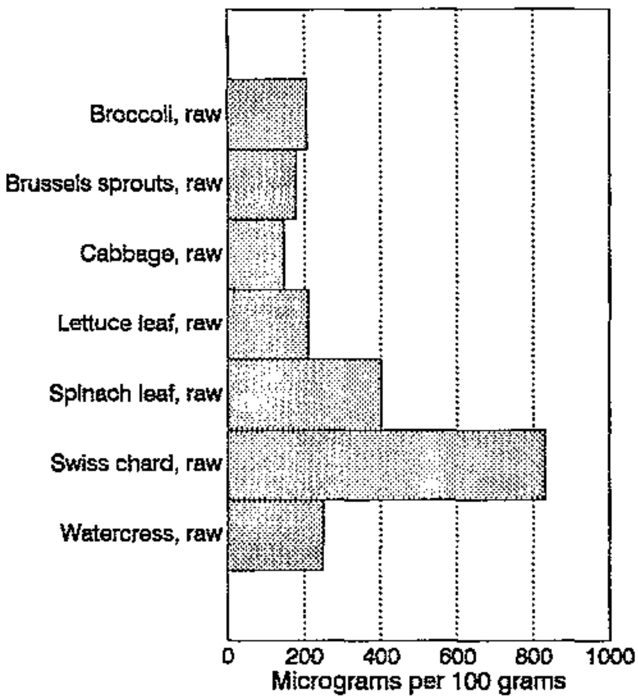

Figure 5-5. Median vitamin K content of selected foods that are high in vitamin K

SOURCE: USDA, Provisional Table on Vitamin K Content of Foods (Weihrauch and Chatra, 1993).

Consistency within and among data sources for assessing change over time

Changes in food composition

The composition of foods changes over time for a variety of reasons. Breeding practices and biotechnology developments cause genetic changes in plants and animals. Growing practices also affect food composition. Any of these changes may be prompted by changes in consumers' perception of optimal products. This situation is best illustrated by reductions in the fat contents of foods. Over the past 25 years, changes in the perception of optimal beef and pork products have prompted industry to produce leaner products; similarly, public awareness has resulted in the development of milk that has lower cholesterol levels.

Changes in food composition occur continually as products enter and leave the marketplace. Overall, the turnover rate of food products in the marketplace is about 10% per year. The international distribution of foods has become more common. For those products remaining on the market, recipes may change in response to many factors, including the availability and price of the ingredients.

Because of these changes, it is essential to document in the USDA Nutrient Data Base for Standard Reference the date a food was analyzed, the ingredients present in the food as analyzed, how the ingredients were processed (i.e., hydrogenation of oils), and ingredient substitutions that could alter the food's nutrient content. Continual updating of food composition data and nutrient data bases used for food consumption surveys is needed to ensure that data accurately represent the composition of foods at the time they are consumed.

Table 5-12. Evaluation of assay methods and quality of food composition data for use in assessing dietary intakes of nutrients

Food component	Rating of assay method[1]	Rating of data quality[2]	Comments[3]
Food energy	Conflicting	Variable	The mode of handling fiber contents causes some confusion in computation of food energy. The quality of the data on mixed foods is questionable in some cases because of lack of knowledge of amount of gums and modified starches added to foods.
Protein	Adequate	Acceptable	
Total fat	Conflicting	Variable	The determination of total fat content will be a problem because of a new definition of fat resulting from the Nutrition Labeling and Education Act of 1990 (NLEA; Public Law 101-535). Accepted assay methods for "total fat," as defined by the NLEA, have yet to be developed. Efforts will have to be made to ensure that a consistent definition of "total fat" is used for foods incorporated into the USDA Nutrient Data Base for Standard Reference and the USDA Survey Nutrient Data Base.
Saturated, monounsaturated, and polyunsaturated fatty acids	Substantial	Variable	Capillary gas-liquid chromatography (GLC) should be used for saturated, monounsaturated, and polyunsaturated fatty acids. Packed-column GLC is inadequate because packed columns do not separate the various isomers of mono- and polyunsaturated fatty acids. The data are variable because some of the data were obtained by packed-column GLC. Source oil calculations may not be acceptable because of changes that occur during processing.
Trans fatty acids	Conflicting	Unacceptable	Very high-quality capillary GLC methodology is required to measure *trans* fatty acids. Very few foods have been assayed by this method. Calculation from source of oil added to food is not acceptable because of changes in composition brought about by processing.
Cholesterol	Adequate	Variable	Lipid extraction and capillary GLC should be used for cholesterol assays. Colorimetric assays are frequently not acceptable.
Carbohydrate	Conflicting	Variable	The traditional assay method for determining carbohydrate is by calculation of difference. It was validated to some degree for whole foods but not for complex foods and mixed foods. Determination of carbohydrate content is also complicated by the same problems identified for determination of food energy.
Total dietary fiber	Substantial	Variable	Some assays do not measure total dietary fiber.

Table 5-12. Evaluation of assay methods and quality of food composition data for use in assessing dietary intakes of nutrients—continued

Food component	Rating of assay method[1]	Rating of data quality[2]	Comments[3]
Dietary fiber fractions	Conflicting	Variable	There is no consensus among experts about what is an acceptable fiber-fraction method. Because different methods were used for different data sets, there is potential for significant confusion. The exact method used must be noted on the fiber-fraction data sets. This annotation is frequently missing.
Alcohol	Substantial	Acceptable	Alcohol data are acceptable for alcoholic beverages. Good GLC and liquid-chromatography methods exist but rarely have been validated for food matrices. There are very few analytical data for alcohols in foods; however, foods contribute very little to total alcohol consumption.
Vitamin A	Conflicting	Variable	Excellent high-performance-liquid-chromatography (HPLC) methods exist. Colorimetric assays are generally not acceptable for foods. Few data have been obtained with modern methods. Complex foods and mixed foods have special problems. Good data exist for simple foods.
Carotenes	Conflicting	Variable	See comment for vitamin A methods. New HPLC methods exist for identifying and quantifying specific carotenoids in low-fat foods (especially fruits and vegetables). Comparison with the open-column method is needed. Existing data for carotenes in the Survey Nutrient Data Base assume carotene content is primarily β-carotene. Recent collaborative efforts between the Food Composition Laboratory at ARS and NCI have resulted in the production of a data base for chromatographic values (analytical) for five carotenoids in fruits and vegetables and calculated values for approximately 2,300 mixed dishes. The data base includes quality indicators for specific foods and carotenoids.
Vitamin E	Conflicting	Moot	HPLC method with fluorometric detection is preferable. Capillary-GLC method may be biased toward low values. Special care is needed for sample extraction. Data on simple foods are acceptable. There are some serious questions about the appropriateness of data for complex foods and mixed dishes.
Vitamin C	Conflicting	Variable	Colorimetric methods have been acceptable in the past for determining total vitamin C in simple foods but are not suitable for the analysis of mixed dishes because of manufacturers' addition of iso-ascorbic acid as an antioxidant. A few good HPLC methods exist. Colorimetric methods may not be acceptable for some foods because of interferences and the inability of this method to distinguish between inactive (iso-ascorbic acid) and active forms.

Table 5-12. Evaluation of assay methods and quality of food composition data for use in assessing dietary intakes of nutrients—continued

Food component	Rating of assay method[1]	Rating of data quality[2]	Comments[3]
Thiamin	Substantial	Acceptable	
Riboflavin	Substantial	Acceptable	
Niacin	Substantial	Acceptable	
Vitamin B_6	Substantial	Acceptable	
Vitamin B_{12}	Conflicting	Moot	Some methods (immunoassays) provide good results; however, a significant portion of food composition data was obtained with older, less reliable methods.
Folate	Conflicting	Variable	Recent findings suggest that traditional assay methods are not acceptable for the assay of complex foods and mixed dishes. This is a very controversial area. Research is needed on the development and validation of the methodology.
Iron	Substantial	Acceptable	
Calcium	Adequate	Acceptable	
Phosphorus	Adequate	Acceptable	
Magnesium	Adequate	Acceptable	
Sodium	Adequate	Variable	Flame-emission and atomic-absorption methods are good. Chloride determination for sodium content is a problem. Calculations from generic recipes are suspect because information on sodium addition is usually proprietary.
Potassium	Adequate	Acceptable	
Copper	Adequate	Variable	Copper data are lacking for many foods, and there is not an agreed-upon method for computation. Data availability is poor for complex foods, mixed dishes, and foods that are not key sources of copper.
Zinc	Adequate	Acceptable	
Selenium	Substantial	Acceptable	New methods are quite good. Selenium contents of foods vary considerably with region of country where the food was produced. A USDA provisional table on the selenium content of foods was published by Gebhardt and Holden (1992).
Fluoride	Conflicting	Moot	Several good methods exist but most have not been validated for fluoride in foods. Almost no data from direct analyses exist for fluoride content of foods.
Iodine	Unacceptable	Unacceptable	A generally accepted method for assaying iodine in foods has not been developed.

Table 5-12. Evaluation of assay methods and quality of food composition data for use in assessing dietary intakes of nutrients—continued

Food component	Rating of assay method[1]	Rating of data quality[2]	Comments[3]
Fat substitutes	Lacking	Nonexistent	Fat substitutes include modified fats, proteins, gums, and dietary fiber.
Sugars	Substantial	Unacceptable	Several enzyme, HPLC, and GLC methods exist. Few have been validated for complex foods and mixed dishes. Very few analytical data exist for complex foods and mixed dishes. Good data exist for dairy products. Sugar content of other foods varies by ripeness, cultivar, and recipe.
Starch	Substantial	Moot	Several enzyme, HPLC, and GLC methods exist. Few have been validated for complex foods and mixed dishes. Very few analytical data exist for complex foods and mixed dishes. Starch content of other foods varies by maturity, ripeness, and recipe.

[1]Ratings of assay methods are in substantive agreement with those in table 5-7.
[2]Quality of data was rated acceptable, variable, or unacceptable in relation to their use for assessment of nutrition-related health status for nutrition monitoring. Quality of data was rated moot if the Expert Consultants and LSRO considered it unlikely that improved data for that food component would make a difference in the assessment of nutrition-related health status and the assignment of nutrition monitoring priority status. Food composition data for components rated moot may be important for other purposes.
[3]USDA, U.S. Department of Agriculture; ARS, Agricultural Research Service; NCI, National Cancer Institute.

SOURCE: LSRO, 1994.

Evaluating changes in food composition over time

The capacity to compare food and nutrient intakes at different points in time is essential for the long-term tracking of dietary status in the U.S. population. Not only must the data bases be kept current, they must also reflect real changes in foods that have occurred over time. When changes in food composition data occur, whether from improvements in analytical techniques (e.g., improved analysis of cholesterol in foods) or from actual differences in food composition (e.g., changes in the fat content of beef resulting from changed trimming practices by the food industry or changes in nutrient concentrations resulting from revisions in enrichment and fortification practices), the data bases used for food consumption surveys must reflect these changes. Using an updated survey nutrient data base to recalculate earlier nutrient intakes to adjust for artifactual changes may introduce new errors because a data base that is accurate for one point in time may not accurately represent food composition if applied to another point in time (Raper, 1993).

After NFCS 1977-78, USDA improved available food composition data by developing the computerized National Nutrient Data Bank system, which made expanded sets of nutrient values of foods available for use in CSFII 1985-86, HHANES 1982-84, NHANES III 1988-94, NFCS 1987-88, and CSFII 1989-91. For NFCS 1977-78 and earlier food consumption surveys, nutrient composition values are available on magnetic tape. Documentation of nutrient values and recipes exist in handwritten form.

USDA conducted a bridging study that examined differences in data collection and processing between NFCS 1977-78 and NFCS 1987-88 (Guenther and Perloff, 1990; Guenther et al., 1994). Examining the effects of differences in the nutrient data bases used in the NFCS 1977-78 and NFCS 1987-88 on estimates of mean intakes of food energy and 14 other nutrients indicated that changes in the nutrient data base resulting from improved analytic techniques and from an increased number of foods analyzed were sufficient to justify revising the NFCS 1977-78 estimated intakes for iron, magnesium, and vitamins B_6 and B_{12}. Changes in intakes of fat, vitamin A, and thiamin resulted from real changes in foods, so revisions were not needed for accurate estimates of mean intakes of these nutrients at the time they were consumed. Changes in the survey nutrient data bases used for the two surveys did not result in the need to revise estimated intakes of food energy, protein, carbohydrate, calcium, phosphorus, riboflavin, niacin, or vitamin C (Guenther et al., 1994).

Comparing intake estimates from different national surveys: food composition issues

The nutrient data base used by NCHS for NHANES II 1976-80 was different from the one used for HHANES 1982-84 and NHANES III 1988-91. NCHS used a nutrient composition data base based on USDA's data base, with additions and modifications by NCHS, for calculating nutrient intakes for NHANES II 1976-80. As part of efforts to make the USDA and HHS surveys more comparable, USDA's Survey Nutrient Data Base was used for HHANES 1982-84 and NHANES III 1988-91. The effects of differences in the nutrient composition data bases used for the series of HANES surveys have not been examined.

A survey nutrient data base that permits reanalysis of food consumption data collected before 1985 is not available for use with either USDA or HHS food consumption surveys. Therefore, any analysis of time trends in nutrient intakes is difficult, and any comparisons over time should be interpreted with caution.

A nutrient data base for trend analyses from 1985 forward is being developed by ARS with input from NCHS, FDA, and the Working Group on Food Composition Data of the Interagency Board on Nutrition Monitoring and Related Research (IBNMRR). The data base for trend analysis will build on the Survey Nutrient Data Base. It will contain multiple sets of nutrient values to reflect the composition of foods for specific time periods.

Food composition changes incorporated into the nutrient data base for trend analysis will be designated as "food" or "data" changes. "Food" changes will be those resulting from changes in fortification, reformulation, or other agricultural, food processing, or marketing changes. These are incorporated into the data base for the time period for which the change was made. For example, some brands of wheat flour were fortified with calcium during the time that the NFCS 1987-88 was conducted. Nutrient intakes calculated from food consumption data collected during that period reflect a higher level of calcium, accounted for by the fortification practice. "Data" changes will be those resulting from improvements in analytical methodology or from replacement of imputed values with analytical data. In the new nutrient data base for trend analysis, when "data" changes occur, they will be applied retroactively to all the values in the data base. For example, improved methodology led to a lower cholesterol value for eggs in 1989. That change will be applied to the calculation of cholesterol intakes over the entire time range of the data base (Raper, 1993). The nutrient data base for trend analysis will not permit reanalysis of food consumption data collected before 1985; however, it should provide a sound framework for comparisons of data collected at different time points from 1985 onward.

Summary

Analyzing foods is costly, and priorities must be set so that the analysis of food components and foods and, thus, the food composition data can be improved systematically. The process currently used to prioritize the selection of food components and foods is discussed above. The quality of estimates of nutrient intakes in the NNMRRP is also affected by the development and validation of accurate and precise analytic procedures; design, implementation, and evaluation of sampling strategies and sample handling procedures to ensure representative and accurate data; and development of a system to evaluate the quality of food composition data. The status of development of each of these factors is summarized.

The food composition information that has the most immediate impact on nutrition monitoring includes the National Nutrient Data Bank and the Survey Nutrient Data Base. The data bank is a group of research data bases containing analytical and imputed data for food ingredients, simple foods, and some complex foods. Sources of food composition data include analytical data, nutrition labeling values, and imputed values. Concerns associated with each type of data for nutrition monitoring purposes are identified. Within the National Nutrient Data Bank, the USDA Nutrient Data Base for Standard Reference serves as the major source of food composition data used for the Survey Nutrient Data Base. Data in the Survey Nutrient Data Base are used with food consumption data reported in surveys to provide estimates of nutrient intakes. The Survey Nutrient Data Base contains 1) analytical and imputed data for simple foods, food ingredients, some complex foods, and some mixed dishes and 2) data calculated from recipes for some complex foods and some mixed dishes.

Because it is not possible to analyze all of the foods that people report in food consumption surveys, the Survey Nutrient Data Base was developed. The Recipe Calculation Program is used to derive nutrient composition for complex foods and mixed dishes using the PDS of food composition values for simple foods, food ingredients, and complex foods together with information from the Recipe File and the Nutrient Retention Factors File. Approximately half of the data in the Survey Nutrient Data Base is calculated from recipes. Evaluating the quality of food composition data in the PDS has been done by monitoring or verifying nutrient data in key foods that cumulatively provide 80% of the intake of a given nutrient by the U.S. population. Considerations about the use of food composition data to assess nutrient intakes at one point in time and to assess changes in nutrient intakes over time are discussed.

Gaps in knowledge

USDA Nutrient Data Base for Standard Reference

To some extent, gaps in food composition data exist for all nutrients. The gaps are of greater concern for nutrients that are categorized as current or potential public health concerns. For the following nutrients, improvements in the quality of the food composition data will depend on the development of analytical methodology that provides accurate and reliable assessments: food energy, total fat, saturated fatty acids, carbohydrates, dietary fiber fractions, vitamin A, carotenes, folate, and vitamin C. Recent research has suggested a possible association between intake of *trans* fatty acids and coronary heart disease. At present, there are no data on *trans* fatty acids in foods in the Survey Nutrient Data Base.

Although analytical data are relatively complete for the nutrient composition of key foods representative of diets of the total U.S. population (foods supplying 80% of total nutrient intake in CSFII 1989-91), analytical data are less extensive for the nutrient composition of key foods traditionally consumed by some racial/ethnic subgroups. The Survey Nutrient Data Base was expanded to include data for traditional Mexican-American and other Hispanic dishes; however, more analytical data may be needed for the composition of foods prepared by traditional methods by immigrants from various Asian and African countries.

For the existing data in the USDA Nutrient Data Base for Standard Reference, documentation must include the following:

- date(s) of laboratory analysis;
- analytical methods used and the detection limits of the methods;
- the meaning of zero values for nutrients (i.e., whether the nutrient is not present at all in a food or may be present in concentrations lower than the detection limit of the analytical method);
- the number of samples analyzed;
- the variability of the measurements (standard error of the mean);
- whether the mean value is a mean for a single food (e.g., one variety, growing region, season, brand, and/or lot) or a weighted mean of a commingled composite of foods of different types (e.g., more than one variety, growing region, season, brand, and/or lot); and
- source(s) of data and procedures for all imputed values.

USDA Nutrient Data Base for Individual Food Intake Surveys

Because the PDS component of the Survey Nutrient Data Base is derived from the USDA Nutrient Data

Base for Standard Reference, the same gaps in information regarding the adequacy of data for specific nutrients in foods and dietary supplements and the documentation of information in the data base are carried into the Survey Nutrient Data Base. In addition, the documentation of recipe sources is not readily available for investigators who use the data base. The capacity to compare nutrient intakes retrospectively across time periods is extremely limited, in part because of changes in the data bases used with the various surveys and in part because information used for analyzing nutrient intakes before 1985 is not available in a readily usable format and does not always have a date tag.

Dietary supplement composition

The 1986 National Health Interview Survey on Vitamin and Mineral Supplements provided nutrient contents of supplements for 12 vitamins and 12 minerals by product type. However, many new dietary supplement products have been introduced into the market since 1986. A data base does not yet exist for product-specific nutrient composition of dietary supplements currently in the marketplace. Because these products are used by a substantial portion of the U.S. population, a data base for the nutrient composition of these products is needed to assess their impact on intakes of nutrients by the total population and population subgroups.

Recommendations

- Use food composition data bases compiled for analytical research purposes (i.e., the USDA Nutrient Data Base for Standard Reference) to form the basis of nutrient data bases used for estimating nutrient intakes from food consumption data (i.e., the Survey Nutrient Data Base). Because the data are used in very different ways in these two types of data bases, the data bases should be maintained as two separate entities.

- Continue to give high priority to the improvement of the quality of food composition data for food components, particularly those identified as current or potential public health concerns. The approaches used by USDA for prioritizing foods and food components for analysis appear to be sound.

- Make quality-assurance procedures an integral part of the generation of any new data, and use quality-evaluation criteria in a timely manner to evaluate both newly generated and extant data. A data-quality-evaluation system that is an integral part of the data base management system is needed for the USDA Nutrient Data Base for Standard Reference.

- Give priority to providing analytical data for key foods (items contributing 80% of total intake for a nutrient). Key foods for particular racial/ethnic subgroups as well as for the total population should be identified, and nutrient values for these foods should be analyzed for inclusion in the USDA Nutrient Data Base for Standard Reference and in the PDS for the Survey Nutrient Data Base. When chemical analysis of key traditional foods is not possible because of limited resources, traditional recipes and preparation methods for foods should be used to calculate nutrient values for these foods.

- Improve the quality of food composition data provided by all sources, including industry, university, and government laboratories. A good starting point for this would be to convene a conference or establish a working group to address how to attain the highest possible analytical standards in different laboratory settings.

- Improve the documentation of information for the USDA Data Base for Standard Reference and the PDS of the Survey Nutrient Data Base. This documentation should include the following:
  - — analytical methods used and the detection limits of the methods;
  - — the meaning of zero values for nutrients (whether the nutrient is not present at all in a food or is present in concentrations lower than the detection limit of the analytical method);
  - — the number of samples analyzed;
  - — the variability of the measurements (standard error of the mean);
  - — whether the mean value is a mean for a single food (e.g., one variety, growing region, season, brand, and/or lot) or a weighted mean of a commingled composite of foods of different types (e.g., more than one variety, growing region, season, brand, and/or lot);
  - — source(s) of data and imputing procedures for all imputed values; and
  - — date of assay.

- Improve the documentation of items in the Survey Nutrient Data Base System, including
  - — sources of recipes for complex foods and mixed dishes analyzed for inclusion in the USDA Nutrient Data Base for Standard Reference or calculated by using the Recipe Calculation Program for the Survey Nutrient Data Base and
  - — the derivation of nutrient retention factors used in calculations of the nutrient content of complex foods and mixed dishes.

- Improve and standardize the information in nutrient data bases that is currently used for surveys and document that information for the appropriate time periods so that time-trend analyses can be made in the future.

- Include intakes from dietary supplements in analyses of nutrient intakes. In addition to a data base for nutrient composition of foods, a product-specific data base for nutrient composition of dietary supplements is needed to assess total nutrient intake.

- Continue to implement the system for electronic transfer of data to data base users. The system must include a requirement for strict adherence to quality-control criteria for inclusion of data into the data base and protection against change by unauthorized individuals or organizations.

- Draw conclusions cautiously about the existence of associations between nutrient intakes and health because of inadequate data about the composition of several food components for which there is current or potential public health concern. Confirm the existence of any diet-health relationships by a variety of means.

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Chapter 6

Food Consumption and Nutrient Intake

Introduction

Food consumption and nutrient intake by individuals and populations are determined not only by the foods available from the food supply but also by sociocultural, demographic, educational, environmental, physiological, and behavioral influences. The central role of food consumption in determining dietary status—that is, the condition of a population's intake of foods and food components, especially nutrients—is depicted in figure 6-1. The food consumption and nutrient intake data from the NNMRRP used for assessing dietary status are presented in this chapter. Estimates of nutrient intakes in this chapter are limited to intakes from food, and the data for most nutrients were evaluated with regard to the possibility that median nutrient intakes of population subgroups were below values considered adequate.

High intakes of nutrients are also of nutrition monitoring concern. However, the possibility of high intakes of most nutrients from food alone was considered unlikely—except for food energy, total fat, saturated fatty acids, cholesterol, and sodium. Quantitative estimates of total nutrient intakes from food plus dietary supplement products were considered necessary to evaluate high intakes of most nutrients. The prevalence of the use of vitamin and mineral supplements is reported, but quantitative data were not available to estimate total nutrient intakes from food plus dietary supplements.

Available methodologies

Several methodologies are used to estimate the mean consumption of foods and intakes of nutrients in the NNMRRP. Food available to the total population and per capita consumption are estimated from food-supply data. Food-supply and per-capita-consumption data are discussed in chapter 3, and average annual food use by households, estimated from household food records, is described in chapter 4.

Food consumption information is also collected directly from individuals. This approach was used for CSFII 1989-91, HHANES 1982-84, and NHANES III 1988-91. In those surveys, data were collected from individuals by quantitative daily-consumption methods, which attempt to capture the nature and amounts of individual foods consumed in defined periods of time, often 1 day or multiples thereof. For HHANES 1982-84 and NHANES III 1988-91, 1-day data were collected by a single 24-hour recall for all subjects and, in NHANES III 1988-91, by two additional 24-hour recalls for participants 50 years of age and older. In CSFII 1989-91, data were collected for 3 consecutive days: for the first day, by 24-hour recall, and for the second and third days, by food records. Intakes of nutrients were calculated by multiplying the amounts of all foods consumed on individual days by the estimated concentration of the nutrient or other food component in each individual food.

Factors to consider when using 1-day and multiple-day food consumption data were reviewed in the EPONM report (LSRO, 1989) and by Anderson (1986). NHANES III 1988-91 and HHANES 1982-84 also included a food frequency component in which participants recalled their usual consumption of foods or groups of foods for a targeted time period in the past. Because of limitations of the food frequency approach for quantitative estimates of nutrient intakes (Briefel et al., 1992), these data were not used to estimate nutrient intakes for this report.

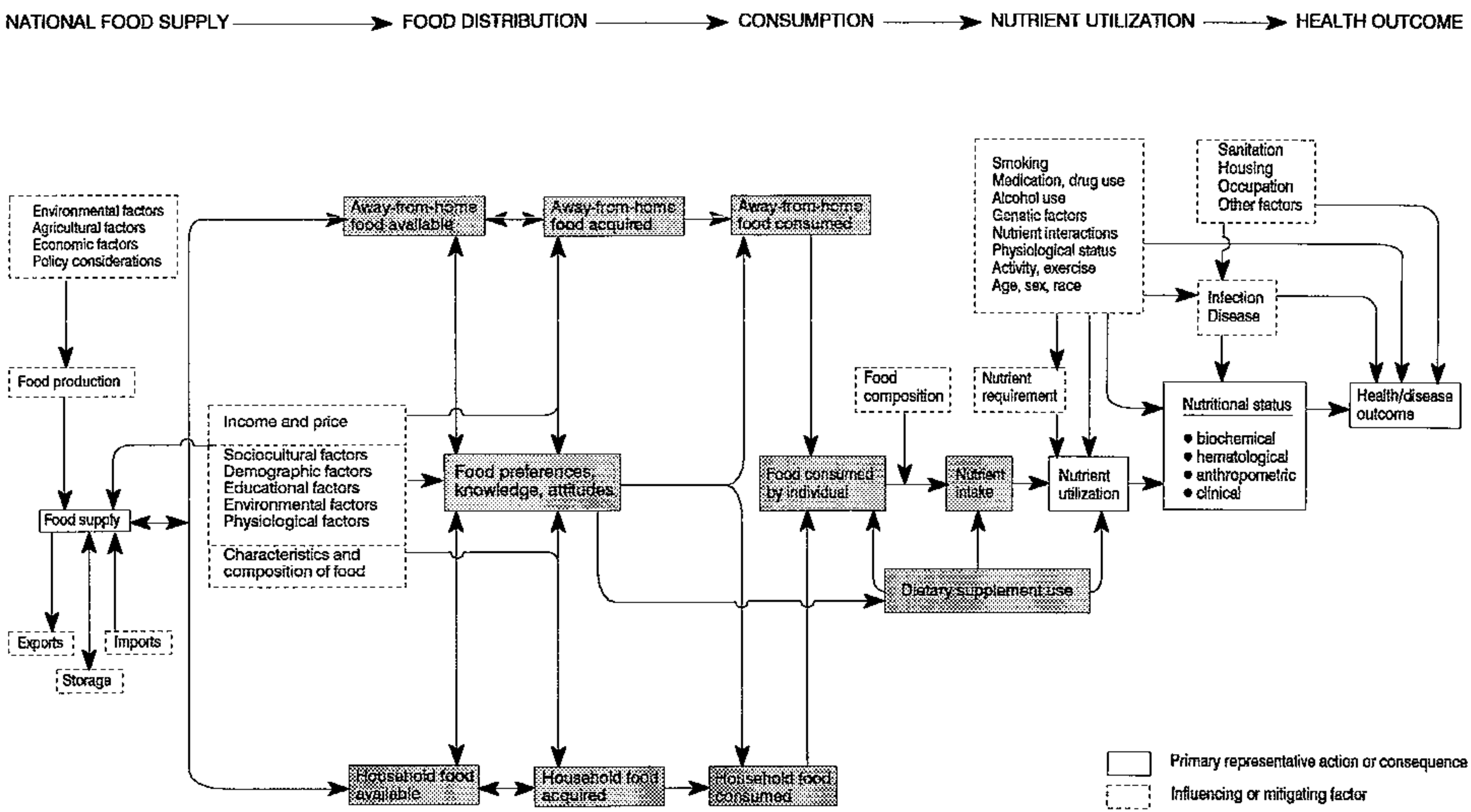

Figure 6-1. General conceptual model highlighting food choice and food and nutrient intake in the relationship of food to health (see text for explanation)

SOURCE: LSRO (1989).

However, the data were used to compare the frequencies of consumption of alcoholic beverages among subgroups in NHANES III 1988-91.

An alternative to collecting food consumption information from individuals is a method used in the Total Diet Study, conducted annually by the Food and Drug Administration (FDA), that involves direct analysis of "core" foods in U.S. diets. The foods that are analyzed represent aggregates of foods and are selected based on food consumption information from NFCS and NHANES. Estimates of the intakes of various mineral elements (nutrient and contaminant), pesticide residues, and organic contaminants other than pesticides are made for selected age-sex groups on the basis of the analysis of the core foods. The program in place from 1982 to 1991 included 11 nutritional elements, 234 core foods, and 8 age-sex groups. Data from 1982-89 are included in the TRONM. The current program (revised in 1991) includes 10 nutritional elements, 261 core foods, and 14 age-sex groups. For additional information on 1982-89 data from the Total Diet Study, see Pennington and Young (1991).

Types and sources of data

The types and sources of data on food consumption and nutrient intake used in this chapter are listed in table 6-1. The data include information on food consumption, intakes of nutrients and other food components, the use of vitamin and mineral supplements collected in surveys in the NNMRRP, and food insufficiency. CSFII 1989-91 provided data on the percentage of people consuming foods based on commodity food groups (grain products; vegetables; fruits; milk and milk products; meat, poultry, and fish; eggs; legumes; nuts and seeds; fats and oils; sugars and sweets; and beverages). Estimates of fruit and vegetable consumption were also provided by CSFII 1989-91 and the 5 A Day for Better Health Baseline Survey.

In addition to information on the consumption of foods in commodity food groups, this chapter includes information on consumption of water (NHANES III 1988-91) and alcoholic beverages (CSFII 1989-91 and NHANES III 1988-91) and on discretionary salt use (CSFII 1989-91 and NHANES III 1988-91). Data on food sources of nutrients as consumed (HHANES 1982-84), food consumption patterns (CSFII 1989-91), and food consumption away from home (CSFII 1989-91, NFCS 1987-88, and the School Nutrition Dietary Assessment Study (SNDA) 1992) are also discussed here. Data on food insufficiency came from both CSFII 1989-91 and NHANES III 1988-91.

CSFII 1989-91 and NHANES III 1988-91 provided nutrient intake estimates calculated from reported food consumption data for nationally representative samples of the U.S. population. HHANES 1982-84 provided nutrient intake estimates for Mexican Americans, Cuban Americans, and Puerto Ricans. Data available from these surveys included estimates of 1-day mean and median intakes of food energy and 27 food components for subjects 2 months of age and older (NHANES III 1988-91), 6 months to 74 years of age (HHANES 1982-84), and all ages (CSFII 1989-91). Food composition data from the USDA Nutrient Data Base for Individual Food Intake Surveys (Survey Nutrient Data Base) were used with the three surveys. One-day nutrient intake estimates for the three surveys were calculated from 24-hour dietary recall data. In addition, mean 3-day nutrient intake data were calculated from 24-hour dietary recall and 2-day dietary records from CSFII 1989-91.

Data from all surveys were used to estimate nutrient intakes of the U.S. population in this chapter. Median 1-day nutrient intakes calculated from NHANES III 1988-91 data were used to examine nutrient intakes of population subgroups by age, sex, and race/ethnicity. Mean 3-day nutrient intakes calculated from CSFII 1989-91 data were used to examine nutrient intakes of population subgroups by income level. Selected mean nutrient intakes from CSFII 1989-91 were compared with mean nutrient intakes from NFCS 1977-78 and NFCS 1987-88.

For this report, estimates of 1-day mean nutrient intakes of American Indians 45-74 years of age residing in three States in 1989-91 came from the Strong Heart Dietary Study. For school-age children, SNDA 1992 also provided information on mean intakes of food energy and nutrients on 1 school day. However, methodological differences may contribute to an unknown extent to differences in mean intake estimates from this survey compared with CSFII 1989-91, HHANES 1982-84, and NHANES III 1988-91. Data from FDA's Total Diet Study used for this report included estimates of mean intakes of 11 mineral elements, as determined by direct chemical analysis of 234 foods representative of diets for eight age-sex groups.

Table 6-1. Types and sources of data on food consumption and nutrient intake used in chapter 6 of the *Third Report on Nutrition Monitoring*

Type of data	Source of data[1]
Food consumption	CSFII 1989-91 (USDA, HNIS)[2] NHANES III 1988-91 (CDC, NCHS) 5 A Day for Better Health Baseline Survey, 1991 (NCI)
Intake of nutrients and other food components calculated from food-consumption and food-composition data[3]	CSFII 1989-91 (USDA, HNIS) NHANES III 1988-91 (CDC, NCHS) HHANES 1982-84 (CDC, NCHS) Strong Heart Dietary Survey 1989-91 (IHS and CDC) School Nutrition Dietary Assessment Study 1992 (USDA, FCS) NFCS 1977-78 (USDA, ARS) NFCS 1987-88 (USDA, HNIS)
Intake of food components provided by direct chemical analysis of core foods representative of diets for selected age/sex groups	Total Diet Study, 1982-89 (FDA)
Use of vitamin and mineral supplements	NHANES III 1988-91 (CDC, NCHS) 1991 Longitudinal Followup to the 1988 National Maternal and Infant Health Survey (CDC, NCHS) National Health Interview Survey on Vitamin and Mineral Supplements, 1986 (CDC, NCHS; FDA)
Food insufficiency	CSFII 1989-91 (USDA, HNIS) NHANES III 1988-91 (CDC, NCHS)

[1]CSFII, Continuing Survey of Food Intakes by Individuals; USDA, U.S. Department of Agriculture; HNIS, Human Nutrition Information Service; NHANES, National Health and Nutrition Examination Survey; CDC, Centers for Disease Control and Prevention; NCHS, National Center for Health Statistics; NCI, National Cancer Institute; HHANES, Hispanic Health and Nutrition Examination Survey; IHS, Indian Health Service; FCS, Food and Consumer Service; NFCS, Nationwide Food Consumption Survey; ARS, Agricultural Research Service; FDA, Food and Drug Administration.
[2]Legislation passed on Feb. 20, 1994, transferred the functions and staff of the Human Nutrition Information Service (HNIS) of the USDA to the existing Agricultural Research Service (ARS) of that department.
[3]The USDA Survey Nutrient Data Base appropriate for the years of the following surveys was used: NFCS 1977-78, HHANES 1982-84, CSFII 1985-86, NFCS 1987-88, NHANES III 1988-91, CSFII 1989-91, and Strong Heart Dietary Survey 1989-91. The sponsoring agency was ARS (USDA) for 1977-81 and HNIS (USDA) for 1981-91.

SOURCE: LSRO, 1994.

Recent data on the use of vitamin and mineral supplements were provided for subjects 2 months of age and older from NHANES III 1988-91 and for 3-year-old children from the 1991 Longitudinal Followup to the 1988 National Maternal and Infant Health Survey. These data update earlier surveys of the use of vitamin and mineral supplements (1986 National Health Interview Survey on Vitamin and Mineral Supplements and the 1980 Telephone Survey on Vitamin and Mineral Supplement Use) conducted by FDA. Because of differences in procedures and differences in age groups included in the various surveys, comparisons among the various data sources are limited.

Criteria for assessment

Food consumption data

The quality of data on food consumption by individuals depends on the appropriateness of the methodology used for the data collection and on the accuracy and completeness of the recall or record-keeping of the individual. Culturally appropriate modifications to dietary interviews may be needed to collect accurate dietary information from ethnic groups (Loria et al., 1994). General criteria for assessing the quality of food consumption data include whether the methods used could collect the desired information, whether identical measurement procedures have been used with adequate precision throughout the study, whether independent quality-control procedures have been used, and whether interviewer error and bias have been minimized (Anderson, 1986). Sources of error in food consumption data were discussed by Anderson (1986, 1988) and in the proceedings from the Dietary Methodology Workshop for the third National Health and Nutrition Examination Survey (Briefel and Sempos, 1992).

There is no absolute measure of food consumption that can be used as a standard of comparison for evaluating the accuracy and completeness of the recalls or records provided by the participants in a survey. However, automated data-collection and data-coding procedures and protocols for extensive probing by interviewers have been developed in an effort to decrease error associated with interviews and data processing. For CSFII 1989-91, manual data-collection and computer-assisted coding procedures were used. For NHANES III 1988-91, automated data-collection and data-coding procedures were begun in 1988 (Alaimo et al., 1994; Briefel, 1994; NCHS, 1994).

Implicit in the criteria used to evaluate the quality of food consumption data is the response rate for a survey. Response rates for the surveys considered in this report are shown in appendix IV.

Food composition data

As discussed in chapter 5, the quality and quantity of analytical values and the number of foods for which data are available, as well as the adequacy of the analytical methodology, vary widely for specific nutrients. Values included in data bases used for calculating nutrient intakes include published and unpublished analytical values, imputed values, label information, and values calculated from recipes. However, much of the detail and documentation originally available with some of the data has not been transferred into the nutrient data bases used in surveys. At present, the Survey Nutrient Data Base includes little information that allows for evaluating the quality of nutrient composition data for individual foods.

Linking food consumption and food composition data

It is logistically and economically impossible to analyze the chemical composition of all of the foods consumed by participants in nationally representative surveys. Therefore, to estimate nutrient intakes, data on foods consumed must be linked with data from nutrient data bases. If foods consumed (e.g., ethnic foods, highly processed snack items, and reduced-fat products) are described in great detail, much of the specificity of this information may be lost or inaccurately recorded if analytical data are not available for the foods and if the nutritional composition of those foods is imputed from foods that are not similar in composition. Development of the Survey Nutrient Data Base has helped to improve the closeness of matches between foods reported by survey participants and the food composition data used to calculate nutrient intakes for the population as a whole, but further study is needed to ensure the most appropriate linkages between food consumption and composition data.

Nutrient intake data

The quality of the food consumption data and the food composition data in the survey nutrient data base used to calculate nutrient intakes determines the quality of nutrient intake estimates. The following section addresses approaches that can be used to evaluate adequacy of nutrient intakes. Criteria available for estimating the likelihood of inadequate dietary intakes from survey data include nutrient density, the Recommended Dietary Allowances (RDAs), and the probability that a specific intake will be inadequate to meet the requirement of an individual. (See app. II for tables of 1989 RDA values.)

Nutrient density

Nutrient density provides a unit measurement of intake of a given nutrient for each 1,000 calories (kcal) consumed. Appropriate nutrient-to-energy ratios remain to be established for most nutrients, and nutrient density is not widely used as a criterion for assessing dietary intakes.

A variation of this measurement, percent of calories provided by energy-yielding macronutrients (e.g., total fat, protein, total carbohydrate, and alcohol), was used to evaluate progress toward meeting Healthy People 2000 Objective 2.5 (HHS, 1991). This objective specifies, "Reduce dietary fat intake to an average of 30 percent of calories or less and average saturated fat intake to less than 10 percent of calories among people aged 2 and older" (HHS, 1991). *Nutrition and Your Health: Dietary Guidelines for Americans* (USDA and HHS, 1990) also suggests that fat and saturated fatty acid intakes be reduced to 30% and 10% of calories, respectively.

Recommended Dietary Allowances

The evaluation of dietary data for potentially inadequate intakes has often been based upon comparisons of mean intakes of population groups with the RDAs prepared by the Food and Nutrition Board of the National Research Council (NRC). With the exception of recommended food energy intakes, RDAs for most nutrients have been defined as the "levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons" (NRC, 1989a). Currently, RDAs are set for protein, 11 vitamins, and 7 minerals. In cases of nutrients for which information was considered insufficient for establishment of an RDA—biotin, pantothenic acid, copper, manganese, fluoride, chromium, and molybdenum—Estimated Safe and Adequate Daily Dietary Intakes (ESADDIs) provide ranges of recommended intakes. For the electrolytes sodium, potassium, and chloride, estimates of minimum requirements and recommended intakes of healthy people are provided. Recommended Energy Intakes are set to meet the mean population requirements of age-sex groups because consumption of food energy at a level intended to cover the variation in energy needs among individuals could lead to overweight or obesity in many people.

Mean intakes of nutrients are often greater than median intakes. Thus, comparison of the median intake with the RDAs may be less likely to underestimate inadequate intakes. If the median intake of a population is similar to or greater than the RDA for that group, the probability of a deficiency of that nutrient is considered to be low in that population unless there is a very wide spread in the distribution of usual intakes. Because the RDAs include a margin of safety, median intakes below an RDA are often not inadequate. However, the risk of inadequate intake of nutrients from food increases as the median intake of a population falls.

The Expert Consultants and LSRO were more constrained in evaluating high or excessive nutrient intakes. Although the Expert Consultants and LSRO considered high intakes when they assigned nutrition monitoring priority, fewer criteria were available for these evaluations (see ch. 9). For example, RDA values were not designed to evaluate high or excessive nutrient intakes. In general, the Expert Consultants and LSRO did not consider the likelihood of adverse effects from high nutrient intakes except for total food energy, total fat, saturated fatty acids, cholesterol, and sodium. For food energy, median intakes were compared with the Recommended Energy Intakes. For intakes of total fat, saturated fatty acids, and cholesterol, recommendations of the National Cholesterol Education Program were used as criteria for evaluating median intakes of these food components (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II), 1993; Expert Panel on Blood Cholesterol in Children and Adolescents, 1991). For sodium, median intakes from food (not including discretionary salt use) were compared with the maximum recommended intake for healthy people (NRC, 1989a).

The nutrient intake estimates included in this report represent intakes of nutrients from food only. The Expert Consultants considered it unlikely that foods would provide excessive intakes of nutrients other than those nutrients listed above. Excessive intakes of most nutrients would be more likely to result from consumption of dietary supplements plus food than from food alone.

Probability approach

The variability of nutrient requirements or nutrient intakes among individuals is not accounted for when median intakes are compared with a fixed cutoff point such as an RDA or a given level of nutrient density. Consequently, that comparative approach may produce a bias in the estimate of the prevalence of inadequate intakes and may lead to misinterpretation. Use of the RDA as a fixed cutoff point may overestimate the true prevalence of inadequate intakes, particularly when large intraindividual (within-person) variability in requirements exists (NRC, 1986). The Subcommittee on Criteria for Dietary Evaluation developed a probability approach because of the shortcomings of fixed cutoff values (NRC, 1986). This approach was based on the probability that a specific intake is inadequate to meet an individual's requirement. The approach can provide estimates of the prevalence of nutrient inadequacy in a population group, but it cannot assess nutrient inadequacy for an individual.

The probability approach requires estimates of the distributions both of nutrient requirements and of usual nutrient intakes (NRC, 1986). Information on the distributions of usual intakes (intake over a period of several weeks or months) may be derived from multiple days of dietary intake data, such as those available from CSFII 1989-91; however, information on distributions of nutrient requirements does not appear to be available for most nutrients.

Approach used to evaluate nutrient intakes in the TRONM

To evaluate whether intakes of certain nutrients might be sufficiently low to warrant further attention, median intakes based on the 1-day data from NHANES III 1988-91 and HHANES 1982-84 were compared with the 1989 RDAs for each age and sex group. These data were used for this purpose because the median intake may be reasonably estimated from 1-day dietary intake data and data were available for three racial/ethnic subgroups from NHANES III 1988-91 (non-Hispanic whites, non-Hispanic blacks, and Mexican Americans) and three Hispanic subgroups from HHANES 1982-84 (Cuban Americans, Puerto Ricans, and Mexican Americans).

The Expert Consultants and LSRO did not consider the comparison between median intakes and the RDAs sufficient as a sole criterion for assessing the adequacy of dietary intake of population groups. In most cases, distributions of intakes are likely to be wider than distributions of requirements. Typical estimates of the coefficient of variation (CV) of intakes are about 25-45%, depending on the number of days food consumption is measured for each individual, whereas CVs for requirements are generally thought to be around 10-20%. If there is considerable variability in intakes, a substantial proportion of the population may have intakes that fall below the mean requirement even if the median intake is at the RDA.

To confirm the information obtained by comparing median intakes with the RDA for each nutrient, the Expert Consultants and LSRO made additional comparisons that used the principles of the probability approach. Because the average requirements and CVs for most nutrients are unknown, a crude approximation of the mean requirements for each nutrient was calculated, based on the assumptions that all RDA values approximate the mean requirement plus 2 standard deviations (SDs) and that the CV was 15% for all nutrients. With these assumptions, approximate mean nutrient requirements were calculated as 77% of the RDA for each of the RDA age-sex subgroups. Individuals with intakes below this level have a probability of consuming less than their individual requirement for that nutrient of over 50%. The Expert Consultants and LSRO examined the percentage of the population with 3-day mean intakes of nutrients below 77% of the RDA to find other nutrients that might be considered potential public health issues. For this exercise, the distributions of 3-day nutrient intakes from CSFII 1989-91 were used because they were considered a better approximation of the distributions of usual intakes than 1-day dietary intake data. Examination of the percentages of the population from CSFII 1989-91 with 3-day mean intakes below 77% of the RDA confirmed the observations from comparisons of RDA values with 1) the 1-day median intakes from NHANES III 1988-91 and HHANES 1982-84 and 2) the 3-day mean intakes from CSFII 1989-91.

Analyses of dietary data alone do not provide an indication of the nutritional status of populations or individuals. For nutrient intake estimates, information on dietary intakes was considered together with information on adequacy of food composition data. For assigning priorities for nutrition monitoring, information on nutritional status and nutrition-related health status was used, as described in chapter 9.

Appropriate uses and limitations of the data

The data from both CSFII 1989-91 and NHANES III 1988-91 that are discussed in chapter 6 may be used to estimate means, medians, and distributions of food consumption and nutrient intakes by populations or large population subgroups. Appropriate use of data collected by quantitative daily-consumption methods is influenced by the number of days for which data are collected. Data obtained for a single day may estimate the mean or median intake for a population reasonably well if the sample size is large enough to minimize chance errors (Beaton et al., 1983; Liu et al., 1978; Todd et al., 1983). However, data based on a single day's food consumption typically result in a distribution that is flatter and wider than the population it represents. Use of 1-day data may lead to overestimates of prevalences of intakes in the upper or lower percentiles of the distribution (Hegsted, 1972). Large intraindividual variation associated with single-day dietary data may also mask associations between dietary intake and disease (Beaton et al., 1979; Jacobs et al., 1979; Keys et al., 1966; Liu et al., 1978).

All food consumption data collected in the NNMRRP surveys are data reported by survey participants. Such data may lead to underestimates of food consumption and nutrient intakes because of underreporting of foods consumed (Bandini et al., 1990; Bingham, 1987; Black et al., 1991, 1993; Forbes, 1993; Lichtman et al., 1992; Livingstone et al., 1991; Mertz et al., 1991; Schoeller et al., 1990). Mean food energy intakes reported by adults 20 years of age and older were about 300 kcal/d higher in NHANES III 1988-91 than in CSFII 1989-91. Mean intakes of other nutrients were also generally higher in NHANES III 1988-91 than in CSFII 1989-91. Although the completeness of food consumption data is not known for any survey, improvements in dietary recall and recording methods may have contributed to less underreporting in NHANES III 1988-91 than in other current and previous national surveys (Briefel et al., in press). NHANES III 1988-91 data probably underestimated mean and median nutrient intakes to a lesser extent than did data from CSFII 1989-91. However, because of methodological differences between the surveys, additional research on methodologies is needed to identify the sources of the differences.

Assessing the dietary status of an individual or population groups is not the same as assessing nutritional status (Beaton, 1982). An interrelated sequence of physiological processes—including absorption, transport, storage, mobilization, and metabolism—occurs between when food is eaten and when it affects nutritional status. As discussed in chapter 7, the determination of nutritional status requires clinical observations and measurement of anthropometric and biochemical indices. The food consumption and nutrient intake data considered in this chapter can be used to evaluate dietary status, which, in turn, affects nutritional status. Nutrient intake estimates derived from the currently available food consumption surveys may be underestimates because of possible underreporting of food intakes and/or because they include intakes only from food (i.e., they do not include intakes from dietary supplements or drinking water).

The data included in the Survey Nutrient Data Base may be adequate for evaluating the mean dietary intakes of the population as a whole. However, with the great ethnic diversity of the U.S. population, more consideration must be given to adequate descriptions of the various foods people are eating and to including ethnic foods in food composition data bases. Loria et al. (1991) discussed the adequacy of the Survey Nutrient Data Base as a source of nutrient composition data for Mexican-American foods. In the past, nutrient data for some Mexican foods in the Survey Nutrient Data Base were based on commercially prepared, Americanized versions of the foods, whose recipes, ingredients, and preparation techniques may not match those used by Mexican Americans in the home (Loria et al., 1991). The National Center for Health Statistics (NCHS) and USDA have incorporated food composition data for many traditional Mexican foods into the Survey Nutrient Data Base; however, food composition data for traditional foods consumed by other ethnic groups may need to be added.

The impact of a lack of data on ethnic foods will depend on the use made of the data. For example, if the nutrient data are used for a few ethnic foods in studying the dietary intake of the U.S. population, only a small amount of error may be introduced into nutrient intake estimates, and the impact will be small. However, if a study focuses on food consumption of a particular ethnic group and inappropriate nutrient data are used for many, frequently reported foods, the amount of error may be larger and less tolerable.

Data generated by the Total Diet Study approach have the advantage of being based on direct analysis of 200-300 core foods consumed by the U.S. population. The Total Diet Study does not provide distributions of nutrient intakes, however. Although the diets represent 100% of the weight and food energy of the average diets consumed by the selected age-sex groups of the U.S. population, they do not represent the full diversity of foods consumed by the U.S. population.

Current data on food consumption

Food consumption by commodity groupings

As noted in the conceptual model (fig. 6-1), food consumption by individuals is influenced by many factors, including income, race/ethnicity, age, and sex. This section describes notable differences in food consumption of individuals, based on data collected in CSFII 1989-91, the 5 A Day for Better Health Baseline Survey, and HHANES 1982-84.

Data on percentages of individuals who reported using foods in certain commodity groups at least once during the 3 days of data collection in CSFII 1989-91 stratified by sex, race, age, and income levels are discussed below. The commodity groups included grain products; vegetables; fruits; milk and milk products; meat, poultry, and fish; eggs; legumes; nuts and seeds; fats and oils; sugars and sweets; and nonalcoholic beverages. As a guideline for interpreting these data, the Expert Consultants and LSRO considered differences among groups of about 10 percentage points noteworthy. Foods included in specific categories are listed in the table notes in appendix VB. More detailed data on percentages of individuals who reported using food commodities and detailed data on amounts of food consumed from the various commodity groups are provided in tables A.T6-2a through A.T6-11d in appendix VA.

Grain products

As shown in table 6-2, virtually all people reported using grain products during the 3 days of data collection in CSFII 1989-91. Mixtures, mainly grain, a category that included such items as pizza, enchiladas, and egg rolls, were consumed by higher percentages of children and adolescents of both sexes than by adults. Among adults, the lowest percentages of individuals reporting use of items in this food group were males and females 70 years of age and older. Among races, similar percentages of white and black males and females 20 years of age and older consumed yeast breads and rolls; cereals and pasta; and quick breads, pancakes, and french toast, but higher percentages of white males and females reported consuming cakes, cookies, pastries and pies, crackers, popcorn, pretzels, and corn chips than did black males and females. The percentage of individuals reporting consumption of cakes, cookies, pastries, and pies and of crackers, popcorn, pretzels, and corn chips was lowest for males and for females 20 years of age and older with incomes <131% of the Federal Poverty Income guideline. With each increment in income category (131-350% of poverty and >350% of poverty), higher percentages of males and females 20 years of age and older reported consumption of items in those food groups, with the highest percentages reporting use at the highest income level. The percentage of males and females 20 years of age and older at the lowest income level (<131% of poverty) who reported consuming mixtures, mainly grain, was lower than the percentages of higher income groups.

Vegetables

More than 94% of all age-sex, race, and income groups shown in table 6-3 reported consuming vegetables during the 3 days of dietary data collection in CSFII 1989-91. About 70% or more of people in all subgroup categories reported eating white potatoes in the past 3 days, suggesting that white potatoes may be the vegetable most commonly consumed by the U.S. population. The percentage of individuals using dark-green vegetables, deep-yellow vegetables, lettuce, and other vegetables was higher for adults 20 years of age and older of both sexes than for children and adolescents. Comparisons between black and white adults indicated that higher percentages of blacks of both sexes reported using dark-green vegetables, whereas higher percentages of whites of both sexes reported using deep-yellow vegetables, lettuce, and other vegetables. The lowest percentages of adults 20 years of age and older of both sexes who reported using lettuce, tomatoes, and dark-green, deep-yellow, and other vegetables were in the <131% of poverty category; with each increment in income category, higher percentages of adults reported using these vegetables. Percentages of adults who reported consuming white potatoes; green beans; and corn, green peas, and lima beans were similar across income levels. According to Cleveland et. al. (1995), the mean daily intake of vegetables was 3.8 servings for males and 2.9 servings for females 20 years of age and older in CSFII 1989-91.

Table 6-2. Grain products: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Total	Yeast breads, rolls	Cereal, pasta	Quick breads, pancakes, french toast	Cakes, cookies, pastries, pies	Crackers, popcorn, pretzels, corn chips	Mixtures, mainly grain[1]
Sex and age							
Male and Female							
1-2	99.8	84.1	91.5	48.7	60.1	47.4	70.9
3-5	100.0	94.7	91.9	47.7	67.6	43.6	73.1
Male							
6-11	100.0	92.3	91.7	48.5	72.1	42.8	78.6
12-19	100.0	93.5	75.0	43.5	68.1	45.7	72.2
≥20	99.6	91.9	64.3	39.7	55.0	37.9	57.1
≥70	99.8	91.2	83.8	44.0	64.0	42.0	34.4
Female							
6-11	100.0	96.0	88.7	54.9	71.8	45.6	72.7
12-19	99.5	91.2	72.6	44.3	58.6	41.1	73.2
≥20	99.5	92.0	66.3	40.0	55.8	43.2	54.1
≥70	100.0	94.8	80.3	38.6	62.4	37.7	37.1
Race, ≥20 years							
White							
Male	99.6	92.9	64.0	39.4	57.6	39.9	57.3
Female	99.4	92.4	65.5	39.4	58.2	45.5	54.9
Black							
Male	99.4	88.1	65.9	37.1	42.7	21.6	44.5
Female	99.8	90.0	71.4	40.3	45.1	27.3	46.4
Income level, ≥20 years							
<131% poverty							
Male	99.2	89.4	60.6	45.9	37.2	28.1	47.5
Female	99.6	90.7	68.7	40.6	42.4	35.1	49.9
131-350% poverty							
Male	99.7	90.4	64.7	40.8	55.9	36.4	57.5
Female	99.4	92.2	67.0	38.5	55.6	39.3	53.5
>350% poverty							
Male	99.6	93.1	65.4	37.0	59.5	42.2	58.0
Female	99.6	92.9	65.0	41.2	61.9	50.5	56.9

[1]Data are from tables A.T6-2a through A.T6-2d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days. This group includes mixtures having a grain product as a main ingredient, such as enchiladas, pizza, egg rolls, quiche, spaghetti with sauce, rice and pasta mixtures, frozen meals in which the main course is a grain mixture, noodle and rice soups, and baby-food macaroni and spaghetti mixtures.

SOURCE: USDA, CSFII, 1989-91.

Table 6-3. Vegetables: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Total	White potatoes	Dark-green vegetables	Deep-yellow vegetables	Tomatoes	Lettuce	Green beans	Corn, green peas, lima beans	Other vegetables
Sex and age									
Male and female									
1-2	94.0	74.7	16.5	18.6	36.6	12.4	31.2	41.8	41.4
3-5	96.2	73.6	18.3	16.5	52.5	22.8	26.3	39.1	45.8
Male									
6-11	97.9	74.9	12.9	17.1	56.3	35.6	22.0	42.5	55.5
12-19	97.7	81.9	13.4	15.7	58.8	44.0	18.7	36.6	51.0
≥20	97.4	75.4	21.7	21.9	62.3	52.7	21.4	32.4	70.0
≥70	98.8	75.1	28.2	33.2	61.4	51.0	22.3	37.7	77.4
Female									
6-11	97.8	79.1	16.4	17.7	61.1	40.1	26.4	41.4	53.3
12-19	96.2	79.1	14.0	16.5	56.5	43.0	20.8	26.4	53.6
≥20	97.4	71.6	25.7	26.8	57.4	53.8	22.5	31.7	71.2
≥70	98.5	70.4	30.2	37.0	50.8	45.5	29.6	31.8	76.7
Race, ≥20 years									
White									
Male	97.6	76.5	21.1	22.6	63.1	54.6	20.8	32.8	71.5
Female	97.7	72.4	24.9	28.4	59.3	56.3	22.5	32.0	72.9
Black									
Male	96.1	70.6	26.0	14.9	57.8	40.3	27.0	33.5	61.4
Female	95.1	69.9	33.8	15.1	43.9	35.1	22.4	33.1	59.4
Income level, ≥20 years									
<131% poverty									
Male	95.8	71.7	16.0	16.5	52.9	34.7	21.6	30.4	60.3
Female	96.6	68.7	19.9	18.8	49.8	38.8	24.8	31.9	61.1
131-350% poverty									
Male	98.1	77.6	20.8	19.1	61.2	47.3	23.6	34.3	68.4
Female	97.1	72.3	22.8	24.3	56.7	49.2	23.1	30.7	67.2
>350% poverty									
Male	98.2	75.3	23.6	25.7	65.2	60.8	19.7	32.3	74.2
Female	98.2	74.3	29.5	32.0	62.1	64.8	19.4	32.0	77.7

[1]Data are from tables A.T6-3a through A.T6-3d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days. The "white potatoes" group includes raw, baked, boiled, mashed, scalloped, and fried potatoes; potato skins; potato chips, and mixtures having potatoes as a main ingredient, such as potato salad, stuffed baked potatoes, and potato soup. The "tomatoes" group includes raw and cooked tomatoes; tomato juice, catsup, chili sauce, and other tomato sauces; and mixtures having tomatoes as a main ingredient, such as tomato-based soups, tomato and corn, tomato and okra, and tomato sandwiches coded as a single item. The "other vegetables" group includes raw and cooked vegetables other than white potatoes, deep-green and deep-yellow vegetables, tomatoes, lettuce, green beans, corn, peas, and lima beans and their mixtures. It also includes vegetable juices and soups; pickles, olives, and relishes; baby-food vegetables and baby-food vegetable mixtures with meat; and mixtures having "other" vegetables as a main ingredient.

SOURCE: USDA, CSFII, 1989-91.

The 5 A Day for Better Health Baseline Survey found that 16-19% of the males surveyed reported consuming 5 or more daily servings of fruits and vegetables, compared with 23-34% of the females (fig. 6-2). Within each sex, the proportion of people consuming 5 or more servings of fruits and vegetables per day was greatest for the group 60 years of age and older. Approximately half of the males and females 40-59 years of age reported consuming between 2.5 and 5 servings of fruits and vegetables per day.

Fruits

Overall, smaller percentages of the population reported fruit consumption than vegetable consumption (table 6-4). Only 59% of black males 20 years of age and older reported eating fruit during the 3 days of dietary data collection in CSFII 1989-91, and about 70% of adolescent males and females 12-19 years of age and white males and black females 20 years of age and older reported eating fruits during this time period. These values do not include fruits and vegetables eaten as part of food mixtures. Higher percentages of children 1-2 years of age and adults 70 years of age and older reported consuming dried fruit than other age groups. Higher percentages of adults 70 years of age and older reported eating citrus fruits and juices, bananas, and melons and berries than other age groups. Noncitrus juices and nectars were consumed by higher percentages of children than adolescents and adults. Higher percentages of white males and females 20 years of age and older reported consuming melons and berries and other fruits and mixtures that were mainly fruit than did black adults of both sexes. Higher percentages of adults 20 years of age and older reported consuming fruit with each increment in income category. This occurrence was more marked for total fruit, citrus fruits and juices, dried fruits, melons and berries, and other fruits and mixtures that were mainly fruit than it was for apples, bananas, and noncitrus juices and nectars. Regardless of income level, higher percentages of adult females than males reported consuming fruits. Males and females 20 years of age and older, on average, consumed only 1.3 servings per day from the fruit group (Cleveland et al., 1995).

Milk and milk products

With the exception of black adults of both sexes and adults of both sexes with income levels <131% of poverty, more than 90% of people reported using milk and milk products during the 3 days of dietary intake data collection in CSFII 1989-91 (table 6-5). Higher percentages of children and adolescents than adults reported using whole milk. Higher

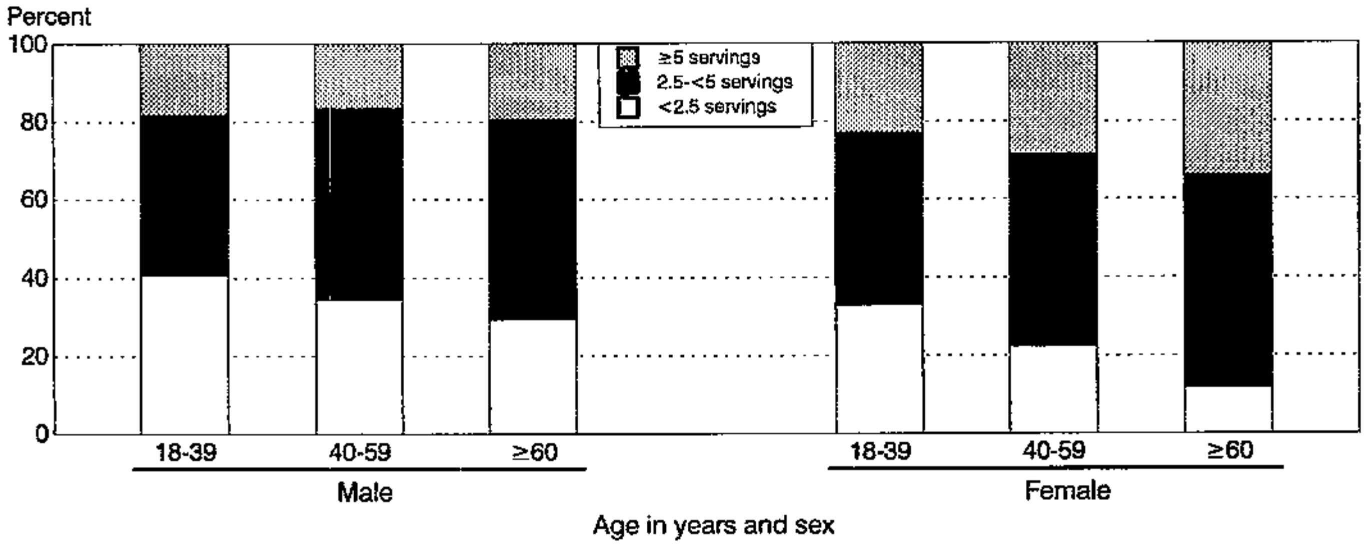

Figure 6-2. Percent distribution of daily servings of fruits and vegetables consumed by people 18 years of age and older, by age and sex, 1991

NOTE: Data are from table A.F6-2 in appendix VA.

SOURCE: HHS, Baseline Survey of the 5 A Day for Better Health Program, 1991.

Table 6-4. Fruits: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Total	Citrus fruits and juices	Dried fruits	Apples	Bananas	Melons and berries	Other fruits and mixtures, mainly fruit	Noncitrus juices and nectars
Sex and age								
Male and female								
1-2	86.9	38.5	9.5	29.7	30.1	10.4	33.1	40.9
3-5	85.2	46.3	5.0	36.3	21.6	11.1	29.6	38.9
Male								
6-11	82.9	41.4	4.7	39.4	18.9	9.8	38.4	22.5
12-19	69.9	41.8	2.9	21.0	18.0	7.3	22.4	12.1
≥20	67.7	39.7	4.9	20.6	21.3	13.0	24.7	8.8
≥70	88.4	50.2	14.8	30.3	43.5	23.4	46.3	12.7
Female								
6-11	86.1	43.9	4.0	38.2	23.8	8.2	45.0	24.8
12-19	69.7	43.9	2.1	16.7	14.9	8.8	23.1	13.0
≥20	75.9	44.7	5.7	24.8	25.1	16.3	30.6	11.8
≥70	90.3	55.3	10.7	25.9	41.8	23.1	44.2	12.8
Race, ≥20 years								
White								
Male	68.7	39.7	5.3	21.7	22.2	13.3	25.7	8.6
Female	76.8	45.2	6.1	25.5	24.9	16.9	31.8	11.7
Black								
Male	59.4	37.4	4.2	12.9	14.4	7.1	15.8	10.9
Female	68.8	38.4	2.6	17.1	23.7	9.6	18.7	12.4
Income level, ≥20 years								
<131% poverty								
Male	54.1	29.5	3.0	14.8	15.5	6.7	13.3	7.9
Female	66.2	36.4	3.8	20.2	21.1	8.8	23.2	11.7
131-350% poverty								
Male	65.5	36.2	3.9	18.6	22.8	9.9	21.2	8.2
Female	76.0	41.2	4.8	23.7	28.0	15.4	27.5	11.4
>350% poverty								
Male	72.1	44.8	6.0	24.3	21.4	16.4	28.7	10.2
Female	80.2	50.3	6.0	26.5	25.0	20.0	35.0	12.0

[1]Data are from tables A.T6-4a through A.T6-4d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days. The "other fruits and mixtures mainly fruit" group includes fruits other than citrus fruits, dried fruit, apples, and bananas; mixtures of apple or banana and other noncitrus fruits coded as a single item; and baby-food noncitrus fruits (except applesauce) and mixtures having fruit as a main ingredient. Foods in this group have not been disaggregated.

SOURCE: USDA, CSFII, 1989-91.

Table 6-5. Milk and milk products: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Total	Whole milk	Low-fat milk	Skim milk	Yogurt	Milk desserts	Cheese
Sex and age							
Male and Female							
1-2	98.8	61.6	42.5	5.0	8.7	25.4	51.4
3-5	99.0	54.9	49.9	7.2	7.5	40.5	46.5
Male							
6-11	98.0	51.1	53.4	7.8	5.8	40.7	49.8
12-19	97.4	44.8	50.5	5.7	1.1	32.9	49.6
≥20	92.0	30.0	35.9	12.0	4.0	29.0	52.7
≥70	92.3	29.2	41.2	17.3	6.7	37.6	39.7
Female							
6-11	99.3	57.3	45.5	7.2	5.4	45.9	54.0
12-19	93.3	47.0	34.4	7.3	5.1	30.8	52.6
≥20	92.2	27.6	37.1	15.9	7.7	29.4	53.4
≥70	94.7	28.5	43.3	17.1	5.9	34.0	45.3
Race, ≥20 years							
White							
Male	93.8	29.0	38.6	13.6	4.4	31.1	54.8
Female	93.7	24.8	40.7	17.8	8.3	30.8	55.6
Black							
Male	79.6	39.7	15.1	2.0	1.7	15.8	36.2
Female	83.7	43.5	14.5	5.7	3.6	23.1	37.4
Income level, ≥20 years							
<131% poverty							
Male	87.6	45.9	26.8	5.7	2.4	17.8	41.4
Female	87.9	41.3	28.1	6.9	3.7	19.0	40.6
131-350% poverty							
Male	91.8	32.0	38.3	7.6	3.4	26.8	52.9
Female	91.4	28.6	37.2	11.7	5.7	29.3	51.8
>350% poverty							
Male	95.0	24.8	37.0	16.9	4.9	32.4	57.7
Female	95.0	22.1	41.0	22.5	10.2	32.8	61.4

[1]Data are from tables A.T6-5a through A.T6-5d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days.

SOURCE: USDA, CSFII, 1989-91.

percentages of adults than children or adolescents reported using skim milk. Lower percentages of males and females 70 years of age and older reported Consumption of milk desserts tended to be higher for children 3-11 years of age than for people in other age groups. Among males and females 20 years of age and older, smaller percentages of blacks than whites reported using milk and milk products. Notable differences were observed among types of milk consumed by black and white adults, with higher percentages of black males and females 20 years of age and older consuming whole milk, and higher percentages of white males and females 20 years of age and older consuming low-fat and skim milks. At higher income levels, higher percentages of adults of both sexes reported consuming all categories of milk and milk products except for whole milk. The highest percentage of adults using whole milk was in the <131% of poverty income category; with each increment in income level, the percentage of adults using whole milk decreased.

Meat, poultry, and fish

As was the case for grain products, virtually all people reported using meat, poultry, and fish in CSFII 1989-91 (table 6-6). Use of fish and shellfish and lamb, veal, and game was reported by lower percentages of people in all age-sex categories than use of products in other meat and poultry categories. Comparisons between races showed that higher percentages of white than black adults reported using beef, whereas higher percentages of black than white adults reported using pork and poultry. Higher percentages of adults of both sexes reported consuming beef and fish and shellfish at each increment in income category, whereas percentages of adults who reported use of poultry and pork were similar across income levels.

Nonalcoholic beverages

As shown in table 6-7, beverages in this commodity group included coffee, tea, regular and low-calorie fruit drinks and ades, and regular and low-calorie carbonated soft drinks. Coffee consumption was reported primarily by adults, with the highest percentages in the group 70 years of age and older. Coffee consumption was reported by higher percentages of white than black adults and by higher percentages of adults in the higher income categories. Tea consumption did not differ as dramatically by age, race, or income as did coffee consumption, but the differences were similar to those for coffee. The age groups with the highest use of regular fruit drinks and ades were children and adolescents, with about 35-44% reporting consumption. Higher proportions of black than white adults reported consuming regular fruit drinks and ades. Lower percentages of adults in higher income categories reported consuming these products. For regular soft drinks, the percentage of people reporting use peaked in adolescence. Higher percentages of black than white adults reported using regular carbonated soft drinks, but the reverse was noted for low-calorie carbonated soft drinks. Higher percentages of adults in higher income categories than lower income categories reported using low-calorie carbonated soft drinks, and higher percentages of females than males reported using these products at each income level.

Miscellaneous commodity groups

Percentages of individuals using eggs; legumes, nuts, and seeds; fats and oils; and sugars and sweets are shown in table 6-8. Higher percentages of black than white males and females 20 years of age and older reported using eggs including whole eggs, egg substitutes, and eggs in other forms. The highest percentages of adults reporting egg consumption were in the income category <131% of poverty. Because eggs and egg substitutes were not listed separately, consumption of each type of product cannot be examined in this report. Use of legumes was generally reported by about 20-30% of the population, with somewhat lower percentages for adults in higher income categories. Use of total fats and oils, table fats, and salad dressings was reported by higher percentages of males and females 20 years of age and older with each increase in income category. Use of salad dressings was reported by higher percentages of white than black adults. Higher percentages of children and adolescents than adults reported consuming candy. Candy consumption was reported by higher percentages of adults in higher income categories and by higher percentages of white than black adults.

Table 6-6. Meat, poultry, and fish: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Total	Beef	Pork	Lamb, veal, game	Frankfurters, sausage, luncheon meats	Poultry	Fish and shellfish	Mixtures, mainly meat, poultry, fish
Sex and age								
Male and female								
1-2	97.0	40.4	30.4	4.0	62.6	45.8	19.2	61.9
3-5	98.7	42.2	29.1	3.3	54.7	45.2	23.2	71.0
Male								
6-11	99.4	44.3	33.7	1.5	57.9	50.5	24.3	66.1
12-19	99.2	54.3	35.7	2.1	55.9	49.8	19.6	67.7
≥20	99.0	54.3	43.4	3.5	54.9	49.7	29.1	68.8
≥70	99.0	53.4	41.9	4.1	51.9	49.0	27.0	63.6
Female								
6-11	99.8	48.3	35.6	1.8	62.6	50.0	21.4	67.4
12-19	96.4	42.7	39.4	0.9	49.4	47.9	18.8	68.7
≥20	98.2	46.7	35.3	2.4	44.2	50.5	29.0	63.7
≥70	98.0	42.7	37.4	3.1	43.2	51.7	30.7	56.3
Race, ≥20 years								
White								
Male	98.9	55.2	43.0	3.8	54.7	47.3	28.4	69.0
Female	98.2	48.3	34.0	2.6	43.4	48.5	28.5	64.4
Black								
Male	99.8	48.2	53.5	0.9	57.5	65.3	33.8	65.7
Female	98.1	31.9	47.8	1.1	50.8	64.6	33.1	56.4
Income level, ≥20 years								
<131% poverty								
Male	98.5	46.5	43.6	3.2	58.5	44.0	21.2	61.2
Female	97.9	43.5	41.0	1.7	50.8	51.3	23.9	54.8
131-350% poverty								
Male	99.2	54.3	43.7	2.2	56.8	50.8	27.9	69.0
Female	98.0	45.1	37.8	1.5	46.5	48.7	28.3	66.2
>350% poverty								
Male	99.0	57.6	43.6	4.5	54.0	50.0	32.6	70.9
Female	98.4	49.9	33.1	3.5	40.1	51.2	31.6	65.9

[1]Data are from tables A.T6-6a through A.T6-6d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days. The "mixtures mainly meat, poultry, fish" group includes mixtures having meat, poultry, or fish as a main ingredient, such as chicken cacciatore; beef potpie; tuna-noodle casserole; venison stew; liver dumplings; hash; shrimp salad; corn dog; chicken soup; frozen meals in which the main course is a meat, poultry, or fish item; meat, poultry, or fish sandwiches coded as a single item (for example, cheeseburger on a bun); and baby-food meat and poultry mixtures. Foods in this group have not been disaggregated.

SOURCE: USDA, CSFII, 1989-91.

Table 6-7. Nonalcoholic beverages: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Total	Coffee	Tea	Fruit drinks and ades: Regular	Fruit drinks and ades: Low calorie	Carbonated soft drinks: Regular	Carbonated soft drinks: Low calorie
Sex and age							
Male and female							
1-2	63.9	0.4	12.2	35.4	4.1	35.6	5.5
3-5	72.9	0.3	13.3	38.5	5.6	42.4	7.6
Male							
6-11	81.4	2.8	18.6	39.5	8.5	61.4	8.4
12-19	94.4	7.1	24.7	28.3	6.0	77.3	11.4
≥20	96.4	67.7	35.3	15.3	4.2	53.3	21.2
≥70	96.7	83.3	38.0	18.2	2.5	25.1	15.1
Female							
6-11	80.5	1.1	17.9	44.2	2.8	51.8	13.4
12-19	92.9	8.4	32.5	31.7	4.9	70.3	22.9
≥20	95.6	63.4	41.2	17.9	3.1	43.6	28.2
≥70	94.6	77.9	45.8	16.0	3.4	22.1	12.5
Race, ≥20 years							
White							
Male	96.3	69.0	35.1	13.4	4.5	52.6	23.1
Female	95.5	64.9	41.7	15.9	3.3	40.8	30.2
Black							
Male	95.6	55.1	33.2	32.2	0.5	60.1	7.2
Female	96.1	52.9	37.4	32.5	1.1	59.8	14.8
Income level, ≥20 years							
<131% poverty							
Male	93.9	62.5	30.0	22.0	1.0	53.5	10.5
Female	94.9	61.6	35.1	22.8	2.0	44.9	14.6
131-350% poverty							
Male	96.0	65.0	37.0	16.7	4.4	56.9	17.7
Female	94.7	60.4	42.6	17.2	3.3	46.4	25.1
>350% poverty							
Male	97.5	73.0	35.9	13.0	4.7	49.7	28.4
Female	97.4	67.1	44.1	17.3	3.3	41.7	37.5

[1]Data are from tables A.T6-7,11a through A.T6-7,11d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days. The "regular fruit drinks and ades" group includes all fruit drinks, punches, and ades except low-calorie and low-sugar types, and the "low-calorie fruit drinks and ades" group includes low-calorie and low-sugar fruit drinks, punches, and ades. The "regular carbonated soft drinks" group includes all carbonated soft drinks except unsweetened and sugar-free types, and the "low-calorie carbonated soft drinks" group includes unsweetened and sugar-free carbonated soft drinks, seltzer water, and carbonated mineral water.

SOURCE: USDA, CSFII, 1989-91.

Table 6-8. Eggs, legumes, nuts and seeds, fats and oils, and sugars and sweets: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Eggs	Legumes	Nuts and seeds	Total fats and oils	Table fats	Salad dressings	Total sugars and sweets	Candy
Sex and age								
Male and female								
1-2	51.2	21.4	31.8	64.4	51.0	25.1	71.2	24.2
3-5	39.6	17.4	44.5	76.1	60.7	31.4	76.9	27.3
Male								
6-11	41.5	20.0	30.4	78.3	62.7	42.7	74.9	28.5
12-19	31.9	20.7	22.5	80.5	58.0	53.2	68.1	24.5
≥20	45.9	29.7	18.8	86.5	65.8	59.0	68.9	14.4
≥70	48.0	32.0	18.8	84.8	74.3	49.5	79.0	10.9
Female								
6-11	40.2	27.9	32.6	84.3	63.7	51.0	80.6	26.4
12-19	33.6	20.9	18.1	82.4	56.1	53.3	66.0	19.4
≥20	37.2	24.4	19.0	87.0	66.1	58.9	70.3	17.8
≥70	39.1	22.6	18.8	91.8	78.3	53.2	79.6	13.2
Race, ≥20 years								
White								
Male	44.5	28.7	20.1	87.3	66.6	60.2	68.1	15.3
Female	35.2	24.3	19.9	88.2	67.7	61.1	70.5	19.0
Black								
Male	54.3	27.3	13.1	80.7	58.5	51.7	71.9	8.8
Female	50.5	22.1	16.0	80.5	59.2	46.7	68.1	9.9
Income level, ≥20 years								
<131% poverty								
Male	55.9	36.3	16.1	78.5	59.3	44.3	66.3	9.9
Female	44.6	27.9	16.0	80.7	62.2	46.4	69.9	9.4
131-350% poverty								
Male	45.7	32.3	19.5	86.9	64.5	57.5	70.4	13.1
Female	38.1	23.2	18.9	86.8	64.7	57.1	70.8	17.1
>350% poverty								
Male	44.0	25.7	18.9	89.8	69.7	63.8	68.7	16.5
Female	35.1	24.0	20.0	90.6	70.7	66.6	70.5	21.4

[1]Data are from tables A.T6-8a through A.T6-8d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days. The "eggs" group includes whole eggs, egg whites, egg yolks, meringues, egg substitutes, baby-food egg yolks, and mixtures having egg as a main ingredient, such as omelets, egg salad, or egg sandwiches coded as a single item. Excluded are eggs that were ingredients in food mixtures coded as a single item and tabulated under another food group (for example, eggs in baked goods, which are tabulated under grain products). The "total fats and oils" group includes table fats; cooking fats such as bacon drippings, lard, and vegetable shortening; vegetable oils; salad dressings; nondairy sweet cream and sour cream substitutes; and hollandaise and other sauces that are mainly fat or oil. Excluded are fats and oils that were ingredients in food mixtures coded as a single item and tabulated under another food group (for example, fats or oils used to fry chicken, which are tabulated under meat, poultry, or fish, or mayonnaise in cole slaw, which is tabulated under vegetables). The "total sugars and sweets" group includes sugar, sugar substitutes, syrups, honey, molasses, sweet toppings, frostings, sweet sauces, jellies, jams, preserves, fruit butters, marmalades, sweet pastes, gelatin desserts, ices, fruit bars, sorbets, popsicles, candy (including dietetic sweets), and chewing gum, and it excludes sugars that were ingredients in food mixtures coded as a single item and tabulated under another food group (for example, sugar in baked goods, which is tabulated under grain products, or sugar in carbonated soft drinks, which is tabulated under beverages). The "candy" group includes all types of candy (including dietetic sweets), chocolate-covered and sugar-coated nuts, chocolate chips, fruit leather, chewing gum, breath mints, and cough drops.

SOURCE: USDA, CSFII, 1989-91.

Differences in food consumption among Hispanic subpopulations

Ethnicity has been shown to be an important predictor of the frequency of food consumption. Using the food frequency data collected during HHANES 1982-84, differences in food use among Mexican-American, Cuban-American, and Puerto Rican adults were identified. Significant differences were reported for such items as legumes, grain products (especially tortillas), coffee, and fruit-flavored drinks. Mexican Americans reported higher consumption of protein foods, legumes, and tortillas than did Cuban Americans and Puerto Ricans. Coffee consumption by Cuban Americans and Puerto Ricans was higher than that of Mexican Americans, whereas consumption of fruit-flavored drinks was lower (Kuczmarski et al., 1995). Regardless of ethnicity, higher percentages of females than males reported consuming fruits and vegetables more than once a day.

Water consumption

Water is essential for maintaining normal fluid and electrolyte balance and preventing dehydration. Estimates of total water intake represent tap and spring water consumed as a beverage plus the water added during the preparation of foods and beverages and water contained in ready-to-eat foods and beverages. These estimates are useful for identifying population groups at risk of developing dehydration; for providing more accurate intake estimates of minerals contributed by fluoridated, hard, and soft water; and for estimating exposure to waterborne and environmental contaminants.

At the end of the 24-hour dietary recall interview, respondents in NHANES III 1988-91 were asked about their usual consumption of plain water in a 24-hour period (NCHS, 1994). Plain water consumed as a beverage (drinking water) included only tap and spring water. Standardized drinking glasses of various sizes were used to assist the respondents when amounts of plain water were quantified as "glassfuls"; respondents could also report the total quantity using units of volume such as fluid ounces, quarts, or cups.

Mean intakes of plain water consumed by people 3-5 and 60-69 years of age in 1988-91 are presented in table 6-9, and intake of people 2 months of age and older, by race/ethnicity, is shown in table A.T6-9 in appendix VA. The age groupings 3-5 and 60-69 years were selected because children and older adults are at higher risk for dehydration than are adolescents and younger adults. Mean daily intakes of water of the children 3-5 years of age ranged from 15 to 28 fl oz (about 2 to 3.5 8-oz glasses), and daily mean intakes of the adults 60-69 years of age ranged from 40 to 57 fl oz (5 to 7 8-oz glasses). Regardless of age, non-Hispanic blacks reported consuming more plain water than did non-Hispanic whites or Mexican Americans.

Table 6-9. Daily mean water consumption of children 3-5 years of age and male and female adults 60-69 years of age, by sex and race/ethnicity, 1988-91 (fl oz)[1]

		60-69 years	
	3-5 years	Male	Female
Non-Hispanic			
White	15.1	39.6	41.1
Black	27.6	56.9	49.1
Mexican American	20.5	37.3	40.1
Overall population	17.8	40.7	41.3

[1]Data are from table A.T6-9 in appendix VA. Mean water consumption includes tap and spring water.

SOURCE: HHS, NHANES III, 1988-91.

The only population-based estimates of total water intake derived from dietary intake data were calculated from data collected in NFCS 1977-78 (Ershow and Cantor, 1989). Mean total daily water intake derived from all sources including foods, beverages, and drinking water was 53 fl oz for children aged 1-10 years and 74 fl oz for men and women aged 65 years and older. To estimate quantity of plain drinking water, individuals were asked how many cups (i.e., 8 fl oz) of water, other than water in coffee, fruitade, and other beverages, they drank for each of the 3 days of dietary data collection. The mean amount of water consumed as a beverage for children aged 1-10 years was 17 fl oz, and for men and women aged 65 years and older, the mean was 26 fl oz.

Estimates of individual and population intakes of water can vary from day to day, as can intakes of other essential nutrients. Ershow and Cantor (1989) reported that the variance of the 3-day average of total water or tapwater intake from NFCS 1977-78 data was approximately 75% of the variance for day 1 alone or any single randomly selected day. The reasons for the differences in the estimates of plain water (i.e., drinking water) intake obtained from the NFCS 1977-78 and NHANES III 1988-91 are not clear. Differences in the time period used to calculate the estimate of drinking water (i.e., 1 vs. 3 days) and other factors, such as the question posed to the respondent, the measurement aids used to assist with portion-size estimation, and reporting categories for age, may partially explain the differences.

Alcohol and alcoholic-beverage consumption

Mean alcohol consumption was derived from the 24-hour dietary recall data collected in NHANES III 1988-91. The following conversion factors were used to estimate ethanol in alcoholic beverages: 3.6 g/100 g of beer, 9.3 g/100 g of wine, and 36 g/100 g of whiskey. Mean reported ethanol intake was higher in males than females, and in adults 20-59 years of age, than it was in adolescents 16-19 years of age or adults 60 years of age and older (table 6-10). The mean intakes of non-Hispanic white adolescents were notably higher than the non-Hispanic blacks or Mexican Americans 16-19 years of age. The mean daily intake of 16 g for adolescent males would be equivalent to approximately 14 fl oz of beer, 6 fl oz of wine, or 1.5 fl oz of whiskey.

Table 6-10. Daily mean ethanol intake from 24-hour recalls of people 16 years of age and older, by race/ethnicity, sex, and age, 1988-91 (g)[1]

Race/ethnicity and sex	Age in years		
	16-19	20-59	≥60
Non-Hispanic			
White			
Male	16	19	9
Female	2	8	3
Black			
Male	5	20	7
Female	1	5	1
Mexican American			
Male	8	17	5
Female	1	4	1

[1]Data are from tables A.T6-10a and A.T6-10b in appendix VA. Data are skewed; interpret with extreme caution.

SOURCE: HHS, NHANES III, 1988-91.

In HHANES 1982-84, mean alcohol intakes were also found to be higher among males than females and among people 20-59 years of age than those less than 20 and 60-74 years of age. Mexican-American males 20-59 years of age had higher mean alcohol intakes than did Cuban-American and Puerto Rican males in the same age group (see tables A.6a and A.6b in app. VA). Mean alcohol intakes of Mexican-American, Cuban-American, and Puerto Rican females 20-59 years of age were about the same. Among males aged 16-19 years, Mexican Americans and Cuban Americans had higher intakes than Puerto Ricans. For females of this age, Cuban Americans had higher intakes than Mexican Americans and Puerto Ricans.

Mean alcohol intakes must be interpreted with caution because the values represent nondrinkers as well as drinkers and because alcohol consumption reported in national surveys is only a portion of the amount known to have been sold (Babor et al., 1987; Hilton, 1994). In 1991, per capita alcohol (ethanol) consumption, calculated from Alcohol Epidemiologic Data System (AEDS) sales data, was 19 g/d for the U.S. population 14 years of age and older. (See ch. 3 for information on per capita ethanol consumption derived from AEDS sales data.) The percentage of drinkers varies considerably by age, sex, race/ethnicity, and income. As shown in table 6-11, data from CSFII 1989-91 indicate that about 2% of people 12-19 years of age and about 32% of males and 17% of females 20 years of age and older reported consuming alcoholic beverages over the 3-day dietary collection period. Reported use varied by both race and income level. More whites than blacks and more people with household incomes >350% of poverty than people with incomes <131% of poverty used alcoholic beverages over the 3-day dietary record period.

The frequency of consumption of alcoholic beverages in NHANES III 1988-91 is shown in table 6-12. Regardless of race/ethnicity, more than 70% of males 20-39 years of age reported consuming alcoholic beverages monthly or more frequently, with progressively smaller percentages of males 40-59 and 60 years of age and older reporting that they consumed alcoholic beverages monthly or more frequently. Higher percentages of males than females

Table 6-11. Alcoholic beverages: percentage of people reporting use during 3 days, by sex, age, race, and income level, 1989-91 (%)[1]

Sex, age in years, race, and income level	Total	Wine	Beer and ale
Sex and age			
Males and females			
1-2	0.0	0.0	0.0
3-5	0.2	0.2	0.0
Males			
6-11	0.1	0.1	0.0
12-19	1.6	0.5	1.1
≥20	31.7	7.8	23.6
≥70	16.5	5.6	6.6
Females			
6-11	0.5	0.5	0.0
12-19	2.5	1.0	1.4
≥20	17.3	7.9	7.5
≥70	9.1	3.2	1.2
Race, ≥20 years			
White			
Males	33.1	8.7	24.1
Females	18.5	8.7	7.5
Black			
Males	22.9	2.2	22.0
Females	11.8	4.1	8.4
Income level, ≥20 years			
<131% poverty			
Males	17.2	1.1	15.5
Females	6.0	1.9	3.6
131-350% poverty			
Males	25.1	3.8	19.4
Females	11.8	4.5	5.5
>350% poverty			
Males	40.6	13.3	28.7
Females	28.2	14.4	11.7

[1]Data are from tables A.T6-7,11a through A.T6-7,11d in appendix VA. User is an individual reporting any food item in the specified food group or subgroup at least once in 3 days. The "total alcoholic beverages" group includes wine, beer, ale, liqueurs, cocktails, other mixed drinks, and distilled liquors. The "wine" group includes wine, cooking wine, light wine, and mixtures made with wine, such as wine coolers, and excludes nonalcoholic wine, which is tabulated under nonalcoholic beverages. The "beer and ale" group includes beer, ale, light ("lite") beer, and beer coolers, and excludes near beer, which is tabulated under nonalcoholic beverages.

SOURCE: USDA, CSFII, 1989-91

Table 6-12. Alcoholic beverages: percentage of people 20 years of age and older consuming alcoholic beverages monthly or more frequently, by sex, race/ethnicity, and age, 1988-91 (%)[1]

Sex, race/ethnicity, and age in years	Total	Wine	Beer	Hard liquor
Males				
Non-Hispanic white				
20-39	74.1	29.1	67.9	36.6
40-59	66.4	32.2	56.1	33.4
≥60	51.7	21.8	36.2	29.4
Non-Hispanic black				
20-39	72.2	27.3	66.6	42.5
40-59	61.2	18.8	51.1	38.8
≥60	42.1	9.6	33.1	24.2
Mexican American				
20-39	75.1	13.7	71.9	22.2
40-59	63.8	16.7	58.6	24.0
≥60	42.6	9.8	35.2	13.0
Females				
Non-Hispanic white				
20-39	59.6	38.1	36.7	31.0
40-59	49.1	34.6	20.8	23.3
≥60	30.0	18.1	9.5	15.1
Non-Hispanic black				
20-39	53.9	30.8	36.0	22.4
40-59	36.9	12.9	24.3	17.5
≥60	16.7	5.9	10.4	6.2
Mexican American				
20-39	34.8	17.5	21.7	15.5
40-59	32.6	14.0	22.5	12.0
≥60	16.4	7.3	10.0	2.8*

[1]Data are from table A.T6-12 in appendix VA. Alcoholic beverages include beer, wine, and hard liquor. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

in each age category reported consuming beer than wine or hard liquor. In general, smaller percentages of females than males reported consuming alcoholic beverages monthly or more often. Of females 20-39 years of age, more than 50% of non-Hispanic whites and non-Hispanic blacks and 35% of Mexican Americans reported consuming alcoholic beverages monthly or more often. As noted for males, the percentage of females who reported consuming alcoholic beverages monthly or more often decreased with each increment in age category. In general, higher percentages of females reported consuming wine and beer than hard liquor.

Discretionary salt use

Recent estimates suggest that, on average, discretionary salt use contributes about 20% of total sodium intake (Mattes and Donnelly, 1991). Healthy People 2000 Objective 2.9 is to "Decrease salt and sodium intake so . . . at least 80 percent of people avoid using salt at the table . . . " (HHS, 1991). Data from NHANES III 1988-91 and CSFII 1989-91 provide some information about current discretionary salt use in the U.S. population. In these surveys, about 58% of males and 68% of females reported never using salt, using lite salt or a salt substitute, or rarely using ordinary table salt. In addition, adults who provided responses for children reported that 89% of children 1-2 years of age and 79% of children 3-5 years of age never use salt, use lite salt or a salt substitute, or use ordinary table salt rarely. These data suggest that a substantial proportion of the population is trying to avoid using salt at the table. Additional detailed data on use of salt at the table is provided in table A.T6c in appendix VA.

The major portion of dietary sodium (about 80%) is provided by salt added to processed foods and home-, deli-, and restaurant-prepared foods. For example, breads and grain products provide the greatest amount of sodium in the diet because they are basic foodstuffs consumed in relatively large quantities by the entire population (Pennington and Young, 1991; SCOGS, 1979). Greater reductions in sodium consumption may be achieved by reducing salt used in processing and preparing food and by consumer selection of modified- or lower-salt products than by avoiding use of salt at the table. These measures are also included in Healthy People 2000 Objective 2.9: "Decrease salt and sodium intake so at least 65 percent of home meal preparers prepare foods without adding salt . . . and at least 40 percent of adults regularly purchase foods modified or lower in sodium" (HHS, 1991). The Expert Consultants and LSRO did not evaluate data related to achieving these recommendations. Information on awareness of health problems related to sodium intake, the importance of following dietary guidance on salt and sodium, the perceived appropriateness of dietary sodium intakes, and sodium intakes of individuals who were or were not aware of an association of sodium intake with hypertension is discussed in chapter 8.

Food sources of nutrients as consumed

The 1990 *Dietary Guidelines for Americans* recommends the consumption of a variety of foods, rather than dietary supplements, to obtain essential nutrients and food components needed for good health (USDA and HHS, 1990). Knowing which foods are the greatest contributors of nutrients is desirable for nutrition education messages and for helping people make appropriate food selections. Data from HHANES 1982-84 were used to identify the top 10 food sources of calcium for adolescent and adult Mexican Americans, Cuban Americans, and Puerto Ricans (Looker et al., 1993). To generate these lists, the individual seven-digit USDA food identification numbers were used. The percentage contribution of (commodity) food groups to total calcium intake was also determined by using the first two digits of the USDA food identification numbers. Such food listings differ depending upon the number of food identification digits used and on whether food items are aggregated in the nutrient data bank. For example, thin-crust pizza was among the top 10 food sources of calcium for Cuban Americans, whereas thick-crust pizza was among the top 10 for Puerto Ricans (Looker et al., 1993). Aggregation of thin- and thick-crust pizza would provide a better indication of the contribution of pizza to total calcium intakes. This approach was recently used by Block et al. (1995) to identify important food sources of food energy, protein, total fat, vitamin A, vitamin C, calcium, and iron for low-income women and their children in HHANES 1982-84. Given that more combination foods (e.g., pizza and tacos), microwavable meals, and fast foods are being consumed, the nutrient contributions of these items should be emphasized for nutrition monitoring purposes rather than those of commodity foods.

Food consumption patterns

The percentages of food energy intake and total fat intake contributed by breakfast and snacks are shown in figures 6-3 through 6-6 for participants in selected age-sex groups who provided 3 days' food consumption data for CSFII 1989-91. Over the 3-day period, 94% of the total population reported that they ate breakfast at least once and 82% reported that they ate snacks at least once.

Breakfast contributed between 17% and 25% of food energy intakes for the selected age-sex subgroups (fig. 6-3). The proportions were highest for males and females 70 years of age and older, for whom breakfast provided 25% and 23% of daily food energy intake, respectively. The percentage of total fat intake per day provided by breakfast ranged from 15% to 21% across these age-sex groups (fig. 6-4). The finding that the percentage of total fat provided by breakfast was less than the percentage of food energy provided by breakfast suggests that foods eaten at breakfast tend to be lower in total fat than are foods eaten at other times of the day.

Snacks (eating occasions designated by the respondent as a snack, a coffee break, or a beverage break) contributed as much as 16% of food energy consumed for the age-sex groups shown in figure 6-5. The percentages were highest for children 5 years of age and younger (16%) and for adolescent males and females 12-19 years of age (15%). Percentages were lowest for males and females 70 years of age and older (9% of food energy). The data in figures 6-5 and 6-6 show that consumption of snacks makes a substantial contribution to the energy and total fat intakes of most age-sex groups.

Data from CSFII 1989-91 and NHANES III 1988-91 can be used to analyze specific types of food consumption patterns associated with intakes of total fat and other nutrients from food. Those data can thus provide insights into recommendations for more specific interventions designed to improve dietary intakes. Comparative analyses of food consumption that use the food and food group recommendations of the Food Guide Pyramid (USDA, 1992) are being developed to assess food consumption patterns.

Food consumption away from home

Percentages of participants in CSFII 1989-91 and NFCS 1987-88 who reported eating away from home for specified eating occasions (1-day data) are shown in table 6-13. Food purchased away from home at fast-food restaurants but consumed at home is not included. Overall, for each type of eating occasion, the percentage of individuals who reported eating away from home increased with each increment in income level (<131% of poverty, 131-350% of poverty, and >350% of poverty). These results suggest that eating away from home may be classified as a "normal good," that is, a good purchased to a greater extent as income increases. Males 20 years of age and older are more likely to eat away from home than are females in this age group, and whites tend to eat away from home more frequently than do blacks.

School-age children and adolescents usually eat lunch and often breakfast away from home. For many of these children, the National School Lunch Program (NSLP) and School Breakfast Program (SBP) provide these meals. According to Gleason (1995), among schools offering the pertinent program, the participation rate in the NSLP is 56% and in the SBP, it is 19%. This means that on school days, programs provide two of the three major meals for 1 in 10 school-age children, and one of the three major meals for more than half of school-age children (Dwyer, 1995). Nutrient intakes of school-age children are discussed below, under "Children 1-11 Years of Age."

Food insufficiency

Nutritional status is a critical factor in children's development. Recent research findings indicate that lack of sufficient food, interacting with other environmental insults associated with poverty, is likely to result in impaired growth and cognitive development (Sherman, 1995). Prevalence of food insufficiency, defined as inadequate food intake due to a lack of money or resources, was estimated in CSFII 1989-91 and NHANES III 1988-91. In CSFII 1989-91, the following question was asked to assess food sufficiency in households:

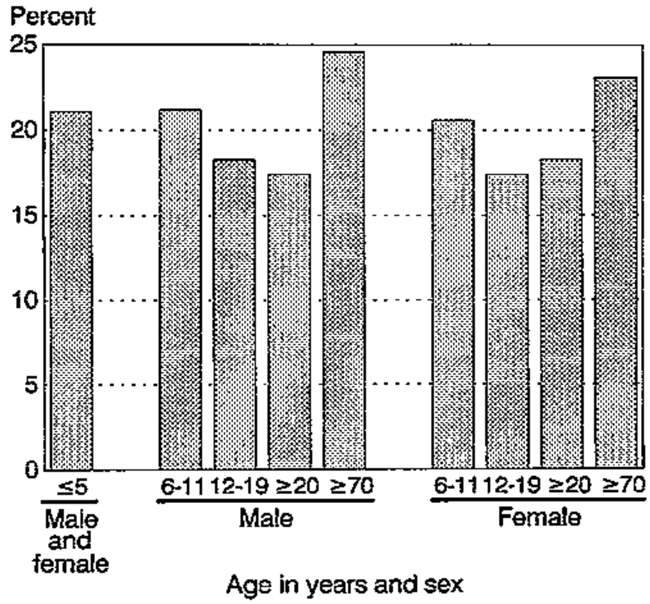

Figure 6-3. Nutrient contribution of breakfast: mean percentage of food energy intake per individual per day over 3 days, by sex and age, 1989-91

NOTE: Data are from table A.F6-3,4 in appendix VA.

SOURCE: USDA, CSFII, 1989-91.

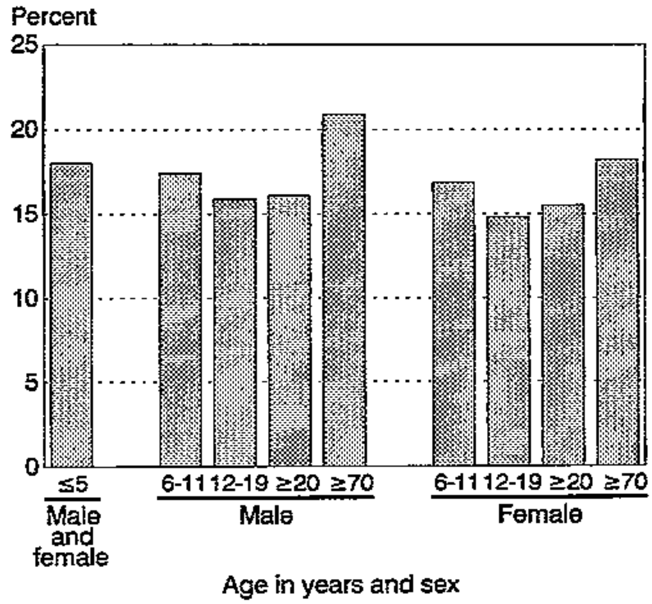

Figure 6-4. Nutrient contribution of breakfast: mean percentage of total fat intake per individual per day over 3 days, by sex and age, 1989-91

NOTE: Data are from table A.F6-3,4 in appendix VA.

SOURCE: USDA, CSFII, 1989-91.

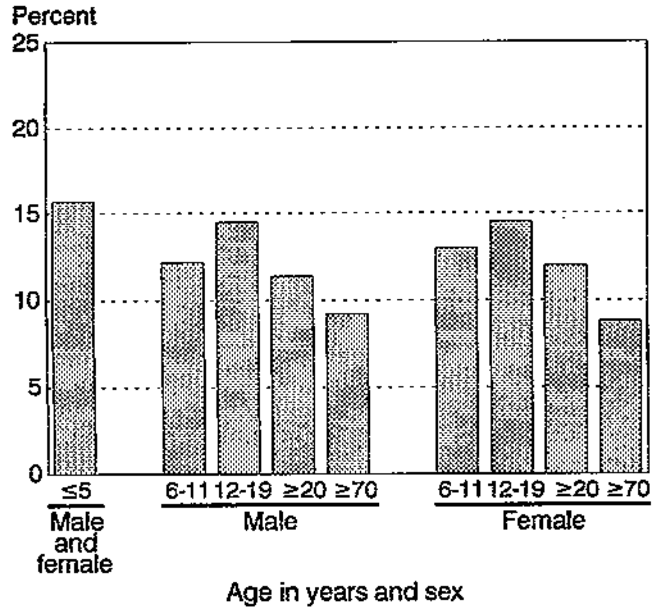

Figure 6-5. Nutrient contribution of snacks: mean percentage of food energy intake per individual per day over 3 days, by sex and age, 1989-91

NOTE: Data are from table A.F6-5,6 in appendix VA.

SOURCE: USDA, CSFII, 1989-91.

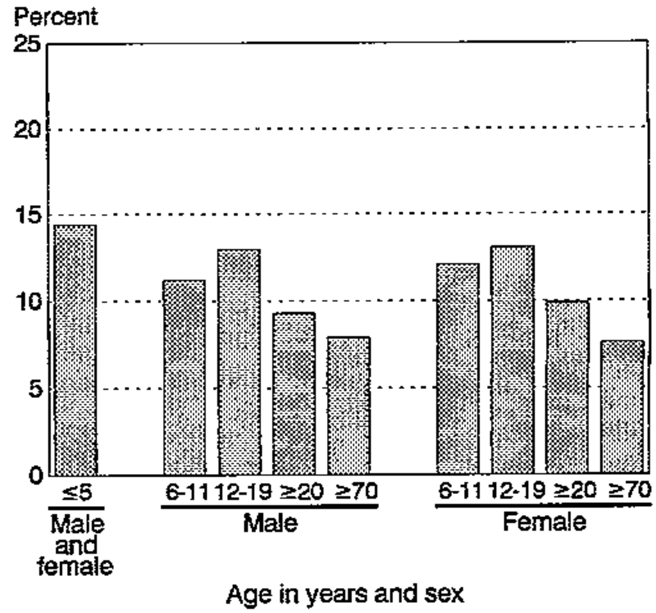

Figure 6-6. Nutrient contribution of snacks: mean percentage of total fat intake per individual per day over 3 days, by sex and age, 1989-91

NOTE: Data are from table A.F6-5,6 in appendix VA.

SOURCE: USDA, CSFII, 1989-91.

Table 6-13. Percentage of people eating specified occasions away from home during 1 day, by sex, race, and income level, 1987-88 and 1989-91 (%)[1]

Sex, race, and income level	Breakfast	Brunch or lunch	Dinner or supper	Snack or beverage break
All individuals				
1989-91	**10.3**	**31.1**	**17.2**	**18.8**
1987-88	**8.9**	**31.3**	**16.9**	**15.2**
Males ≥20 years of age				
1989-91	**11.9**	30.3	**18.4**	**20.8**
1987-88	**11.7**	33.8	**18.3**	**16.8**
Females ≥20 years of age				
1989-91	8.7	27.2	**17.2**	**18.2**
1987-88	7.1	25.7	**17.0**	**15.1**
White				
1989-91				
All individuals	**10.5**	**32.0**	**18.0**	**19.6**
Males ≥20 years of age	12.6	31.3	19.0	21.7
Females ≥20 years of age	8.4	27.9	17.9	18.5
1987-88				
All individuals	**8.9**	**31.8**	**18.1**	**16.1**
Males ≥20 years of age	11.7	33.6	19.0	17.3
Females ≥20 years of age	7.4	26.3	18.0	15.9
Black				
1989-91				
All individuals	**10.2**	**26.7**	**12.3**	**15.5**
Males ≥20 years of age	8.5	21.7	14.3	15.3
Females ≥20 years of age	10.1	22.6	11.8	17.2
1987-88				
All individuals	**8.8**	**27.8**	**10.9**	**10.5**
Males ≥20 years of age	10.4	31.1	13.2	12.6
Females ≥20 years of age	6.3	22.2	11.9	11.5
<131% poverty				
1989-91				
All individuals	**7.1**	**24.0**	**11.3**	**10.8**
Males ≥20 years of age	6.3	20.2	10.0	8.9
Females ≥20 years of age	4.5	14.6	11.3	9.8
1987-88				
All individuals	**6.4**	**21.5**	**11.3**	**7.8**
Males ≥20 years of age	6.2	18.5	10.3	8.2
Females ≥20 years of age	2.9*	14.0	12.2	7.0
131-350% poverty				
1989-91				
All individuals	**10.8**	**31.0**	**17.0**	**17.6**
Males ≥20 years of age	10.9	27.4	18.3	17.6
Females ≥20 years of age	9.5	26.6	16.3	18.2
1987-88				
All individuals	**8.5**	**29.2**	**16.2**	**15.1**
Males ≥20 years of age	11.2	30.8	15.2	16.4
Females ≥20 years of age	6.4	21.1	16.7	15.7
>350% poverty				
1989-91				
All individuals	**11.4**	**35.6**	**20.0**	**24.7**
Males ≥20 years of age	13.9	35.5	19.7	26.1
Females ≥20 years of age	10.1	33.8	20.2	23.6
1987-88				
All individuals	**10.8**	**39.2**	**20.0**	**20.6**
Males ≥20 years of age	13.5	40.5	23.2	21.2
Females ≥20 years of age	10.1	37.6	19.3	20.6

[1]Data are from tables A.T6-13a through A.T6-13f in appendix VA. Those who reported eating any meal away from home based on 1-day data. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, CSFII, 1989-91; NFCS, 1987-88.

"Which of the following statements *best* describes the food eaten in your household?

- Enough of the kinds of food we want to eat
- Enough but not always the kinds of food we want to eat
- Sometimes not enough to eat
- Often not enough to eat."

In NHANES III 1988-91, the family respondent in the household and individuals examined in the mobile examination center (MEC) answered the food-sufficiency and related questions. At the family level, information was collected on food sufficiency, the number of days per month on which there is no food or no money to buy food, and the reasons for such a lack of food. At the individual level, at the time of the 24-hour dietary recall, seven specific questions were asked about the frequency of and reasons for going without food (Briefel and Woteki, 1992).

Data on the prevalence of household food sufficiency of low-income subgroups of CSFII 1989-91 sample are shown in table 6-14. Approximately 9% of households with incomes <131% of poverty reported that sometimes there was not enough to eat (7.2%) or often not enough to eat (1.9%). Another 37% reported that there was enough food but not always what they wanted to eat. A higher percentage of low-income households that did not participate in the Food Stamp Program reported that they had enough of the kinds of foods they wanted to eat than did low-income households that participated in this program. Participants in the Food Stamp Program were more likely than nonparticipants, and blacks were more likely than whites, to respond that they were often or sometimes not getting enough to eat or enough of the kinds of food they wanted to eat.

Table 6-15 summarizes data on the prevalence of food sufficiency based on responses to the family questionnaire from NHANES III 1988-91. Overall, 96% of respondents lived in a family that had enough food, with about 4% living in a family responding that they sometimes or often did not have enough food. Mexican Americans were most likely to live in a family responding that they sometimes or often did not have enough food (about 15%). Approximately 7% of non-Hispanic blacks and nearly 3% of non-Hispanic whites lived in families that provided responses indicating that they sometimes or often did not have enough food. Individuals with family incomes <100% and <131% of poverty were more likely to live in a family that reported that they sometimes or often did not have enough food than were those with incomes ≥100% of poverty. In CSFII 1989-91 and NHANES III 1988-91, similar percentages of respondents with household incomes <131% of poverty reported that there was sometimes or often not enough food (9% and 13%, respectively). Data from these two surveys suggest that about 9-13% of people living in low-income households or families may experience some degree of food insufficiency.

Table 6-14. Household food sufficiency of the low-income population, by Food Stamp Program (FSP) participation and race, 1989-91 (%)[1]

FSP participation and race	Enough of the kinds of food we want	Enough, but not always what we want	Sometimes not enough	Often not enough
Overall low-income population	53.9	36.7	7.2*	1.9*
FSP participation				
Participant	43.0	43.3	10.2*	3.5*
Nonparticipant	58.7	33.8	5.9*	1.2*
Race				
White	58.2	34.4	5.9*	1.2*
Black	44.3	42.7	8.9*	4.0*

[1]Data are from table A.T6-14 in appendix VA. Based on households with gross incomes <131% of the Federal Poverty Income guideline. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, CSFII, 1989-91.

Table 6-15. Prevalence of a reported family food-sufficiency problem in individuals, by race/ethnicity and poverty status, 1988-91 (%)[1]

Race/ethnicity and poverty status	Enough food	Sometimes not enough	Often not enough
Overall population	96.1	3.3	0.6*
Race/ethnicity			
Non-Hispanic white	97.4	2.1	0.5*
Non-Hispanic black	92.7	6.7	0.6*
Mexican American	84.5	14.2	1.3
Poverty status			
≥100% poverty	98.3	1.5	0.1*
<100% poverty	84.1	13.2	2.7*
<131% poverty	87.0	10.7	2.2*

[1]Data are from table A.T6-15 in appendix VA. An asterisk (*) indicates a statistic that is potentially unreliable because of a large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

Although data from CSFII 1989-91 and NHANES III 1988-91 provide an estimate of the national prevalence of food insufficiency, groups at higher risk of food insufficiency, such as homeless people, American Indians living on reservations, migrant workers, and some institutionalized people, have not been included in the samples for these surveys. In addition, sample sizes for some ethnic groups and for pregnant women may be inadequate to assess the food insufficiency for these groups. Surveys that add to the information from CSFII 1989-91 and NHANES III 1988-91 are needed to adequately study the extent of food insufficiency in the United States.

Current data on nutrient intakes from food

The NNMRRP data sets reviewed in this section are from NHANES III 1988-91 for nutrient intakes of non-Hispanic whites, non-Hispanic blacks, and Mexican Americans; HHANES 1982-84 for nutrient intakes of Mexican Americans, Cuban Americans, and Puerto Ricans; CSFII 1989-91 for intakes of the U.S. population by income group; SNDA 1992 for intakes of school-age children; the Strong Heart Dietary Survey (1989-91) for intakes of American Indians; and the Total Diet Study (1982-89) for intakes of selected age-sex groups of the U.S. population. Selected comparisons are made in this chapter; more detailed data are included tables A.T6-16,21a through A.T6-16,21v; A.T6-17,22a through A.T6-17,22u; A.F6-7,8,9,10,11,12; A.T6-18a through A.T6-18l; A.T6-19a through A.T6-19l; A.T6-20; A.T6-23; and A.T6-24 in appendix VA. Because of differences in methodologies among the surveys, few comparisons of data across surveys were made.

As described above, under "Nutrient Intake Data," the Expert Consultants and LSRO evaluated nutrient intakes from food for those nutrients whose intakes were calculated in NNMRRP surveys and that have recommended intake values. Median 1-day nutrient intakes from food from NHANES III 1988-91 and HHANES 1982-84 were compared with the 1989 RDA values for infants, children, adolescents, and adults. Recommendations by other expert groups were used as criteria for evaluation for some nutrients and food components that do not have RDAs. These nutrients and evaluative criteria included median cholesterol intake compared with the recommendation of <300 mg/d for adults and children over 2 years of age (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol (Adult Treatment Panel II), 1993; Expert Panel on Blood Cholesterol in Children, 1991). Median total fat and saturated fatty acid intakes were compared with the recommended ranges of ≤30% of calories for total fat and 8-10% of calories for saturated fatty acids for individuals over 2 years of age (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol (Adult Treatment Panel II), 1993; Expert Panel on Blood Cholesterol in Children, 1991). Median dietary fiber intakes of adults were compared with the recommendation of 20-30 g/d for healthy adults by the National Cancer Institute (NCI, 1987).

Intakes of other nutrients and food components were not evaluated in cases where intakes were calculated from NNMRRP survey data but criteria for evaluation were not available (e.g., carotenes and alcohol), or where intake information was not available from NNMRRP survey data and criteria for evaluation were not available (e.g., *trans* fatty acids, fat substitutes, sugars, and fluoride). Only the median nutrient intakes that were below RDA values or that did not meet the recommendations specified above are noted in the text. More detailed data are provided in the text tables cited in this section, in appendix tables, and in the publications by Alaimo et al. (1994), Briefel et al. (in press), and McDowell et al. (1994). Some associations of dietary intake with health status are discussed in chapter 7.

The ratios of median nutrient intake to 1989 RDA value based on 1-day median nutrient intakes from NHANES III 1988-91 and HHANES 1982-84 were calculated by the Expert Consultants and LSRO using the RDA age groups that most closely matched the age groups used for analyses in this report. (See app. II for tables of 1989 RDA values.) Data on 3-day mean nutrient intakes from CSFII 1989-91 expressed as percentages of the RDAs were examined by income level (<131% of poverty, 131-350% of poverty, and >350% of poverty) for nutrients considered current or potential public health issues by the EPONM in 1989 (LSRO, 1989). SNDA 1992 also provided additional data on the nutrient content of school lunches and mean nutrient intakes of school-age children. Mean nutrient intakes of pregnant females in NHANES III 1988-91 were compared with 1989 RDA values for pregnant females.

The Total Diet Study provided ancillary information on dietary intakes for selected mineral elements for certain population subgroups (table A.6d in app. VA). Analytical data from the Total Diet Study may differ from dietary intake data collected in surveys conducted in similar time periods because the core foods chosen for the samples for the Total Diet Study are based on food consumption information from earlier dietary surveys.

Infants 2-11 months of age

As shown in tables 6-16 and 6-17, median intakes from food for food energy, protein, vitamins, and minerals ranged from near the RDAs to several-fold higher than the RDAs for infants 2-11 months of age (NHANES III 1988-91) and 6-11 months of age (HHANES 1982-84). Data on mineral intakes of infants 6-11 months of age from the Total Diet Study (1982-89) (table A.6d in app. VA) were in general agreement with intakes from NHANES III 1988-91. Analyses of the NHANES III 1988-91 and HHANES 1982-84 data excluded breastfed infants; thus, the high intakes reported for infants may reflect the levels of nutrients found in infant formulas.

Children 1-11 years of age

Median food energy intakes were below 1989 Recommended Energy Intakes for children 3-5 and 6-11 years of age in all racial/ethnic groups in NHANES III 1988-91 and for Mexican-American and Puerto Rican children 6-11 years of age in HHANES 1982-84 (tables 6-16 and 6-17). This observation may be the result of underreporting of food consumption, of having recommendations for food energy intakes that are higher than the energy needs of most children, and/or of low energy expenditures by children.

For children 1-11 years of age, median vitamin E intakes from food were below RDA values for all racial/ethnic groups in NHANES III 1988-91 and HHANES 1982-84. Median intakes of zinc were below RDA values in all racial/ethnic groups in NHANES III 1988-91 and for all Hispanic subgroups except males 6-11 years of age and Cuban-American females 6-11 years of age in HHANES 1982-84. Median vitamin A and vitamin B_6 intakes were below RDA values for females 6-11 years of age in both surveys. Median calcium intakes of non-Hispanic black children were below RDA values beginning at 1-2 years of age and continuing through 6-11 years of age. Median iron intakes were also below RDA values for children 1-2 years of age but not for older children in both surveys. Median copper intakes were below the lower limit of the ESADDI range for copper for children of both sexes 3-5 years of age and females 6-11 years of age in NHANES III 1988-91 and HHANES 1982-84. Median sodium intakes from food alone of both males and females 6-11 years of age in NHANES III 1988-91 and HHANES 1982-84 were greater than the intake of 2,400 mg or less per day recommended for adults.

Mean 3-day dietary intake data from CSFII 1989-91 expressed as a percentage of the RDA provided

Table 6-16. For children 2 months to 11 years of age, median daily nutrient intakes as percentages of the 1989 recommended values, on 1 day, by sex, age, and race/ethnicity, 1988-91 (%)[1]

	Male and female														
	2-11 months			1-2 years			3-5 years			Male, 6-11 years			Female, 6-11 years		
Nutrient	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA
Food energy[2]	112	113	113	96	100	92	83	89	82	93	97	92	83	87	83
Protein	163	141	170	281	294	281	212	238	225	239	236	246	211	225	214
Vitamin A[3]	214	198	207	149	127	136	135	111	127	112	99	100	99	78	87
Vitamin E	327	354	347	62	72	69	70	78	72	85	84	81	78	84	75
Vitamin C[3]	366	458	403	168	218	172	182	220	189	164	213	182	162	218	193
Thiamin	297	343	300	146	159	137	138	152	132	159	151	154	130	142	129
Riboflavin	358	358	371	195	189	190	152	152	156	172	154	175	152	132	150
Niacin	204	204	188	124	134	114	120	128	114	146	142	128	123	133	118
Vitamin B_6[3]	156	151	160	109	121	111	114	125	124	111	104	113	96	93	94
Folate[3]	453	523	547	338	326	322	276	272	289	253	218	256	210	181	216
Vitamin B_{12}	720	682	798	410	398	417	308	300	311	250	257	279	243	208	239
Calcium[2]	139	121	131	102	82	97	103	84	97	124	95	123	103	86	111
Phosphorus	139	119	133	114	104	113	123	121	126	154	138	162	134	128	142
Magnesium	222	194	212	220	208	218	162	163	166	137	119	144	115	116	128
Iron[2]	176	204	176	85	87	79	101	109	100	132	122	125	107	107	105
Zinc[3]	111	122	120	61	63	58	69	78	74	90	92	93	77	81	81
Copper	144	154	152	91	97	96	79	84	80	101	99	101	86	92	88
Sodium	14	12	16	78	84	74	94	109	92	118	129	116	107	120	105

[1]Data are from tables A.T6-16,21a through A.T6-16,21v in appendix VA. Shaded values indicate intakes that are below (or above, for sodium) recommended amounts. NHW, non-Hispanic white; NHB, non-Hispanic black; MA, Mexican American. For food energy, values represent percentage of the Recommended Energy Intake (NRC, 1989a). For all nutrients except copper and sodium, the 1989 Recommended Dietary Allowances (RDAs) were used as the recommended values; for copper, the lowest values in the Estimated Safe and Adequate Daily Dietary Intake (ESADDI) ranges were used; and for sodium, the Food and Nutrition Board's recommended maximum intake of 2.4 g/d was used (NRC, 1989a). Percentage of the RDA was calculated using the following NHANES III (RDA) age groups: 2-11 months (average of 0.0-0.5 and 0.5-1.0 years), 1-2 years (1-3 years), 3-5 years (4-6 years), and 6-11 years (7-10 years). Nursing infants and children were excluded. Percentages for infants 2-11 months of age and children 1-5 years of age were calculated based on dietary intakes for males and females combined (Alaimo et al., 1994; McDowell et al., 1994).

[2]Considered to be a current public health issue for nutrition monitoring in 1989 (LSRO, 1989).

[3]Considered to be a potential public health issue for which further study was needed in 1989 (LSRO, 1989).

SOURCE: HHS, NHANES III, 1988-91.

Table 6-17. For Hispanic children 6 months to 11 years of age, median daily nutrient intakes as percentages of the 1989 recommended values, on 1 day, by sex, age, and Hispanic origin, 1982-84 (%)[1]

	Male and female														
	6-11 months			1-2 years			3-5 years			Male, 6-11 years			Female, 6-11 years		
Nutrient	MA	CA	PR	MA	CA	PR	MA	CA	PR	MA	CA	PR	MA	CA	PR
Food energy[2]	110	*	120	92	96	101	83	88	88	98	100	98	86	87	94
Protein	236	*	221	319	350	325	238	288	262	275	296	282	243	257	264
Vitamin A[3]	177	*	266	147	178	153	132	123	130	109	104	110	97	74	104
Vitamin E	140	*	295	72	65	63	74	56	76	95	82	89	86	64	88
Vitamin C[3]	271	*	657	152	232	190	156	96	169	187	173	196	169	149	227
Thiamin	272	*	370	123	149	140	123	120	139	142	138	158	122	117	147
Riboflavin	362	*	424	191	221	220	151	169	171	179	172	188	152	150	172
Niacin	142	*	210	108	123	110	112	112	128	132	123	158	116	120	132
Vitamin B_6[3]	137	*	152	108	111	99	115	135	122	111	104	124	99	91	109
Folate[3]	448	*	557	304	290	292	252	204	261	258	185	230	208	155	216
Vitamin B_{12}	796	*	752	480	590	514	365	429	398	349	384	347	291	312	296
Calcium[2]	136	*	124	94	118	122	95	137	119	128	139	117	115	124	118
Phosphorus	155	*	134	119	131	135	126	150	140	176	185	155	151	149	157
Magnesium	233	*	215	222	216	234	162	187	172	156	148	139	135	128	135
Iron[2]	93	*	182	76	101	87	94	101	112	123	128	145	110	109	124
Zinc[3]	122	*	146	66	82	70	77	94	80	108	110	100	95	101	96
Copper	100	*	150	86	100	100	80	70	80	103	98	96	93	87	96
Sodium	32	*	21	78	74	72	94	100	111	120	124	137	106	114	129

[1]Data are from tables A.T6-17,22a through A.T6-17,22u in appendix VA and unpublished data from NCHS. Shaded values indicate intakes that are below (or above, for sodium) recommended amounts. MA, Mexican American; CA, Cuban American; PR, Puerto Rican. For food energy, values represent percentage of the Recommended Energy Intake (NRC, 1989a). For all nutrients except copper and sodium, the 1989 Recommended Dietary Allowances (RDAs) were used as the recommended values; for copper, the lowest values in the Estimated Safe and Adequate Daily Dietary Intake (ESADDI) ranges were used; and for sodium, the Food and Nutrition Board's recommended maximum intake of 2.4 g/d was used (NRC, 1989a). Percentage of the RDA was calculated using the following HHANES (RDA) age groups: 6-11 months (0.5-1.0 years); 1-2 years (1-3 years); 3-5 years (4-6 years); and 6-11 years (7-10 years). Nursing infants and children were excluded. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

[2]Considered to be a current public health issue for nutrition monitoring in 1989 (LSRO, 1989).

[3]Considered to be a potential public health issue for which further study was needed in 1989 (LSRO, 1989).

SOURCE: HHS, HHANES, 1982-84.

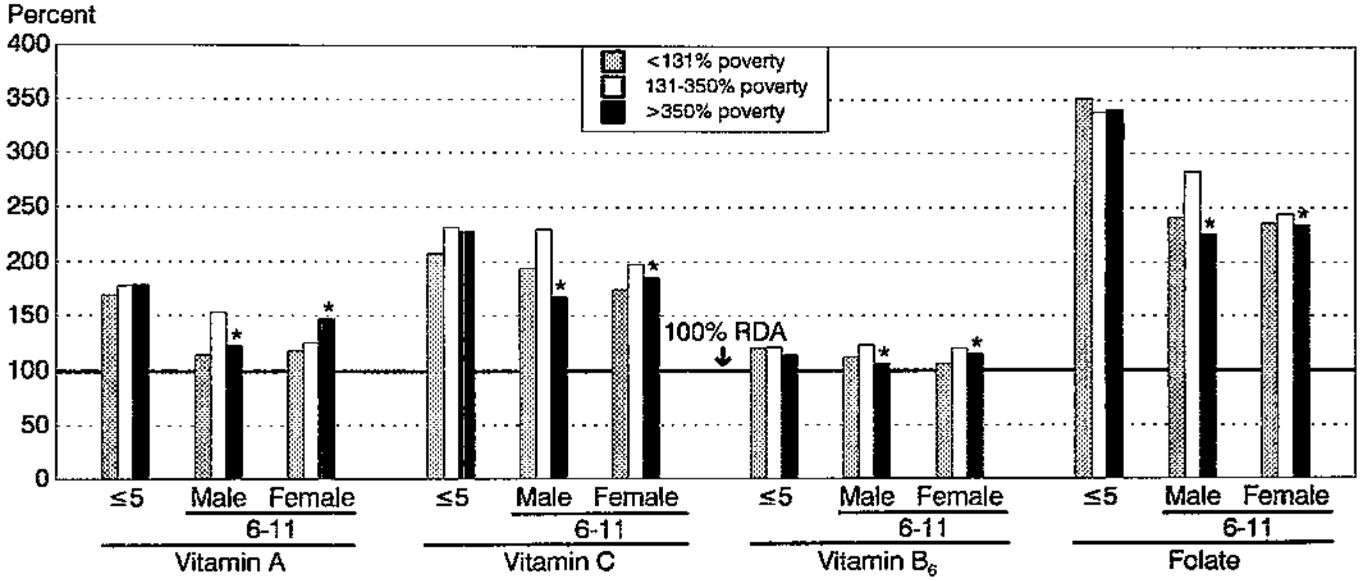

Figure 6-7. Nutrient intakes as percentages of the 1989 Recommended Dietary Allowances (RDAs) of children ≤5 and 6-11 years of age for selected vitamins: mean per individual per day over 3 days, by sex and income level, 1989-91

NOTE: Data are from table A.F6-7,8,9,10,11,12 in appendix VA. These vitamins were selected because they were considered by EPONM in 1989 to be current or potential public health issues (LSRO, 1989). Income level was determined by dividing income by the appropriate Federal Poverty Income guideline. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, CSFII, 1989-91.

additional information on intakes of selected vitamins and minerals for children from households with different income levels (figs. 6-7 and 6-8). Mean intakes of zinc were consistently below the RDAs for children 5 years of age and younger and 6-11 years of age in all income categories.

Regardless of race/ethnicity, children 3-11 years of age in NHANES III 1988-91 and HHANES 1982-84 had median total fat intakes greater than 30% of calories and saturated fatty acid intakes greater than 10% of calories. Median cholesterol intakes of these children were less than or only slightly above 300 mg/d (tables 6-18 and 6-19). As shown in table 6-20, only about 18% of children 6-11 years of age had total fat intakes ≤30% of calories. Similar results were reported for children in NHANES III 1988-91 (Lewis et al., 1994).

For school-age children and adolescents 5-19 years of age, Burghardt et al. (1995) and Gordon et al. (1995) provided extensive analyses of SNDA 1992 results. Lunches provided in the NSLP contributed more total fat in 1992 than recommended in the 1990 *Dietary Guidelines for Americans*. Results from the SNDA supported the finding from NHANES III 1988-91 and HHANES 1982-84 that daily intakes of total fat and saturated fatty acids as a percentage of calories were higher than current dietary recommendations. Mean cholesterol intakes of children and adolescents were also higher than current dietary recommendations. This finding contrasts with the median intakes found for children and adolescents 6-11, 12-15, and 16-18 years of age in NHANES III 1988-91 and HHANES 1982-84, which were within the recommended values. Mean intakes were greater than RDA values for vitamin A, vitamin B_6, calcium, and zinc in SNDA 1992. These differences may be related to comparisons of means, which are usually higher than median values for nutrient intakes, with the RDAs in SNDA 1992 and to methodological differences between the SNDA 1992 and NHANES III 1988-91.

Adolescents 12-19 years of age

Reported median food energy intakes were generally below 1989 Recommended Energy Intakes for adolescents, more so for females than males in NHANES III 1988-91 and HHANES 1982-84

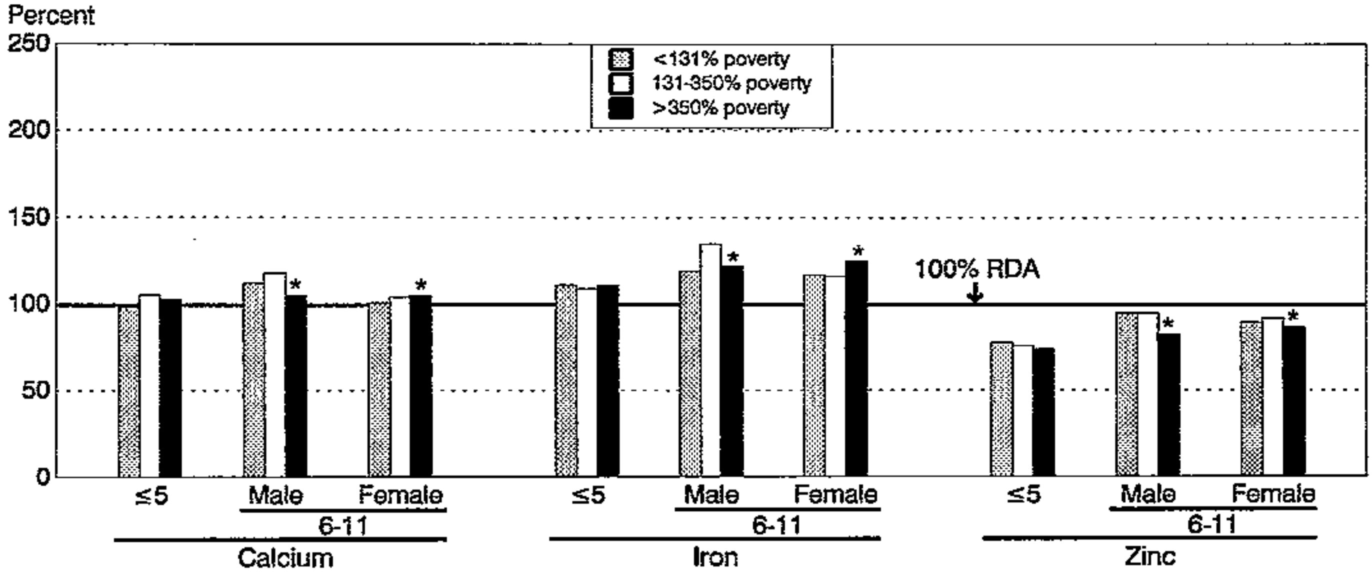

Figure 6-8. Nutrient intakes as percentages of the 1989 Recommended Dietary Allowances (RDAs) of children ≤5 and 6-11 years of age for selected minerals: mean per individual per day over 3 days, by sex and income level, 1989-91

NOTE: Data are from table A.F6-7,8,9,10,11,12 in appendix VA. These minerals were selected because they were considered by EPONM in 1989 to be current or potential public health issues (LSRO, 1989). Income level was determined by dividing income by the appropriate Federal Poverty Income guideline. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, CSFII, 1989-91.

(tables 6-21 and 6-22). This observation suggests that foods consumed were underreported, food-energy-intake recommendations are higher than the energy expenditures of many adolescents, and/or energy expenditures of adolescents are low. Underreporting of food consumption by adolescents was found by Bandini et al. (1990), who demonstrated a greater divergence in food energy reported and food energy actually consumed for overweight adolescents than for other adolescents. The impact of underreporting of food consumption on nutrient intakes is not known. For example, if certain foods (such as foods high in fat but low in most other nutrients) are underreported selectively, then intakes of total fat and food energy will be underestimated more than are intakes of other nutrients. However, if foods are omitted randomly from food recalls or records, the effects will be more difficult to predict. At present, little is known about types of foods underreported and patterns of underreporting.

Median vitamin A intakes below RDA values were observed for males 12-15 and 16-19 years of age in all racial/ethnic subgroups in NHANES III 1988-91 and in all Hispanic subgroups in HHANES 1982-84. Median vitamin E intakes were below the RDA for males 12-15 years of age in all racial/ethnic subgroups in NHANES III 1988-91 and in HHANES 1982-84, with the exception of Cuban-American males 16-19 years of age. Median vitamin C intakes were below RDA values only for Cuban-American males 12-15 years of age in HHANES 1982-84. Except for non-Hispanic white males 16-19 years of age, median vitamin B_6 intakes were below the RDA for adolescent males 12-15 and 16-19 years of age in NHANES III 1988-91.

Median calcium intakes were also below RDA values for adolescent males 12-19 years of age, except non-Hispanic white males, in NHANES III 1988-91 and for adolescent Hispanic males in HHANES 1982-84. With the exception of non-Hispanic white males 12-15 years of age, median magnesium intakes were below the RDA for adolescent males in NHANES III 1988-91 and for males 16-19 years of age in HHANES 1982-84. Median zinc intakes were below the RDA for non-Hispanic white, non-Hispanic black, and Mexican-American males 12-15 and 16-19 years of age in NHANES III 1988-91 and for all adolescent

Table 6-18. For the U.S. population, median daily intake of total fat, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, cholesterol, carbohydrate, and dietary fiber, on 1 day, by age, sex, and race/ethnicity, 1988-91[1]

	Male			Female		
Nutrient or food component and age in years	Non-Hispanic white	Non-Hispanic black	Mexican American	Non-Hispanic white	Non-Hispanic black	Mexican American
Total fat (% kcal)[2]						
3-5	32.9	35.6	32.9	32.6	35.1	33.7
6-11	34.0	35.5	34.9	33.9	35.2	34.6
12-15	31.9	35.2	35.4	33.1	37.7	35.1
16-19	34.4	36.5	34.8	34.2	36.9	34.8
20-59	35.7	34.8	32.8	34.8	35.8	32.9
≥60	33.8	33.6	31.7	32.5	32.8	31.6
Saturated fatty acids (% kcal)[2]						
3-5	12.7	12.9	12.2	12.5	12.4	12.9
6-11	13.0	12.6	12.8	12.5	12.2	12.8
12-15	12.6	12.4	13.1	11.9	12.8	12.9
16-19	12.7	12.5	12.1	12.2	12.7	12.2
20-59	12.1	11.2	10.5	11.9	11.7	11.1
≥60	11.1	11.0	10.3	10.6	10.2	10.3
Monounsaturated fatty acids (% kcal)[2]						
3-5	11.8	13.2	11.7	11.9	13.3	12.1
6-11	12.4	13.2	12.7	12.4	13.5	12.4
12-15	12.0	13.6	12.8	12.3	13.7	13.2
16-19	12.8	14.0	13.1	12.6	13.0	12.5
20-59	13.2	13.2	11.7	12.6	13.3	12.1
≥60	12.5	12.8	11.3	11.9	12.1	11.3
Polyunsaturated fatty acids (% kcal)[2]						
3-5	5.3	6.0	5.4	5.3	6.3	5.5
6-11	5.3	6.1	5.4	5.4	5.8	5.8
12-15	4.9	6.6	5.6	5.4	6.7	5.9
16-19	5.8	6.5	5.9	6.0	7.0	6.5
20-59	6.4	6.6	6.2	6.6	7.0	6.4
≥60	6.2	5.7	5.7	6.4	6.1	5.9
Cholesterol (mg)[2]						
3-5	138	172	205	121	167	206
6-11	181	216	225	163	179	191
12-15	208	240	252	160	169	187
16-19	281	310	308	154	200	219
20-59	279	304	352	182	218	218
≥60	221	258	261	158	164	186
Carbohydrate (% kcal)						
3-5	55.9	52.2	54.0	55.5	52.2	52.6
6-11	54.0	51.0	51.9	53.4	52.1	52.1
12-15	56.0	53.2	49.5	54.9	50.1	52.1
16-19	50.0	49.0	49.3	52.0	51.2	51.7
20-59	46.7	46.1	48.7	49.1	49.1	51.9
≥60	49.3	47.8	50.8	52.3	51.9	52.8
Dietary fiber (g)[3]						
20-59	16.7	13.7	20.6	12.1	10.0	14.2
≥60	15.0	10.8	18.0	12.8	11.0	11.5

[1]Data are from tables A.T6-18a through A.T6-18l in appendix VA. The recommended intake for total fat is ≤30 % of kilocalories (% kcal), saturated fatty acids 8-10% kcal, monounsaturated fatty acids ≤15% kcal, polyunsaturated fatty acids ≤10% kcal, carbohydrate ≥55% kcal, and cholesterol <300 mg/d for individuals older than 2 years of age (Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II), 1993; Expert Panel on Blood Cholesterol in Children and Adolescents, 1991); the recommended intake for dietary fiber is 20-30 g/d for healthy adults (NCI, 1987).
[2]Considered to be a current public health issue for nutrition monitoring in 1989 (LSRO, 1989).
[3]Considered to be a potential public health issue for which further study was needed in 1989 (LSRO, 1989).

SOURCE: HHS, NHANES III, 1988-91.

Table 6-19. For the Hispanic population, median daily intake of total fat, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, cholesterol, carbohydrate, and dietary fiber, on 1 day, by age, sex, and Hispanic origin, 1982-84[1]

	Male			Female		
Nutrient or food component and age in years	Mexican American	Cuban American	Puerto Rican	Mexican American	Cuban American	Puerto Rican
Total fat (% kcal)[2]						
3-5	35.0	35.5*	33.4	36.4	33.2*	34.3
6-11	36.0	32.3	33.0	35.8	35.5	33.8
12-15	36.9	34.7	34.6	36.8	36.9	33.7
16-19	36.9	31.9	32.4	36.7	31.8	33.9
20-59	35.3	31.9	33.6	36.0	32.7	33.8
60-74	36.6	29.8	32.2	35.1	29.0	31.6
Saturated fatty acids (% kcal)[2]						
3-5	13.8	15.7*	13.9	14.0	16.4*	14.4
6-11	14.0	13.4	13.0	14.1	14.3	13.3
12-15	14.0	13.9	13.2	13.7	13.4	13.3
16-19	13.8	12.8	12.4	13.3	12.0	12.4
20-59	12.5	11.7	11.3	12.6	11.8	12.0
60-74	12.8	11.3	10.2	12.6	10.4	12.3
Monounsaturated fatty acids (% kcal)[2]						
3-5	12.8	12.2*	11.7	13.2	12.4*	12.0
6-11	13.6	11.8	11.8	13.5	12.6	11.9
12-15	14.2	12.4	12.2	13.8	14.1	12.2
16-19	14.3	12.9	12.0	13.8	12.4	12.3
20-59	14.0	12.5	12.4	13.7	12.1	12.6
60-74	14.2	11.6	12.1	13.4	10.8	11.6
Polyunsaturated fatty acids (% kcal)[2]						
3-5	5.2	3.7*	5.0	5.5	3.8*	5.2
6-11	5.2	4.2	5.5	5.6	4.7	5.5
12-15	5.4	4.6	5.1	5.4	4.8	5.5
16-19	5.7	4.7	5.3	5.8	5.4	6.1
20-59	5.6	4.7	6.1	6.1	5.5	6.4
60-74	5.7	4.3	6.4	5.9	4.8	5.4
Cholesterol (mg)[2]						
3-5	260	245*	284	254	227*	224
6-11	303	260	312	246	233	286
12-15	352	344	349	247	289	251
16-19	455	416	417	225	215	302
20-59	438	342	350	270	194	227
60-74	430	248	246	292	160	142
Carbohydrate (% kcal)						
3-5	50.3	46.0*	51.7	49.2	49.5*	51.1
6-11	48.4	52.2	51.1	49.0	48.0	50.8
12-15	48.0	49.9	49.7	48.7	47.6	51.9
16-19	45.3	50.2	50.8	48.3	46.8	49.7
20-59	44.0	45.5	46.6	47.0	47.8	47.6
60-74	44.9	49.0	51.3	48.7	51.3	50.8
Dietary fiber (g)[3]						
20-59	17.4	11.0	11.5	10.9	7.2	6.9
60-74	13.5	12.1	10.5	10.0	8.3	6.4

[1]Data are from tables A.T6-19a through A.T6-19l in appendix VA. The recommended intake for total fat is ≤30% of kilocalories (% kcal), saturated fatty acids 8-10% kcal, monounsaturated fatty acids ≤15% kcal, polyunsaturated fatty acids ≤10% kcal, carbohydrate ≥55% kcal, and cholesterol <300 mg/d for individuals older than 2 years of age (Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II), 1993; Expert Panel on Blood Cholesterol in Children and Adolescents, 1991); the recommended intake for dietary fiber is 20-30 g/d for healthy adults (NCI, 1987). An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
[2]Considered to be a current public health issue for nutrition monitoring in 1989 (LSRO, 1989).
[3]Considered to be a potential public health issue for which further study was needed in 1989 (LSRO, 1989).

SOURCE: HHS, HHANES, 1982-84.

Table 6-20. Percentage of people with total fat intake ≤30% of calories, >30% and ≤40% of calories, and >40% of calories during 3 days, by age, race, income level, Food Stamp Program (FSP) participation, and sex, 1989-91 (%)[1]

	≤30%[2]		>30% and ≤40%		>40%	
Age in years, race, income level, and FSP participation	Male	Female	Male	Female	Male	Female
Age						
6-11	18.2	17.7	64.2	66.9	17.6	15.4
12-19	14.0	17.9	67.5	61.1	18.6	21.0
≥20	20.9	25.2	53.8	53.6	25.3	21.1
Race, ≥20 years						
White	20.6	25.3	53.1	53.7	26.3	21.0
Black	17.0	21.3	62.5	55.5	20.5	23.3
Income level, ≥20 years						
<131% poverty	21.7	25.9	50.9	53.0	27.4	21.2
131-350% poverty	18.2	26.0	56.0	54.7	25.8	19.3
>350% poverty	22.3	23.6	52.0	53.4	25.7	23.0
FSP participation, ≥20 years						
Participant	21.5	23.5	48.6	52.7	30.0	23.8
Nonparticipant	21.8	26.9	51.5	53.1	26.7	20.0

[1]Data are from table A.T6-20 in appendix VA.
[2]Recommended intake.

SOURCE: USDA, CSFII, 1989-91.

Hispanic males, except Cuban Americans, 16-19 years of age in HHANES 1982-84. Median copper intakes were below the lower limit of the ESADDI for adolescent males 12-15 and 16-19 years of age in NHANES III 1988-91 and for adolescent males, except Cuban-American males 16-19 years of age, in HHANES 1982-84. Median sodium intakes from food alone for male adolescents were greater than the maximum recommended intake for adults (2,400 mg or less).

Median intakes from food of vitamin A, vitamin E, vitamin B_6, calcium, iron, zinc, magnesium, and copper were below RDA or ESADDI values for adolescent females in all racial/ethnic groups in NHANES III 1988-91 and HHANES 1982-84. Median vitamin C intakes were below RDA values for Mexican-American females 16-19 years of age and Cuban-American females 12-15 and 16-19 years of age in HHANES 1982-84, and median folate intakes were below RDA values for non-Hispanic black females in NHANES III 1988-91 and Hispanic females 16-19 years of age in HHANES 1982-84. Median sodium intakes from food alone of female adolescents were greater than the maximum recommended daily intake for adults (2,400 mg or less).

Estimated daily mean intakes of iron, calcium, phosphorus, magnesium, zinc, copper, and sodium for male and female adolescents 14-16 years of age from the Total Diet Study (1982-89) (table A.6d in app. VA) tended to be similar to NHANES III 1988-91 and HHANES 1982-84 data for adolescents 12-15 and 16-19 years of age.

The findings from CSFII 1989-91 on mean intakes of vitamins and minerals from food as percentages of the RDAs for adolescents of different income levels were substantively in agreement with the findings from NHANES III 1988-91 (figs. 6-9 and 6-10). Mean vitamin A and vitamin B_6 intakes were below RDA values for adolescent males and females 12-19 years of age with household income levels <131% of poverty in CSFII 1989-91. Mean intakes of these vitamins were higher in higher income groups. Mean calcium intakes of males 12-19 years of age with household incomes <131% of poverty

Table 6-21. For adolescents and adults, median daily nutrient intakes as percentages of the 1989 recommended values, on 1 day, by sex, age, and race/ethnicity, 1988-91 (%)[1]

	Male												Female											
	12-15 years			16-19 years			20-59 years			≥60 years			12-15 years			16-19 years			20-59 years			≥60 years		
Nutrient	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA	NHW	NHB	MA
Food energy[2]	102	92	84	106	89	82	90	84	82	81	67	72	79	88	78	74	89	81	79	78	78	75	71	66
Protein	184	160	187	173	163	156	149	140	152	117	103	113	124	137	135	139	150	150	128	126	126	112	104	100
Vitamin A[3]	85	55	70	77	55	67	78	53	62	91	55	61	63	64	59	73	60	54	75	52	66	104	63	60
Vitamin E	68*	74	67	93	92	77	90	75	80	70	51	59	70	85	63	72	78	76	80	75	75	74	57	54
Vitamin C[3]	194	204	180	112	188	137	140	153	148	138	108	125	106	180	144	102	140	127	110	97	110	143	135	102
Thiamin	146	122	134	148	120	109	119	108	109	135	102	120	108	120	107	105	118	107	112	111	112	121	106	95
Riboflavin	169	120	147	148	120	118	129	102	116	139	108	119	112	112	127	119	116	112	118	101	110	124	98	102
Niacin	140	115	120	135	122	96	140	131	120	146	112	108	97	115	100	100	112	96	118	111	103	129	109	90
Vitamin B_6[3]	110	92	95	104	93	83	100	89	98	89	65	67	78	96	83	75	83	87	83	74	82	88	73	67
Folate[3]	203	133	169	140	106	132	146	114	144	141	100	122	120	117	121	102	83	106	107	86	115	127	99	94
Vitamin B_{12}	242	188	212	258	248	244	248	210	225	210	165	164	169	145	170	170	154	148	156	146	150	140	116	114
Calcium[2]	90	60	85	103	76	79	113	74	103	90	62	82	62	51	66	66	52	56	80	62	79	77	50	62
Phosphorus	118	97	114	141	126	122	188	155	196	152	121	148	87	81	94	88	87	90	130	113	134	116	96	102
Magnesium	103	85	97	78	68	70	95	74	96	83	58	74	64	70	74	62	58	66	85	66	85	83	67	65
Iron[2]	128	110	119	146	119	114	161	139	152	140	102	127	67	65	68	63	69	68	74	66	72	103	96	84
Zinc[2]	77	59	70	90	82	80*	87	75	84	72	57	55	67	71	72	70	78	72	70	65	70	62	55	54
Copper	81	76	79	93	87	84	100	82	97	81	59	79	67	62	59	63	66	67	70	59	68	65	55	56
Sodium	154	137	134	194	179	134	161	151	143	128	98	118	108	124	106	103	129	106	110	111	106	96	83	76

[1]Data are from tables A.T6-16,21a through A.T6-16,21v in appendix VA. Shaded values indicate intakes that are below (or above, for sodium) recommended amounts. NHW, non-Hispanic white; NHB, non-Hispanic black; MA, Mexican American. For food energy, values represent percentage of the Recommended Energy Intake (NRC, 1989a). For all nutrients except copper and sodium, the 1989 Recommended Dietary Allowances (RDAs) were used as the recommended values; for copper, the lowest values in the Estimated Safe and Adequate Daily Dietary Intake (ESADDI) ranges were used; and for sodium, the Food and Nutrition Board's recommended maximum intake of 2.4 g/d was used (NRC, 1989a). Percentage of the RDA was calculated using the following NHANES III (RDA) age groups: 12-15 years (11-14 years), 16-19 years (15-18 years), 20-59 years (25-50 years), and ≥60 years (≥51 years). An asterisk (*) indicates a statistic that is potentially unreliable because of a small sample size or a large coefficient of variation.
[2]Considered to be a current public health issue for nutrition monitoring in 1989 (LSRO, 1989).
[3]Considered to be a potential public health issue for which further study was needed in 1989 (LSRO, 1989).

SOURCE: HHS, NHANES III, 1988-91.

Table 6-22. For Hispanic adolescents and adults, median daily nutrient intakes as percentages of the 1989 recommended values, on 1 day, by sex, age, and Hispanic origin, 1982-84 (%)[1]

	Male												Female											
	12-15 years			16-19 years			20-59 years			60-74 years			12-15 years			16-19 years			20-59 years			60-74 years		
Nutrient	MA	CA	PR	MA	CA	PR	MA	CA	PR	MA	CA	PR	MA	CA	PR	MA	CA	PR	MA	CA	PR	MA	CA	PR
Food energy[2]	87	95	94	84	110	91	85	73	75	75	73	74	76	89	85	70	75	83	70	62	66	66	68	51
Protein	202	220	224	181	229	186	156	154	141	122	129	117	143	167	154	141	173	157	124	122	120	106	112	82
Vitamin A[3]	74	58	75	62	62	73	56	52	54	53	44	41	65	50	60	61	49	57	59	46	49	61	59	40
Vitamin E	74	61	72	89	105	88	79	67	75	58	56	67	72	72	74	69	62	80	71	58	64	61	58	46
Vitamin C[3]	154	88	206	143	150	207	120	102	98	78	110	150	126	98	182	95	75	118	98	63	68	115	87	70
Thiamin	115	140	142	102	147	139	99	93	99	98	105	99	104	113	138	93	90	113	86	82	88	84	87	71
Riboflavin	149	156	165	118	123	140	112	101	102	111	103	101	122	133	135	102	105	116	96	92	90	96	102	83
Niacin	117	134	142	108	147	130	126	114	117	112	130	107	98	122	115	90	102	106	93	88	95	90	97	72
Vitamin B_6[3]	99	91	108	94	123	106	96	92	81	68	78	56	87	89	99	75	79	80	73	66	68	68	80	49
Folate[3]	180	127	179	133	150	168	138	104	110	108	92	108	131	105	140	99	75	90	99	73	81	89	86	64
Vitamin B_{12}	276	274	242	302	319	275	246	268	204	192	180	188	179	226	174	158	199	160	148	147	134	110	136	110
Calcium[2]	90	84	80	85	90	97	96	92	79	73	83	66	64	60	69	51	51	52	66	66	65	63	80	60
Phosphorus	125	128	126	148	163	149	187	168	159	150	142	121	93	104	100	82	84	86	123	109	111	108	118	91
Magnesium	100	101	98	80	90	74	92	78	77	73	69	65	75	77	80	66	58	67	74	60	64	70	67	54
Iron[2]	116	136	130	132	184	154	149	151	139	123	111	118	68	78	83	63	69	75	65	63	65	82	91	70
Zinc[2]	85	83	82	97	117	97	91	93	74	67	67	58	76	97	79	69	92	70	70	65	60	56	57	43
Copper	77	85	77	87	109	87	90	79	77	67	69	69	59	65	67	58	59	59	58	49	54	51	49	41
Sodium	136	179	159	157	200	188	141	145	146	111	120	119	100	141	129	98	109	128	91	93	103	77	92	75

[1]Data are from tables A.T6-17,22a through A.T6-17,22u in appendix VA. Shaded values indicate intakes that are below (or above, for sodium) recommended amounts. MA, Mexican American; CA, Cuban American; PR, Puerto Rican. For food energy, values represent percentage of the Recommended Energy Intake (NRC, 1989a). For all nutrients except copper and sodium, the 1989 Recommended Dietary Allowances (RDAs) were used as the recommended values; for copper, the lowest values in the Estimated Safe and Adequate Daily Dietary Intake (ESADDI) ranges were used; and for sodium, the Food and Nutrition Board's recommended maximum intake of 2.4 g/d was used (NRC, 1989a). Percentage of the RDA was calculated using the following HHANES (RDA) age groups: 12-15 years (11-14 years), 16-19 years (15-18 years), 20-59 years (25-50 years), and 60-74 years (≥51 years).

[2]Considered to be a current public health issue for nutrition monitoring in 1989 (LSRO, 1989).

[3]Considered to be a potential public health issue for which further study was needed in 1989 (LSRO, 1989).

SOURCE: HHS, HHANES, 1982-84.

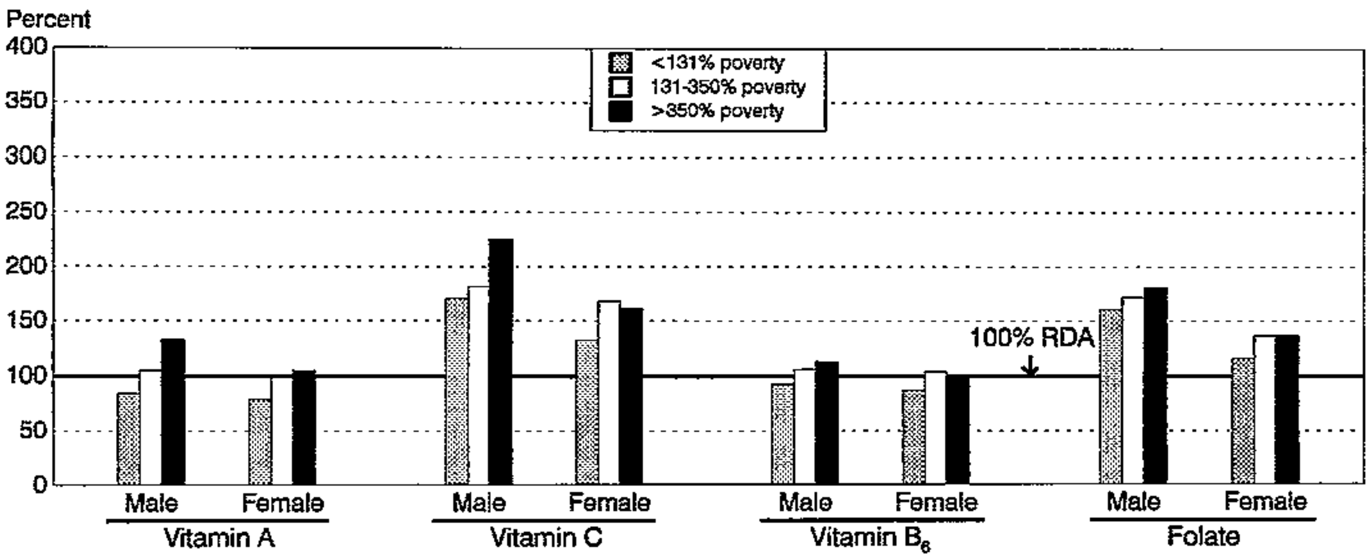

Figure 6-9. Nutrient intakes as percentages of the 1989 Recommended Dietary Allowances (RDAs) of adolescents 12-19 years of age for selected vitamins: mean per individual per day over 3 days, by sex and income level, 1989-91

NOTE: Data are from table A.F6-7,8,9,10,11,12 in appendix VA. These vitamins were selected because they were considered by EPONM in 1989 to be current or potential public health issues (LSRO, 1989). Income level was determined by dividing income by the appropriate Federal Poverty Income guideline.

SOURCE: USDA, CSFII, 1989-91.

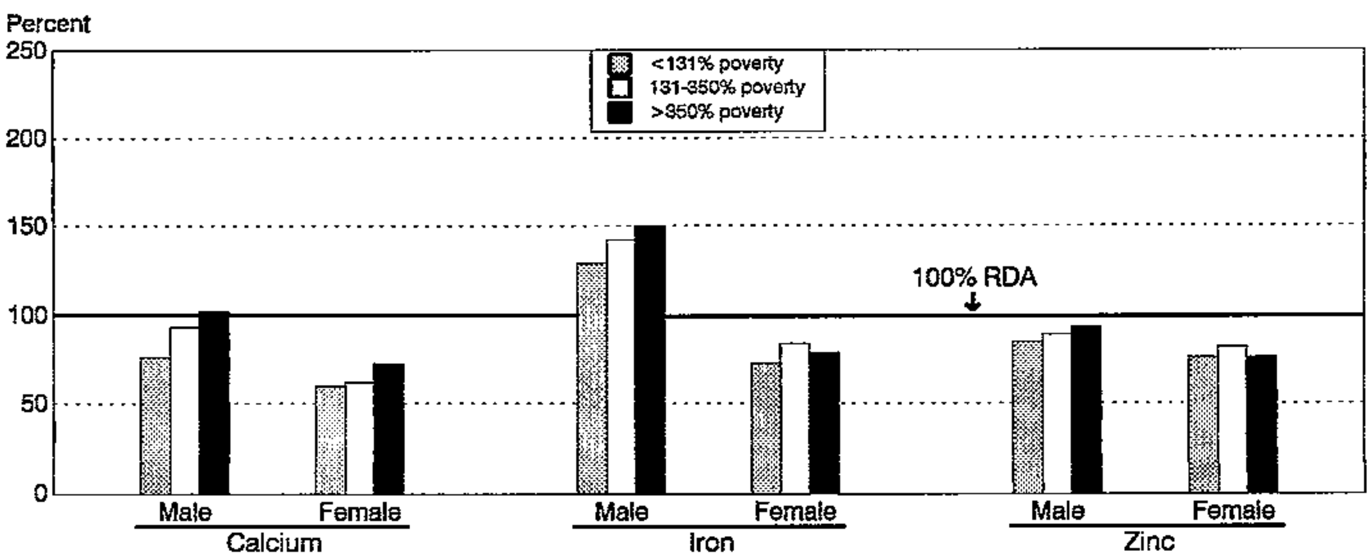

Figure 6-10. Nutrient intakes as percentages of the 1989 Recommended Dietary Allowances (RDAs) of adolescents 12-19 years of age for selected minerals: mean per individual per day over 3 days, by sex and income level, 1989-91

NOTE: Data are from table A.F6-7,8,9,10,11,12 in appendix VA. These minerals were selected because they were considered by EPONM in 1989 to be current or potential public health issues (LSRO, 1989). Income level was determined by dividing income by the appropriate Federal Poverty Income guideline.

SOURCE: USDA, CSFII, 1989-91.

and 131-350% of poverty were also below the RDA for adolescent males, and mean zinc intakes were below the RDA for adolescent males in all income groups. For adolescent females in all income groups, mean intakes of calcium, iron, and zinc were below RDA values.

Data from NHANES III 1988-91 and HHANES 1982-84 showed that median total fat intakes were greater than 30% of calories and saturated fatty acid intakes were greater than 10% of calories for males and females 12-15 and 16-19 years of age in all racial/ethnic groups (tables 6-18 and 6-19). Data from CSFII 1989-91 indicated that only 14% of males and 18% of females 12-19 years of age had total fat intakes ≤30% of calories (table 6-20). Similarly, data from NHANES III 1988-91 indicated that only 15% of adolescents 12-19 years of age had total fat intakes ≤30% of calories and only 7% had saturated fatty acid intakes less than 10% of calories (Lewis et al., 1994). In NHANES III 1988-91, median cholesterol intakes for adolescents were within the recommended range of <300 mg/d; however, in HHANES 1982-84, median cholesterol intakes were greater than 300 mg/d for Mexican-American, Cuban-American, and Puerto Rican males 12-15 and 16-19 years of age and for Puerto Rican females 12-15 years of age.

Adults 20 years of age and older

Nutrient intakes from food for adults are reported for two age groups: 20-59 years of age and 60 years of age and older in NHANES III 1988-91 (60-74 years in HHANES 1982-84). As discussed in chapter 2, the most rapidly growing segment of the U.S. population is the subgroup 65 years of age and older, a trend expected to extend well into the next century. This group is also considered to be at increased risk for impaired nutritional status (either deficient or excessive) compared with younger adults. Knowledge about how nutritional requirements change with aging is limited. Gathering information on the nutritional status of this burgeoning segment of the population now and in the future should be a critical component of nutrition monitoring.

Reported median food energy intakes were generally below 1989 Recommended Energy Intakes for adults 20-59 and 60 years of age and older in NHANES III 1988-91 and 20-59 and 60-74 years of age in HHANES 1982-84 (tables 6-21 and 6-22). As noted for adolescents, this observation suggests that foods consumed were underreported, food-energy-intake recommendations are higher than the energy expenditures of many adults, and/or energy expenditures of adults are low. Underreporting of foods consumed by adults has been reported by investigators including Bingham (1987), Black et al. (1991, 1993), Forbes (1993), Lichtman et al. (1992), Livingstone et al. (1991), Mertz et al. (1991), and Schoeller et al. (1990). Underreporting of food consumption, as evaluated by the ratio of energy intake to basal metabolic rate, also appears to be greater for women and overweight people than for other population subgroups in NHANES III 1988-91 (Briefel et al., in press).

For males 20-59 and 60 years of age and older in NHANES III 1988-91 and 20-59 and 60-74 years of age in HHANES 1982-84, median intakes from food of vitamin A, vitamin E, vitamin B_6, magnesium, zinc, and copper were at or below the RDA or ESADDI values for these nutrients. Median intakes of calcium were below RDA values for non-Hispanic black males 20-59 years of age and all males 60 years of age and older in NHANES III 1988-91 and for all Hispanic males 20-59 and 60-74 years of age in HHANES 1982-84. Except for non-Hispanic black males 60 years of age and older, median daily intakes of sodium from food alone for all groups of adult males in NHANES III 1988-91 and HHANES 1982-84 were greater than 2,400 mg.

Median intakes of vitamin A, vitamin E, vitamin B_6, calcium, magnesium, iron, zinc, and copper were below RDA or ESADDI values for all racial/ethnic subgroups of females 20-59 and 60 years of age and older in NHANES III 1988-91 and 20-59 and 60-74 years of age in HHANES 1982-84, except for non-Hispanic white females 60 years of age and older in NHANES III 1988-91. Vitamin A and iron intakes in that last group were above recommended values. Median folate intakes were below RDA values for non-Hispanic black females 20-59 years of age and non-Hispanic black and Mexican-American females 60 years of age and older in NHANES III 1988-91 and for all subgroups of Hispanic females 20-59 and 60-74 years of age in HHANES 1982-84. Perhaps associated with low folate intakes, median vitamin C intakes were below RDA values for most subgroups of Hispanic females in HHANES 1982-84.

Median intakes of thiamin, riboflavin, and niacin were below RDA values for Hispanic females 20-59 and 60-74 years of age in HHANES 1982-84. This finding may suggest relatively low consumption of enriched grain products by Hispanic females, although intakes of thiamin, riboflavin, and niacin were not generally below RDA values in Mexican-American adult females in NHANES III 1988-91. Only females 60 years of age and older in all racial/ethnic groups in NHANES III 1988-91 and HHANES 1982-84 had median sodium intakes from food alone that were lower than the recommended daily intake of 2,400 mg or less for adults. Estimated mean intakes of calcium, iron, magnesium, and copper from the Total Diet Study (1982-89) were somewhat higher for males and females 25-39 and 60-65 years of age than median intakes for adults 20-59 and 60 years of age and older in NHANES III 1988-91.

Findings from CSFII 1989-91 on intakes of vitamins and minerals from foods as percentages of the RDAs for adults 20 years of age and older, by income level, are shown in figures 6-11 and 6-12. With the exception of males in the household income level >350% of poverty, mean vitamin B_6 intakes were below RDA values for all males and females 20 years of age and older. Mean calcium intakes were below the RDA for adult males with household incomes <131% of poverty, and mean zinc intakes were below the RDA for adult males at all income levels. Mean intakes of calcium, iron, and zinc were below the RDA for adult females in all income groups.

Data from NHANES III 1988-91 and HHANES 1982-84 also showed that median total fat intakes were >30% of calories and saturated fatty acid intakes were >10% of calories for adult males and females (tables 6-18 and 6-19). This observation was also reported by Loria et al. (1995) in a detailed analysis of differences in macronutrient intakes among Mexican Americans, Cuban Americans, and Puerto Ricans in HHANES 1982-84. Data from CSFII 1989-91, shown in table 6-20, suggest that only about 21% of males and 25% of females 20 years of age and older have total fat intakes ≤30% of calories in CSFII 1989-91. Somewhat higher percentages of white than black males and females 20 years of age and older had total fat intakes ≤30% of calories. Income level and Food Stamp Program participation did not appear to be associated with percentages of individuals who had total fat intakes ≤30% of calories. Data from NHANES III 1988-91 also indicated that 23% and 25% of adults 20 years of age and older met the recommendations for total fat intakes ≤30% of calories and saturated fatty acid intakes <10% of calories, respectively (Lewis et al., 1994).

Median cholesterol intakes were greater than 300 mg/d for non-Hispanic black and Mexican-American males but not for non-Hispanic white males 20-59 years of age, for males 60 years of age and older, or for females 20-59 and 60 years of age and older in any racial/ethnic group in NHANES III 1988-91. The median cholesterol intakes for Mexican-American males were consistently lower for all age groups in NHANES III 1988-91 than in HHANES 1982-84. Median dietary fiber intakes were below recommended intakes (20-30 g/d) for adults in both surveys.

Adequacy of median nutrient intakes appeared similar for younger and older adults in all racial/ethnic groups in 1988-91 when evaluated as a percentage of the RDA value for the appropriate age-sex group. When median nutrient intakes of older people were less than 100% of the RDA, median intakes of adults 20-59 years of age were also less than 100% of the RDA. However, when differences were seen, the actual percentages of the RDA tended to be lower for older than younger adults, and percentages of the RDA tended to be lower for non-Hispanic blacks and Mexican Americans than for non-Hispanic whites 60 years of age and older.

Mean 1-day nutrient intakes from food from the Strong Heart Dietary Study (1989-91) (table 6-23) for American Indians 45-59 and 60-74 years of age residing in Arizona, Oklahoma, and South Dakota were determined using the data-collection and data-analysis methodologies used for NHANES III 1988-91. Mean nutrient intakes for these groups showed similarities to median intakes for other racial/ethnic subgroups reported in NHANES III 1988-91 and HHANES 1982-84. Mean food energy intakes were below RDA values for American Indian males and females in both age groups. Mean vitamin A intakes were below RDA values for American Indian males and females residing in Arizona but not in Oklahoma or South Dakota. Mean intakes of total fat as a percentage of calories were consistently

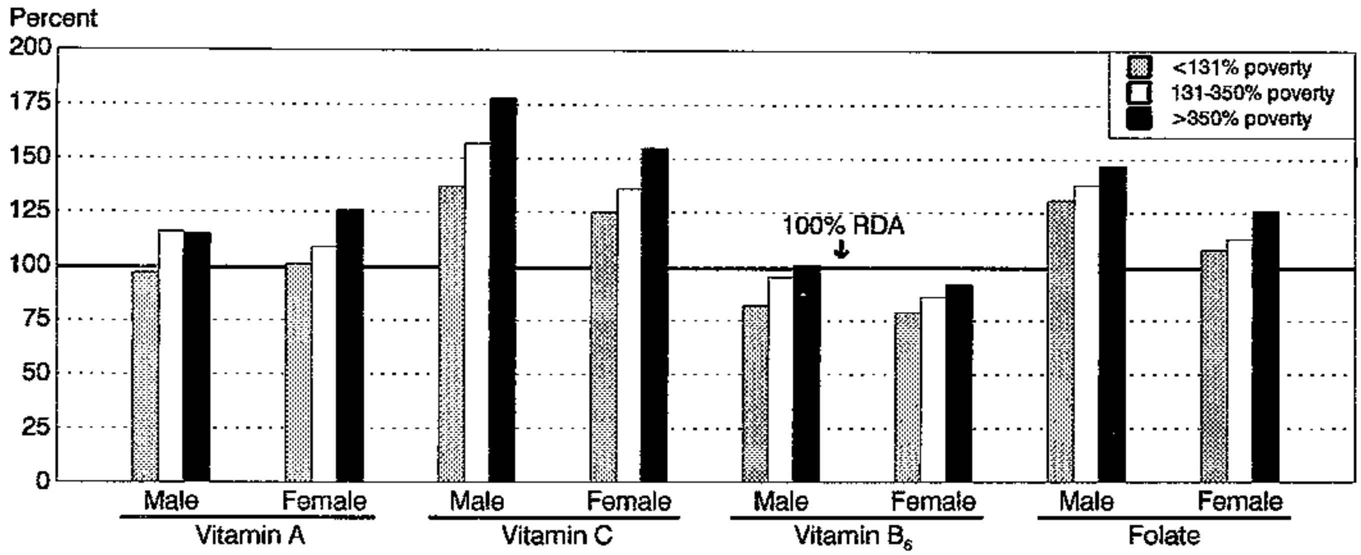

Figure 6-11. Nutrient intakes as percentages of the 1989 Recommended Dietary Allowances (RDAs) of people 20 years of age and older for selected vitamins: mean per individual per day over 3 days, by sex and income level, 1989-91

NOTE: Data are from table A.F6-7,8,9,10,11,12 in appendix VA. These vitamins were selected because they were considered by EPONM in 1989 to be current or potential public health issues (LSRO, 1989). Income level was determined by dividing income by the appropriate Federal Poverty Income guideline.

SOURCE: USDA, CSFII, 1989-91.

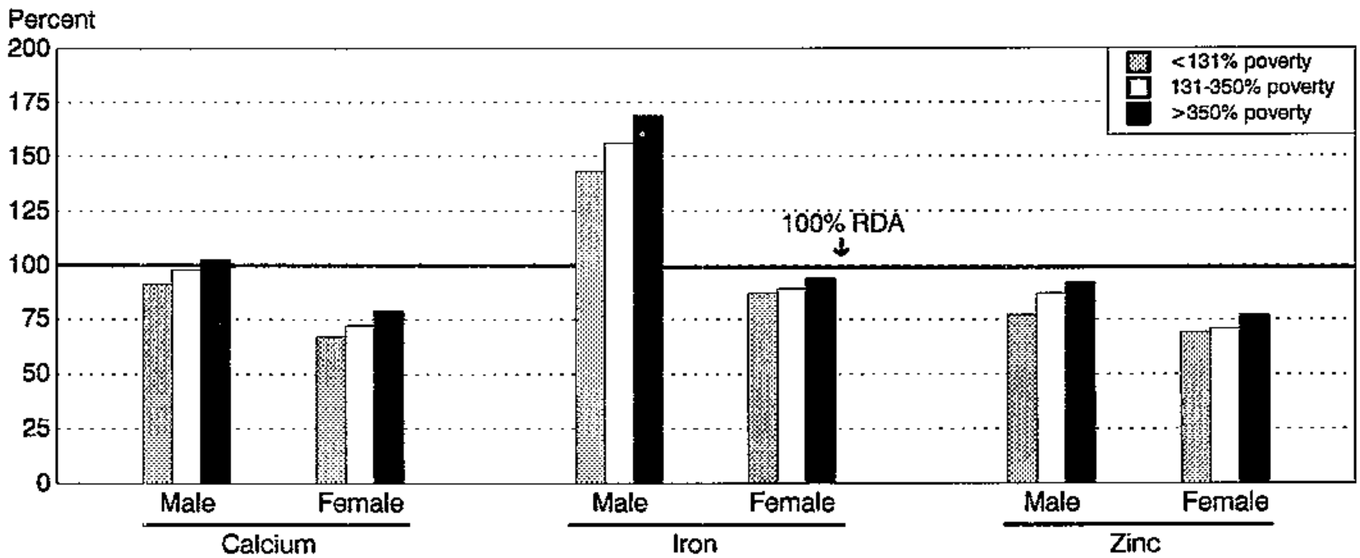

Figure 6-12. Nutrient intakes as percentages of the 1989 Recommended Dietary Allowances (RDAs) of people 20 years of age and older for selected minerals: mean per individual per day over 3 days, by sex and income level, 1989-91

NOTE: Data are from table A.F6-7,8,9,10,11,12 in appendix VA. These minerals were selected because they were considered by EPONM in 1989 to be current or potential public health issues (LSRO, 1989). Income level was determined by dividing income by the appropriate Federal Poverty Income guideline.

SOURCE: USDA, CSFII, 1989-91.

Table 6-23. Mean 1-day nutrient intakes of American Indians 45-74 years of age, by sex, age, and State of residence, compared with the 1989 recommended values or other criterion, 1989-91[1]

Nutrient, sex, and age in years	State of residence			RDA value or other criterion for comparison
	Arizona	Oklahoma	South Dakota	
Food energy (kcal)				
Males				
45-59	2,177	2,156	2,095	2,300
60-74	1,621	1,567	1,594	
Females				
45-59	1,644	1,656	1,801	1,900
60-74	1,476	1,204	1,469	
Vitamin A (µg RE)				
Males				
45-59	778	1,164	1,215	1,000
60-74	886	1,068	1,003	1,000
Females				
45-59	781	1,037	1,323	800
60-74	954	833	1,119	800
β-carotene (µg)				
Males				
45-59	1,672	2,823	3,034	None
60-74	1,590	2,604	2,477	None
Females				
45-59	2,028	2,832	3,767	None
60-74	2,336	2,057	2,903	None
Vitamin C (mg)				
Males				
45-59	116	119	91	60
60-74	79	101	75	60
Females				
45-59	98	142	108	60
60-74	122	101	89	60
Iron (mg)				
Males				
45-59	20	15	15	10
60-74	17	11	11	10
Females				
45-59	16	13	12	10
60-74	15	9	10	10
Total fat (g)				
Males				
45-59	78	92	90	None
60-74	65	63	64	None
Females				
45-59	67	69	72	None
60-74	56	48	58	None

Table 6-23. Mean 1-day nutrient intakes of American Indians 45-74 years of age, by sex, age, and State of residence, compared with the 1989 recommended values or other criterion, 1989-91—continued

Nutrient, sex, and age in years	State of residence			RDA value or other criterion for comparison
	Arizona	Oklahoma	South Dakota	
Total fat (% kcal)				
Males				
45-59	32	38	39	30[2]
60-74	36	36	36	30
Females				
45-59	37	38	36	30
60-74	34	36	36	30
Cholesterol (mg)				
Males				
45-59	447	328	418	300[1]
60-74	447	288	240	300
Females				
45-59	435	276	279	300
60-74	361	190	269	300
Dietary fiber (g)				
Males				
45-59	23	17	15	20-30[3]
60-74	16	13	12	20-30
Females				
45-59	16	14	15	20-30
60-74	17	11	12	20-30

[1]Data are from table A.T6-23 in appendix VA.
[2]Total fat and cholesterol intakes are compared with recommendations by the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II) (1993).
[3]Dietary fiber intakes are compared with recommendations by the National Cancer Institute (1987).

SOURCE: HHS, Strong Heart Dietary Survey, 1990-91.

above 30% of calories, and mean intakes of dietary fiber were below the recommended intake of 20-30 g/d for healthy adults. Mean cholesterol intakes for males and for females residing in Arizona and for males 45-59 years of age in South Dakota were far above 300 mg/d.

Pregnant females

Mean daily nutrient intakes based on reported food consumption for all pregnant females in the NHANES III 1988-91 population and for non-Hispanic white, non-Hispanic black, and Mexican-American subgroups are shown in table 6-24. NHANES III 1988-91 had dietary data for 169 pregnant females: 40 non-Hispanic whites, 53 non-Hispanic blacks, 74 Mexican Americans, and 2 classified as "other" race/ethnicity.

For pregnant non-Hispanic white, non-Hispanic black, and Mexican-American females in NHANES III 1988-91, the mean intakes of vitamin B_6, folate, calcium, iron, magnesium, and zinc were less than the 1989 RDAs for pregnant females. Mean daily vitamin E intakes were also lower than recommended levels for the non-Hispanic white and non-Hispanic black pregnant females. Of the pregnant females in NHANES III 1988-91, 65% reported taking a vitamin-mineral supplement in the past month. Therefore, total mean nutrient intakes may have been expected to be higher than those reported in table 6-24.

Two noteworthy differences were found among the three racial/ethnic groups. Non-Hispanic black pregnant females had the lowest mean daily calcium intake. Mean cholesterol intake of non-Hispanic white pregnant females was lower than the mean

Table 6-24. For pregnant females, daily mean nutrient intakes from food, by race/ethnicity, 1988-91[1]

Nutrient	1989 RDA	All pregnant females	Non-Hispanic white	Non-Hispanic black	Mexican American
Food energy (kcal)	—	2,282	2,265	2,335	2,184
Energy from total fat (% kcal)	—	36.1	36.2	37.4	34.4
Energy from saturated fatty acids (% kcal)	—	13.3	13.6	12.8	12.6
Energy from monounsaturated fatty acids (% kcal)	—	13.0	13.0	13.8	12.1
Energy from polyunsaturated fatty acids (% kcal)	—	7.1	7.1	7.8	6.9
Energy from carbohydrate (% kcal)	—	50.7	50.8	48.7	51.8
Energy from protein (% kcal)	—	14.6	14.5	14.9	15.3
Energy from alcohol (% kcal)	—	0.2*	0.3*	0.0*	0.2*
Protein (g)	60	85	84	88	82
Dietary fiber (g)	—	14.5	14.3	13.3	18.7
Cholesterol (mg)	—	299	274	373	365
Vitamin A (µg RE)	800	1,043	957	1,475*	905
Carotenes (µg RE)	—	409	368	411*	771
Vitamin E (mg α-tocopherol equivalents)	10	9.4	9.5	8.4	12.0
Vitamin C (mg)	70	128	108	140	147
Thiamin (mg)	1.5	1.8	1.8	1.9	1.8
Riboflavin (mg)	1.6	2.2	2.2	2.2	2.3
Niacin (mg)	17	23.3	23.2	24.6	20.7
Vitamin B_6 (mg)	2.2	1.9	1.9	1.9	2.0
Folate (µg)	400	288	281	270	326
Vitamin B_{12} (µg)	2.2	5.5	4.8	8.7*	5.1
Calcium (mg)	1,200	1,064	1,104	851	1,098
Phosphorus (mg)	1,200	1,428	1,449	1,298	1,501
Iron (mg)	30	13.9	13.2	14.4	15.1
Magnesium (mg)	320	285	286	241	303
Zinc (mg)	15	10.9	10.4	12.0	12.3
Copper (mg)	—	1.3	1.2	1.4	1.3
Sodium (mg)	—	3,681	3,784	3,712	3,162
Potassium (mg)	—	2,936	2,893	2,658	2,935

[1]Data are from table A.T6-24 in appendix VA. Shaded values indicate intakes that are below the 1989 Recommended Dietary Allowance (RDA). Nutrient intakes calculated from single 24-hour recalls. Values do not include nutrient intakes from dietary supplements. Based on a sample of 169 pregnant females, there were 40 non-Hispanic whites, 53 non-Hispanic blacks, 74 Mexican Americans, and 2 classified as "other." A dash (—) indicates that there is no RDA for that nutrient for pregnant women. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

intakes of both non-Hispanic black and Mexican-American pregnant females, whose mean intakes exceeded 300 mg/d.

Dietary supplement use

Information on the use of vitamin and mineral supplements from the 1980 FDA Vitamin/Mineral Supplement Intake Survey (Levy and Schucker, 1987; Stewart et al., 1985), NFCS 1977-78 (Moshfegh, 1985), and CSFII 1985-86 (USDA, 1985, 1986) that was summarized in the second report on nutrition monitoring indicated that at least 35-40% of the U.S. population used vitamin and/or mineral supplements. Dietary supplement use was reported by higher percentages of women than men and by higher percentages of older than younger people (LSRO, 1989).

Data on the use of vitamin and mineral supplements have been published from the NHANES I Epidemiologic Follow-up Study (NHEFS), the 1986 National Health Interview Survey (NHIS) on Vitamin and Mineral Supplements, and the 1987 and 1992 NHIS Cancer Risk Factors Supplement. Data on dietary supplement use in NHANES III 1988-91 and the 1991 Longitudinal Followup to the 1988 National Maternal and Infant Health Survey are presented in this report. Because of the differences in the questions asked, the products included, the populations targeted, and the methodologies used, comparisons were not made among surveys in this report. Results from all of the surveys do indicate, however, that a substantial proportion of the U.S. population uses dietary supplements.

In an analysis of the use of vitamins and minerals and mortality in the NHEFS (Kim et al., 1993), baseline data on 10,758 NHANES I 1971-74 participants 25-74 years of age (at baseline) indicated that 23% reported regular (daily) use of vitamins and minerals; 10% reported irregular use (at least once a week but less than daily); and 68% reported not using supplements at least weekly. Regular use of vitamin and mineral supplements was highest for older, white individuals; for females in general; for people with 13 years of education or more; for individuals with higher nutrient intakes from food; for people with lower body mass index (BMI); for people with a past history of smoking; for people on special diets; and for females who drank alcohol regularly (Kim et al., 1993).

Data have been published from NHIS 1986 on the prevalence of the use of vitamin and mineral supplements, nutrient intakes from supplements, and demographic characteristics of supplement users (Moss et al., 1989) and on the characteristics of vitamin- and mineral-supplement products (Park et al., 1991). In that survey, data were collected on the prevalence of use, the nutrient composition of the products consumed, and the dosage and frequency of use by adults 18 years of age and older and children 2-6 years of age during the 2-week period preceding the survey. Information on whether the supplement was consumed under a doctor's prescription was also collected. To estimate supplement use by the self-prescribing user population (self-supplementation), Moss et al. (1989) deleted from their analysis people who used supplements prescribed by a doctor and pregnant and lactating females (supplement use during pregnancy or lactation was not expected to reflect the usual supplement-use practices by these women).

In NHIS 1986, use of vitamin and/or mineral supplements was reported for about 43% of children 2-6 years of age (table 6-25). In adults, more females than males reported using vitamin and/or mineral supplements within the past 2 weeks and, for both sexes, reported use was greatest for adults 45-64 years of age. White adults and children were more likely than blacks to use dietary supplements. Individuals with incomes at or above poverty were more likely to report use of vitamin and/or mineral supplements than were those with incomes below poverty. Use was also higher in adults of all ages with higher education levels and in children who had parents or guardians with higher education levels. More than 70% of all vitamin-mineral supplements used by adults and children were taken every day.

Estimates were also made of the percentage of people using vitamin and/or mineral products classified as single ingredient, multivitamin, multivitamin plus iron, other vitamin combinations, multimineral, other mineral combinations, and other vitamin-mineral combinations (Moss et al., 1989). Single vitamins and vitamin-mineral combinations were the types of products most commonly taken by adults. Multivitamins were the most-often-used vitamin

Table 6-25. Percentage (unadjusted) of children 2-6 years of age and adults ≥18 years of age who reported taking vitamin and/or mineral supplements in the past 2 weeks, by sex, selected demographic characteristics, and age, 1986 (%)[1]

Selected characteristics	Overall population	Children 2-6 years of age	Adults		
			18-44 years of age	45-64 years of age	≥65 years of age
Sex					
Male	31.2	44.4	30.2	32.7	32.2
Female	41.3	42.2	38.6	46.2	42.4
Race and sex					
White					
Male	32.9	47.1	32.1	34.3	33.8
Female	43.7	45.4	40.5	49.4	44.6
Black					
Male	18.7	30.0	18.9	22.4	9.7*
Female	23.8	30.5	25.9	22.1	17.3
NHIS poverty index					
<poverty	24.2	27.3	23.8	24.2	25.7
≥poverty	38.7	48.2	36.9	41.8	40.3
Education[2]					
<12 years	25.5	26.9	20.3	26.3	30.7
12 years	36.0	40.1	31.2	42.1	45.3
≥13 years	44.5	51.0	42.6	49.3	47.3

[1]Values exclude pregnant or lactating females and people using vitamin or mineral supplements only under doctors' prescription. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.
[2]Education of individuals is shown for people ≥18 years of age, and education of responsible adult is shown for children 2-6 years of age.

SOURCE: HHS, NHIS Vitamin and Mineral Supplement Intake Survey, 1986 (Moss et al., 1989).

product for children 2-6 years of age, and iron was the mineral most often taken by children in this age group. For adults, vitamin C was the most commonly consumed vitamin from supplements, reported by nearly one-third of all respondents. Calcium and iron were the minerals most often consumed by adults.

The 50th, 90th, and 95th percentiles of average daily intakes were also estimated for each vitamin and mineral contained in the supplements reported. For adults of both sexes, 50th-percentile intakes provided by the supplements for most vitamins were between 100% and 200% of the RDA; for all minerals, 50th-percentile intakes were below 200% of the RDA or the mid-range level of the ESADDI. At the 90th percentile, average daily intakes of vitamin C, vitamin E, thiamin, riboflavin, vitamin B_6, and vitamin B_{12} by both sexes were more than 15 times the RDA for those nutrients. At the 95th percentile, average daily intakes of thiamin, riboflavin, vitamin B_6, and vitamin B_{12} by both sexes were more than 30 times the RDA for these nutrients, and average daily intake of vitamin E by females was more than 35 times the RDA. For children 2-6 years of age, 50th-percentile intakes were between 100% and 200% of the RDA or the mid-range level of the ESADDI for most nutrients. Ninety-fifth-percentile intakes of nutrients for children 2-6 years of age were about four times the RDA or the mid-range level of the ESADDI for vitamin A, vitamin E, folic acid, and pantothenic acid and about 7.5 times the RDA for vitamin C (Moss et al., 1989).

In the Cancer Risk Factors Supplements for NHIS in 1987 (Subar and Block, 1990) and 1992 (Slesinski et al., in press), adults 18 years of age and older were questioned about their use of any vitamin or mineral supplement in the past year and about frequency of intake of multivitamins, vitamin A, vitamin C, vitamin E, and calcium in that time period. In 1987, 51% of the population reported using a vitamin or mineral supplement in the past year; in 1992, 46% reported doing so. The decline occurred in the white subgroup; the responses of blacks and Hispanics did not change during this time period. About 24% of individuals reported regular daily use of any of the specified supplements in 1987 and 1992. In both years, 9% of the population reported taking more than one type of supplement daily, with 5% reporting use of two different supplements and 0.3% reporting taking all five specified supplements. Regular daily use of multivitamins went from 17% in 1987 to 19% in 1992, whereas use of calcium went from 6% in 1987 to 5% in 1992. Decreases in calcium-supplement use were greatest in people 55-64 years of age and in females 18 years of age and older (Slesinski et al., in press).

Data on the use of vitamin and/or mineral supplements by people 2 months of age and older, including pregnant and lactating females, were also available from NHANES III 1988-91. Vitamin-mineral-supplement products included multiple vitamins, minerals, multiple vitamins and minerals, single nutrients, or combinations containing several nutrients. For single nutrients or combinations of a few nutrients to be included in the NHANES III 1988-91 analyses, at least one of the nutrients had to have an RDA or an ESADDI.

Of all the supplements reported in NHANES III 1988-91, 6% were classified as nonvitamin and nonmineral dietary supplements. These products included amino acids and protein supplements, sports drinks, formula diets, herbs and plants, bee pollen, royal jelly, fiber, brewers' yeast, wheat germ, lecithin, lipotropics, and fish oils (except cod liver oil). These were not included in the tallies of vitamin-mineral-supplement use unless the products had vitamins and/or minerals added to them. In addition, 7% of all supplements reported were classified as unknown products, and they were also excluded from the tallies. The "unknown" designation was for products whose names could not be identified or did not include sufficient descriptive information for classification.

Data on the prevalence of the use of vitamin and mineral supplements in the past month by the U.S. population 2 months of age and older from NHANES III 1988-91 are presented in table 6-26. For the total population, the prevalence of the use of all vitamin and/or mineral supplements appears to be about 40% or higher for young children 1-5 years of age and females 30 years of age and older. For females, the prevalence of use was higher in each successive decade of age, particularly in females 50 years of age and older. Fifty-one percent of females 80 years of age and older reported that they had taken vitamin and/or mineral supplements in the past month. About 31-37% of males 30 years of age and older reported taking vitamin and/or mineral supplements in the past month, but prevalence of use did not increase with age to the extent that it did in females. Within racial/ethnic groups, prevalence of use was highest for non-Hispanic white males and females in all age groups.

In addition to the NHANES III 1988-91 data for people 2 years of age and older, data from the 1991 Longitudinal Followup to the 1988 National Maternal and Infant Health Survey indicated that about 50% of children 3 years of age had used dietary supplements three or more times per week in the past month.

Consistency within and among data sources for assessing change over time

NNMRRP data can be used to assess dietary trends over time under certain conditions. Ideally, measurement procedures and the definition of study populations should be identical, and sampling procedures should be equivalent (Anderson, 1986). Although these conditions are rarely met in surveys, differences between cycles of periodic surveys are smaller than differences among surveys. For this reason, it is most appropriate to compare between cycles of a given survey rather than among surveys over time. Before a time trend is accepted as a real change, it should be observed over several consecutive time periods.

In an effort to improve the quality of dietary information collected in surveys, changes have been made in methodology, such as developing automated data-collection procedures and improving probing techniques, improving interviewer training, and developing improved nutrient data bases for surveys. Although improvements in methodology and nutrient data bases may improve the data collected at one point in time, such changes may affect the comparability of data collected at different times.

Table 6-26. Percentage of children and adults 2 months of age and older who reported taking vitamin and/or mineral supplements in the past month, by sex, age, and race/ethnicity, 1988-91 (%)[1]

Sex and age	Overall population	Non-Hispanic white	Non-Hispanic black	Mexican American
Male				
2-11 months	26.6	29.4	16.9	23.2
1-2 years	39.6	43.5	27.6	33.2
3-5 years	42.1	47.4	28.2	31.3
6-11 years	31.1	33.8	21.8	19.2
12-15 years	15.6	16.7	12.6	16.0
16-19 years	24.3	28.0	10.3	19.8
20-29 years	23.9	26.3	18.4	12.3
30-39 years	30.7	32.1	25.6	23.5
40-49 years	29.4	30.9	24.7	19.2
50-59 years	33.0	34.2	24.5	28.0
60-69 years	33.9	34.9	21.3	30.8
70-79 years	33.3	33.6	32.8	30.7
≥80 years	36.6	38.0	24.7	39.4*
Female				
2-11 months	21.4	21.9	12.6	26.7
1-2 years	43.3	47.1	28.6	40.0
3-5 years	42.2	47.4	29.7	39.6
6-11 years	25.6	27.2	22.7	21.7
12-15 years	20.0	21.5	13.7	20.1
16-19 years	30.1	31.6	20.1	21.4
20-29 years	37.2	42.1	23.5	30.8
30-39 years	41.9	45.0	36.0	25.9
40-49 years	39.8	42.0	27.5	28.9
50-59 years	45.0	47.4	36.7	39.2
60-69 years	47.1	49.0	37.1	35.9
70-79 years	47.8	49.3	37.3	46.4
≥80 years	51.0	53.0	31.0	45.5

[1]Data are from table A.T6-26 in appendix VA. "Overall population" includes data for racial/ethnic groups not shown separately. Unknown or unrecognizable supplements were not counted as vitamin and/or mineral supplements. Nonvitamin, nonmineral dietary supplements such as herbs, food items, or formula drinks were not counted as vitamin and/or mineral supplements. Sample includes pregnant and lactating females. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

In recognition of the potential for differences in nutrient intake data caused by differences in procedures and nutrient data bases used in NFCS 1977-78 and 1987-88, HNIS conducted a "Bridging Study" to identify sources of artifactual differences between results of the two surveys (Guenther and Perloff, 1990; Guenther et al., 1994). Real changes in nutrient intakes were separated from changes that could be attributed to changes in the nutrient data bases between the two surveys and to procedural changes in the interview, in food identification practices, and in weight-conversion factors. Revisions of the intake estimates from NFCS 1977-78 were made for those nutrients for which artifactual differences attributable to improvements in the quality of nutrient data were identified (iron, magnesium, vitamin B_6, and vitamin B_{12}). Because of these revisions, data from NFCS 1977-78 and CSFII 1989-91 could be compared over time. Estimates for NFCS 1987-88 were also included in the time series; however, those estimates should be viewed with caution because of the low response rate of that survey.

The effects of procedural changes and changes in the nutrient data bases used for NHANES II 1976-80, HHANES 1982-84, and NHANES III 1988-91 have not been studied. Because of the introduction of an automated data-collection system and other procedural changes as well as the use of different nutrient data bases for NHANES II 1976-80 and the more recent HHANES 1982-84 and NHANES III 1988-91, comparisons over time were not made for these surveys.

Trends in nutrient intake

Trends in nutrient intake are illustrated by data from NFCS 1977-78, NFCS 1987-88, and CSFII 1989-91. Effects of procedural and nutrient data base differences among the surveys have been investigated (Guenther et al., 1994; Guenther and Perloff, 1990). The procedural differences were not substantial, so these data were used for comparisons over time. Daily mean intakes of food energy over 3 days for males and females 20 years of age and older are shown in figure 6-13. The values reported in the three surveys suggest only small changes in reported food energy intakes between 1977-78 and 1989-91.

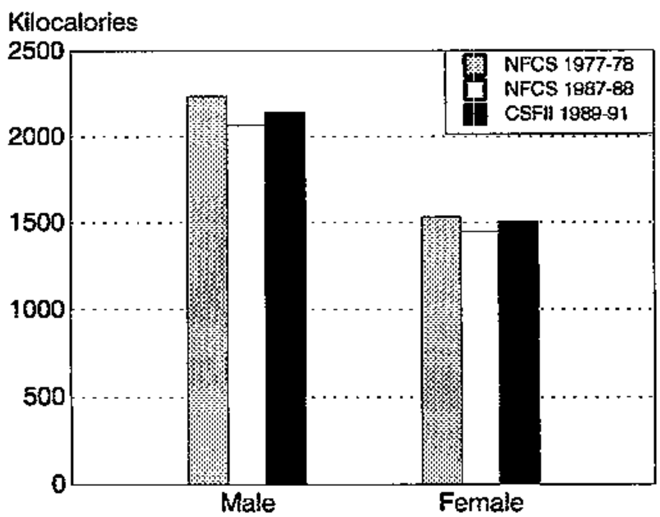

Figure 6-13. Daily mean intake of food energy of people 20 years of age and older, over 3 days, by sex, 1977-78, 1987-88, and 1989-91

NOTE: Data are from table A.F6-13 in appendix VA.

SOURCE: USDA, NFCS, 1977-78; NFCS, 1987-88; CSFII, 1989-91.

The distribution of food energy intake among total fat, protein, and carbohydrate for males and females 20 years of age and older is shown in figure 6-14 for the three surveys. These values suggest that mean intakes of total fat as a percent of calories are decreasing and that mean intakes of carbohydrate as a percent of calories are increasing. Proportions of food energy provided by both total fat and carbohydrate appear to be changing in the direction recommended in the 1990 *Dietary Guidelines for Americans* (USDA and HHS, 1990). Although the proportion of food energy provided by total fat has decreased to about 34% of calories, it is still higher than the recommendation of 30% of calories or less recommended by the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II) (1993), the 1990 *Dietary Guidelines for Americans* (USDA and HHS, 1990), and the Healthy People 2000 objectives (HHS, 1991).

A recent analysis of the percentages of calories provided by total fat and saturated fatty acids in the United States since 1920 also indicated that these percentages fell steadily from about 1960 through 1984. In 1984, total fat supplied about 36% of calories and saturated fatty acids supplied about 12-13% of calories for the U.S. population (Stephen and Wald, 1990). This analysis was based on 171 studies of food intakes of individuals published since 1920, but it did not include the NHANES data.

Changes in daily mean intakes of iron and calcium of males and females 20 years of age and older over time are shown in figures 6-15 and 6-16. Mean iron intakes appear to have increased somewhat over this time period. Although the mean intakes for adult males were above the RDA values, the mean intakes were consistently below the RDA of 15 mg/d for adult females. Determining the reasons for the observed increase in iron intake over time requires more extensive analyses than could be undertaken for this report. However, the increase may be partially attributable to increased fortification of grains with iron and increased intake of grain products. Little change occurred in mean intakes of calcium between NFCS 1977-78 and CSFII 1989-91. Mean intakes of calcium remained well below the RDA of 800 mg/d for adult females.

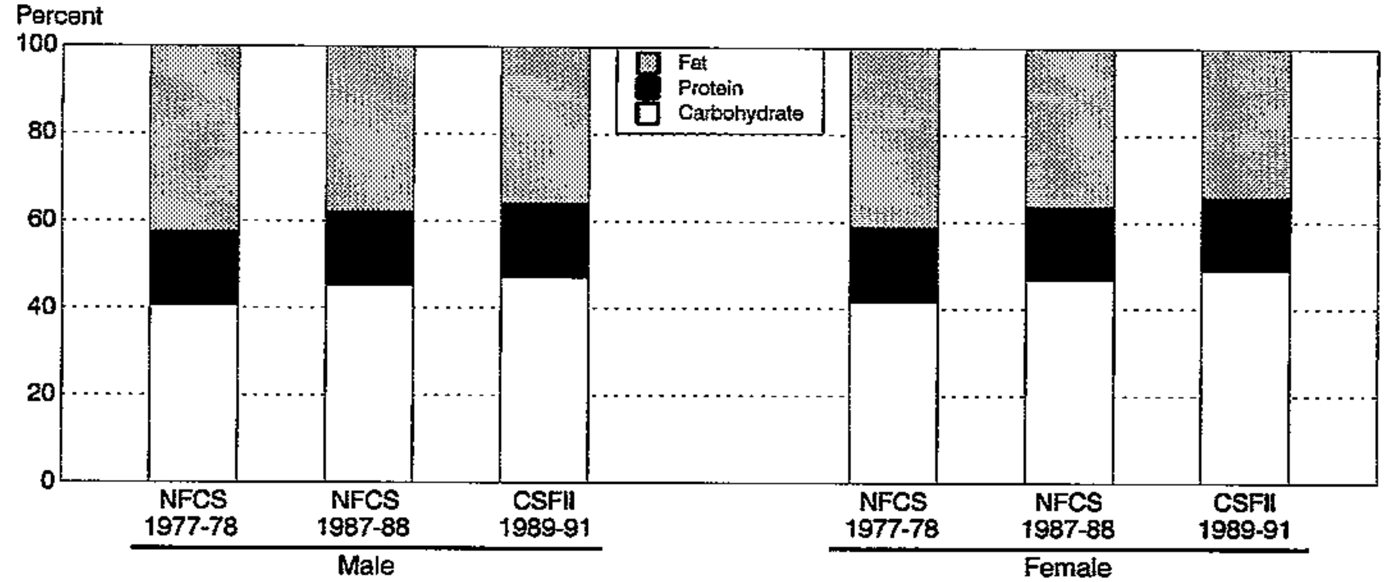

Figure 6-14. Daily mean percentage of kilocalories from carbohydrate, protein, and fat of people 20 years of age and older, over 3 days, by sex, 1977-78, 1987-88, and 1989-91

NOTE: Data are from tables A.F6-14a through A.F6-14c in appendix VA.

SOURCE: USDA, NFCS, 1977-78; NFCS, 1987-88; CSFII, 1989-91.

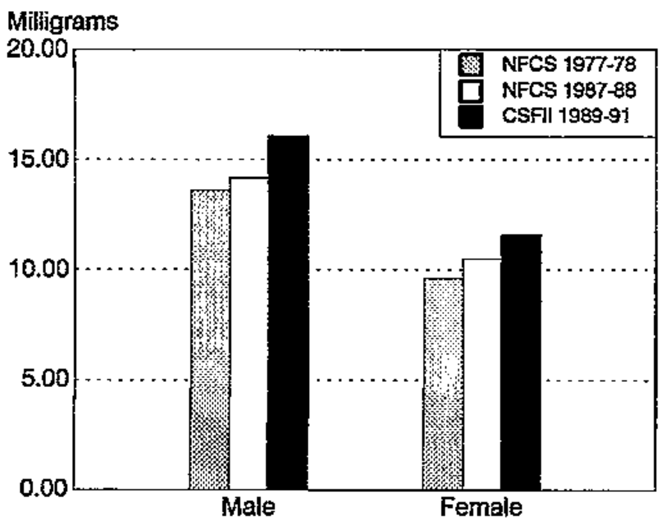

Figure 6-15. Daily mean intake of iron of people 20 years of age and older, over 3 days, by sex, 1977-78, 1987-88, and 1989-91

NOTE: Data are from table A.F6-15 in appendix VA.

SOURCE: USDA, NFCS, 1977-78; NFCS, 1987-88; CSFII, 1989-91.

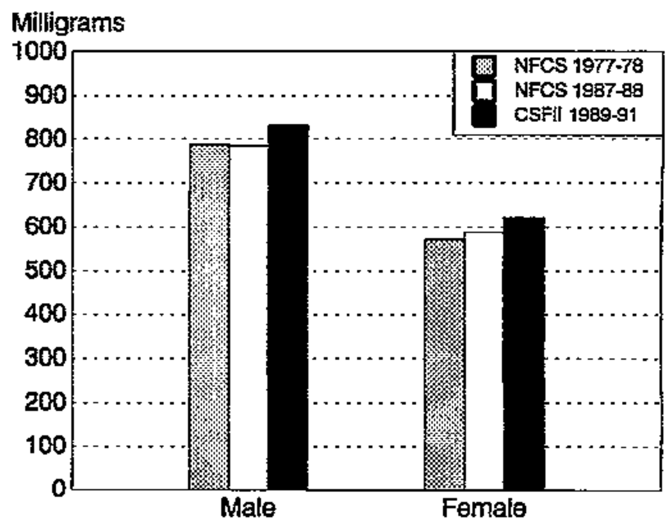

Figure 6-16. Daily mean intake of calcium of people 20 years of age and older, over 3 days, by sex, 1977-78, 1987-88, and 1989-91

NOTE: Data are from table A.F6-16 in appendix VA.

SOURCE: USDA, NFCS, 1977-78; NFCS, 1987-88; CSFII, 1989-91.

Meeting dietary recommendations and long-term health objectives

The 1990 *Dietary Guidelines for Americans* (USDA and HHS, 1990) and certain of the Healthy People 2000 objectives (HHS, 1991) are aimed at reducing health risks by targeting specific dietary changes. These include decreased intakes of total fat, saturated fatty acids, cholesterol, and sodium; increased intakes of fruits, vegetables, grain products, and foods rich in calcium; and moderate intake of sugars, salt, and alcohol. The food consumption data considered in this chapter provide some insight about how Americans' intakes of foods and nutrients compare with these recommendations and objectives.

Healthy People 2000 Objective 2.5 calls for reducing total dietary fat intake to an average of ≤30% of calories and saturated fatty acid intake to <10% of calories among people 2 years of age and older (HHS, 1991). Data from NHANES III 1988-91 indicate that median intakes of total fat are greater than 30% of calories for age, sex, and racial/ethnic groups over 2 years of age. Median total fat intakes for these groups were about 34%. Data from CSFII 1989-91 suggest that fewer than 20% of children 6-11 years of age and adolescents 12-19 years of age and only 21-25% of adults 20 years of age and older are consuming diets with ≤30% or less of the calories from total fat. Additionally, data from NHANES III 1988-91 show that median saturated fatty acid intakes provide about 12-13% of calories, above the target of <10% of calories.

Results in published papers support these findings. For example, the Centers for Disease Control and Prevention (CDC, 1994) and the Healthy People 2000 Nutrition Objectives Work Group (Lewis et al., 1994) also analyzed the NHANES III 1988-91 data and reported that total fat and saturated fatty acids provided on average 34% and 12% of calories, respectively, for people 2 years of age and older. In addition, those papers also reported a slight reduction in total fat intakes compared with those found in NHANES II 1976-80. In the late 1970s, total fat and saturated fatty acids provided 36% and 13% of calories, respectively (CDC, 1994; Lewis et al., 1994). The upper limits of the recommendations for total fat and saturated fatty acid intakes are maximum individual goals. Therefore, the mean or median intakes will have to be below 30% of calories for total fat and below 10% for saturated fatty acids if the U.S. population is going to meet these recommendations.

Median cholesterol intakes were within the recommended range (<300 mg/d) for non-Hispanic white males and for females in all age and racial/ethnic groups in NHANES III 1988-91. Median cholesterol intakes were above 300 mg/d for non-Hispanic black and Mexican-American males 16-19 and 20-59 years of age in NHANES III 1988-91. Mean cholesterol intakes in NHANES III 1988-91 (McDowell et al., 1994) were higher than the medians reported here and were often above 300 mg/d for males 12 years of age and older in all three racial/ethnic groups.

High sodium intake has been associated with increased risk for hypertension. Current status with regard to meeting Healthy People 2000 Objective 2.9 to reduce sodium intake (HHS, 1991) was discussed earlier in this chapter (see "Discretionary Salt Use").

Healthy People 2000 Objective 2.6 specifies that people consume 5 or more servings of fruits and vegetables (including legumes) and 6 or more servings of grain products every day (HHS, 1991). This objective reflects the recommendation shown in the 1990 *Dietary Guidelines for Americans* (USDA and HHS, 1990) and the Food Guide Pyramid (USDA, 1992) to eat a minimum of 2 servings of fruit, 3 servings of vegetables, and 6 servings of grain products every day.

Vegetables and fruits are consumed in many forms, and estimating of intake has been difficult. NCI and USDA have developed methodologies for quantifying consumption of fruits and vegetables (Krebs-Smith et al., in press a). Use of these methodologies for analyzing data from CSFII 1989-91 provided an estimate of 4 servings per day as the mean intake of fruits and vegetables in the adult U.S. population (Cleveland et al., 1995; Krebs-Smith et al., in press a; Lewis et al., 1994). The definition of fruits and vegetables used for this estimate included fruits and vegetables in mixed dishes but excluded fruits and vegetables in potato chips, condiments, and candies. Although the estimate of 4 servings per day may imply that the U.S. population is not far below Healthy People 2000 Objective 2.6 and the recommendations in the 1990 *Dietary Guidelines for Americans*, additional analyses indicate that fewer than one-third of people 20 years of age and older met the target of 5 or more servings per day. More than half of adults consumed less than 1 serving of fruit daily. Dietary fiber intakes of adults in NHANES III 1988-91 were also consistently below 20 g/d (table 6-18). Preliminary analyses from NCI suggested that the majority of children and adolescents also do not consume 5 servings of fruits and vegetables daily (Krebs-Smith et al., in press b; Lewis et al., 1994).

Low intakes of calcium have been associated with higher risks for osteoporosis, hypertension, and colon cancer (NRC, 1989b). Healthy People 2000 Objective 2.8 calls for an increase in calcium intake so that 50% of youth 12 through 24 years of age and 50% of pregnant and lactating women consume 3 or more servings of calcium-rich foods daily (about 900 mg calcium) and at least 50% of people 25 years of age and older consume 2 or more servings daily (about 600 mg calcium) (HHS, 1991). Median intakes from NHANES III 1988-91 (table 6-21) suggest that more than 50% of non-Hispanic black males 12-15 years of age and non-Hispanic white, non-Hispanic black, and Mexican-American females 12-15 and 16-19 years of age consume fewer than 3 servings of calcium-rich foods daily. Mean calcium intakes of pregnant non-Hispanic black females may be low (table 6-24). Although mean calcium intakes for pregnant non-Hispanic white and Mexican-American females were higher than those of pregnant non-Hispanic black females, this does not mean that substantial proportions of females in either of those groups are consuming 3 or more servings of calcium-rich foods daily. More than 50% of females 20-59 years of age and 60 years of age and older in the three racial/ethnic groups and more than 50% of non-Hispanic black males 60 years of age and older in NHANES III 1988-91 failed to consume 2 or more servings of calcium-rich foods daily.

Summary of findings

Data on food consumption in CSFII 1989-91 provided an indication of the percentage of people who used foods categorized by commodity groups over a 3-day period. Virtually all people reported using grain products. Mixtures, mainly grain, a category that included such items as pizza, enchiladas, and egg rolls, were consumed by higher percentages of children and adolescents than by adults. Consumption of white potatoes was reported by about 70% or more of people. Higher percentages of adults than children and adolescents reported using most categories of vegetables. Only 59% of black males 20 years of age and older reported eating fruit during the 3 days of dietary data collected in CSFII 1989-91, and about 70% of adolescent males and females, white adult males, and black adult females reported eating fruits. Higher percentages of adults reported consuming fruit with each increment in income level, but, regardless of income level, higher percentages of adult females than males reported consuming fruits. Additional analyses have indicated that, on average, the general population of the United States consumes 4 servings of fruits and vegetables per day. However, fewer than one-third of the U.S. adult population consumes 5 or more servings per day, as recommended in the Healthy People 2000 Objective 2.6.

Higher percentages of adults of both sexes reported consuming beef and fish and shellfish at each increment in income category, whereas percentages of adults who reported use of poultry and pork were similar across income levels. The highest percentages of adults reporting consumption of eggs, including whole eggs, egg substitutes, and eggs in other forms, were in the income category <131% of poverty, with higher percentages of black adults than whites reporting use of eggs and egg products when all income categories were combined. Use of total fats and oils, table fats, and salad dressings was reported by higher percentages of adults at each increment in income category. Higher percentages of white than black adults reported using salad dressings.

Notable differences were observed among types of milk consumed by black and white adults, with higher percentages of black adults consuming whole milk and higher percentages of white adults consuming low-fat and skim milks. The highest percentage of adults using whole milk was in the <131% of poverty category; with each increment in income level, the percentage of adults using whole milk decreased. Higher percentages of adults than children and adolescents reported using skim milk, whereas higher percentages of children and adolescents reported using whole milk. The highest percentages of users of regular fruit drinks and ades were among children, and the highest percentages of users of regular soft drinks were among adolescents and young adults. Higher percentages of adults than adolescents or children reported use of low-calorie carbonated soft drinks. Higher percentages of adults in higher than in lower income categories reported using low-calorie soft drinks; higher percentages of females than males reported using these products at each income level.

Analysis of data on nationally representative samples in NHANES III 1988-91 and CSFII 1989-91 suggests that about 9-13% of individuals living in low-income families and households experience some degree of food insufficiency and that the prevalence may be higher in Mexican Americans and non-Hispanic blacks than in non-Hispanic whites. The samples for these surveys do not include certain groups at higher risk of food insufficiency, such as homeless people, migrant workers, American Indians living on reservations, and some institutionalized people. Surveys that add to the information from NHANES III 1988-91 and CSFII 1989-91 are needed to evaluate the extent of food insufficiency in the United States.

Median intakes in NHANES III 1988-91 and HHANES 1982-84 for food energy, protein, vitamins, and minerals ranged from near the RDAs to several-fold greater than the RDAs for infants 2-11 months of age. These analyses excluded breastfed infants, and the high intakes reported for infants may reflect the levels of nutrients in infant formulas.

Analysis of data from NHANES III 1988-91 and HHANES 1982-84 indicated that median intakes of total fat and saturated fatty acids as a percentage of calories were generally higher than recommended amounts for children 3-11 years of age, adolescents, and adults. Median cholesterol intakes were higher than recommended levels for non-Hispanic black and Mexican-American males 16-59 years of age. Median sodium intakes from food alone were also above RDA values for children 6-11 years or age, adolescents, and adults. Mean intakes of these nutrients were also above RDA values for American Indians 45-74 years of age living in three States. Lowering the intakes of these nutrients is a goal in the Healthy People 2000 objectives and in the 1990 *Dietary Guidelines for Americans*.

Median food energy intakes in NHANES III 1988-91 and HHANES 1982-84 were lower than 1989 Recommended Energy Intakes for children, adolescents, and adults. This finding suggests underreporting of food consumption, recommendations for food energy intakes that are higher than energy expenditures of many people, and/or low energy expenditures, rather than inadequate food energy intakes.

Median intakes from food for vitamin A, vitamin E, vitamin B_6, zinc, and copper were below RDA or ESADDI values for most age, sex, and racial/ethnic subgroups. In addition, median intakes of several other nutrients were below RDA values for certain age, sex, and racial/ethnic subgroups. Median iron intakes were below the RDA value for children 1-2 years of age, adolescent females, and adult females 20-59 years of age. Median calcium intakes were below RDA values for non-Hispanic black children 1-11 years of age, all adolescents except non-Hispanic white males 12-15 years of age, all females 20-59 years of age and 60 years of age and older, non-Hispanic black males 20-59 years of age, and all males 60 years of age and older. Median intakes of magnesium were also below RDA values for all adolescents and adults except adolescent males 12-15 years of age. Median folate intakes were below RDA values for non-Hispanic black females 16-19 and 20-59 years of age and for non-Hispanic black and Mexican-American females 60 years of age and older. Median intakes of thiamin, riboflavin, and niacin were below RDA values for Hispanic females 20-59 and 60-74 years of age in HHANES 1982-84, suggesting that the consumption of enriched grain products may be relatively low in these groups. That finding, however, was not generally observed in Mexican-American adult females in NHANES III 1988-91.

With few exceptions, the occurrence of median nutrient intake below the RDAs was similar for younger adults (20-59 years of age) and older adults (60 years of age and older). Median calcium intakes were below the RDA for males and females 60 years of age and older, but this was also the case for females 20-59 years of age. Median total fat and saturated fatty acid intakes were above recommended levels in younger and older adults; however, median cholesterol intakes were below 300 mg/d for males as well as females 60 years of age and older.

Substantial proportions of the U.S. population use dietary supplements, as indicated by data from surveys including the NHIS 1986, NHIS 1987, NHIS 1992, NHANES I 1971-74, NHANES II 1976-80, NHANES III 1988-91, and the 1991 Longitudinal Followup to the 1988 National Maternal and Infant Health Survey. Data from these surveys were not compared directly because of methodological differences among the surveys. NHANES III 1988-91 data suggested that the prevalence of the use of all vitamin-mineral supplements was about 40% or higher for children 1-5 years of age and females 30 years of age and older. For females, the prevalence of use increased with age, particularly in those 50 years of age and older. About 31-37% of males 30 years of age and older reported taking vitamin-mineral supplements in the past month, but the prevalence of use did not increase with age to the extent that it did in females. Among racial/ethnic groups, prevalence of use was highest for non-Hispanic white males and females.

Gaps in knowledge

Food consumption

Foods are consumed in a wide variety of forms and mixtures. A great deal of specific information about foods consumed was collected in the NHANES III 1988-91 and CSFII 1989-91, as evidenced by the inclusion of approximately 6,500 food identification numbers in the Survey Nutrient Data Base used with food consumption data from those surveys. Food sources of nutrients need to be captured for foods in the form(s) in which the foods are eaten. Obtaining appropriate information to use in estimating intakes of specific foods and food sources of nutrients has been difficult. For example, obtaining quantitative estimates of the consumption of specific grain products such as rice is problematic because rice is consumed not only as a simple food but as a component of complex foods (e.g., multigrain ready-to-eat cereals and rice pudding) and mixed dishes (e.g., casseroles, sushi, and frozen entrees). Obtaining quantitative estimates of the consumption of mixed dishes (e.g., pizza) is especially problematic with the current system of aggregating about 6,500 seven-digit food identification numbers into approximately 200 three-digit food identification numbers.

A system is needed that provides a degree of aggregation that is intermediate between the Survey Nutrient Data Base seven-digit food identification numbers, which are too detailed for estimation of intakes of specific foods, and the three-digit food identification numbers, which provide too little detail. Generic groupings of food mixtures could be developed to address this need. For example, classifying pizza as "pizza" rather than including it under "mixtures, mainly grain" or listing it by specific type of pizza (e.g., pepperoni, cheese, mushroom) would make it possible to determine calcium and total fat intakes provided by pizza for specific age and sex groups in the population. This type of information would lend itself to the formulation of more specific dietary recommendations targeted to certain population subgroups.

Little information is available about associations of food consumption patterns with intakes of nutrients such as total fat and calcium. Likewise, little is known about the contributions to nutrient intakes of prepared foods and foods consumed away from home. Sodium and total fat contents may be higher for prepared foods and foods consumed away from home and cannot be modified easily by the consumer. Greater knowledge about these aspects of food consumption would enhance nutrition education efforts.

More detailed information is needed to quantify water consumption, including whether the water is bottled water or tap water and, for tap water, whether the origin is a city water supply, a well, or other source. In addition to water consumed as drinking water, information is needed for type and amounts of water used to prepare beverages and foods. When information about intake of nutrients from water is needed, data are needed for amounts of mineral elements in water in addition to information on amounts of water consumed. Because mineral concentrations in water supplies vary among localities, region-specific data on water composition are required.

The information about consumption of alcohol and alcoholic beverages that was used for this report is insufficient. The most likely cause of inaccurate intake information is underreporting. Because not all people consume alcoholic beverages, in contrast to most other categories of foods, estimates of intakes of alcohol are more accurate when statistics are calculated on the basis of drinkers only. Improvements in consumption information, such as more complete reporting by drinkers, more specific descriptions of beverages consumed, and analysis of alcohol consumption by users only, are needed to evaluate the effects of alcohol intake on health and disease status in the U.S. population.

Although national surveys such as NHANES III 1988-91 and CSFII 1989-91 have provided estimates of the prevalence of food insufficiency in the U.S. population, the nature of the insufficiency (i.e., chronic, cyclic, or intermittent) is not known. Identifying factors that contribute to the occurrence of food insufficiency is difficult. Also, these surveys do not include certain groups at higher risk of food insufficiency, such as homeless people, migrant workers, American Indians living on reservations, and some institutionalized people. Finally, knowledge is lacking about long-term effects of food insufficiency on nutritional status including anthropometric indicators and health status.

Comparing data on per capita food consumption (disappearance data), individual food consumption (survey data), and estimates of consumption derived from direct analysis of core foods is very difficult because food consumption data must be broken down to the individual ingredient level and converted to the commodity data used for the disappearance data. Having a set of common food categories and descriptors for those categories that could be applied to all of these types of data would permit more comparisons between sources. USDA's Food Grouping System is being developed to connect these data sources. The usefulness of the system is currently limited by the incomplete automation of the system.

In addition to gaps in knowledge about food consumption, the absolute and relative accuracy of dietary intake data and the effects of inaccurate data on estimates of consumption of specific foods and nutrient intakes are unknown. The underreporting of total food consumption has been documented in several studies, which have found that it occurs to a greater extent in women and overweight people than in other population subgroups. Because it is also unknown whether underreporting occurs for all foods or is more likely to occur for certain foods, the degree of bias in nutrient intake is difficult to predict. Cultural differences in the perception of food consumption may also lead to inaccuracies in reporting.

Nutrient intakes from food

The criteria available for evaluating dietary adequacy are limited. Information on mean requirements and on distributions of requirements for most nutrients for most age-sex groups appears to be scarce, which limits the use of the probability approach for assessing the dietary adequacy of populations. Even less is known about criteria for identifying risk of excessive intakes by populations and population subgroups. For example, except for some case reports of excessive vitamin and mineral intakes, data on levels of nutrient intake resulting in adverse effects are not found in the scientific literature.

The consistently low values for reported food energy intakes are of particular concern. If the low values reflect underreporting, estimates of intakes of nearly all other nutrients are probably affected. Interpretation and comparison of data from NHANES III 1988-91 and CSFII 1989-91 have been very difficult because of the large differences in mean food energy intakes (about 300 kcal/d for adults) reported in the two surveys. This suggests that the completeness of data collection differs for the two surveys or that interview methodologies differ.

Dietary supplement use

Data collected in several recent surveys suggest that a substantial portion of the population uses dietary supplements. However, national surveys have not yet provided quantitative estimates of total nutrient intakes based on food consumption plus dietary supplements, and estimates of nutrient intakes based on food consumption alone may underestimate nutrient intakes for many people. If risk of excessive nutrient intakes is to be evaluated in the NNMRRP, information on total nutrient intakes, including intakes from dietary supplements, is essential. Information on total nutrient intakes may also aid in unraveling incongruities between dietary intake information and 1) biochemical indices of nutritional status and 2) nutrition-related health conditions.

Recommendations

- Develop a set of common food categories that can be applied to per capita food consumption (disappearance) data, individual food consumption data from surveys, and estimates of consumption made from direct analysis of core foods to permit more comparisons among the various data sources.

- Reaggregate foods into categories that will permit the determination of the food sources of nutrients in the forms in which they are eaten, particularly for mixtures (e.g., pizza). Continued development of an alternative system, such as the Food Grouping System, will permit the analysis of data on consumption of the specific ingredients and the regrouping of ingredients for specific purposes.

- Continue developing the USDA Nutrient Data Base for Trend Analysis so that data on food consumption and nutrient intakes from future cycles of the NHANES and CSFII can be compared with other data over time.

- Implement the dietary assessment guidelines recommended by working groups at a consensus workshop on dietary assessment for nutrition monitoring and tracking the Healthy People 2000 objectives (Wright et al., 1994) and by other expert groups to improve comparability among dietary intake methods used in NNMRRP surveys.

- Develop methods for analyzing food consumption patterns in order to identify patterns that may be associated with health and disease status.

- Collect more comprehensive information on the consumption of preprepared foods and food consumption away from home by individuals and households.

- Continue to relate food consumption data to the Food Guide Pyramid as a way to evaluate changes in dietary behavior.

- Support research to determine the extent of underreporting of food consumption that occurs in all nutrition surveys, improve food consumption survey methodology and instruments that minimize underreporting, and develop analytic approaches to adjust for underreporting.

- Develop a standard set of food-sufficiency questions that can be used in NNMRRP surveys and surveillance systems.

- Identify groups at risk for food insufficiency and determine which factors place them at risk.

- Analyze data on food insufficiency that include information on the nature (chronic, cyclic, or intermittent) of the insufficiency; on contributing factors; and on effects on nutritional status, including anthropometric indicators, and health status.

- Continue to develop culturally sensitive dietary assessment methods.

- Develop instruments to better capture total water intake and alcohol intake.

- Determine distributions of nutrient requirements, giving higher priority to groups of people who may be at nutritional risk and whose numbers are increasing in the population (e.g., elderly people).

- Calculate total nutrient intakes from food plus dietary supplements for people who use dietary supplements.

- Develop criteria for evaluating high nutrient intakes.

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Chapter 7

Nutritional Status and Nutrition-Related Health Measurements

Introduction

Interrelationships among diet, health, and disease are complex. Many variables measured in the surveys and surveillance systems of the National Nutrition Monitoring and Related Research Program (NNMRRP) provide information on dietary intake, nutritional status, and health conditions that can be used to examine associations between diet and prevalence of nutrition-related health conditions (fig. 7-1).

The extent of the impact of diet on health in the United States can be estimated by the number of physician office visits for nutrition-related services over time. In 1989-91, over 2 billion visits were made to non-Federal, office-based physicians. Of these, about 114 million visits included weight-reduction counseling, 78 million included cholesterol measurement, and 65 million included cholesterol-reduction counseling. (The visits for these three services are not additive; there can be and likely are visits that include more than one of these services.) Overall, about 3-6% of physician office visits included these nutrition-related services. Table A.T7a in appendix VA provides more detailed information from the National Ambulatory Medical Care Survey (1989-91) about these office visits, by age, sex, and race.

Economic costs in 1986 attributable to obesity and diseases associated with obesity (cardiovascular disease, hypertension, non-insulin-dependent diabetes mellitus, gallbladder disease and cholecystectomy, and colon and postmenopausal breast cancer) were estimated to be more than $39 billion (Colditz, 1992). A similar analysis for the cost of obesity in 1990 produced an estimate of nearly $69 billion (Wolf and Colditz, 1994). The total cost of nutrition-related health conditions is even higher than those estimates because economic costs resulting from maternal and childhood undernutrition (e.g., low birth weight and anemia) and osteoporosis were not included in either estimate.

Nutritional status, nutrition-related health status, and criteria for assessment

The term nutritional status is defined as the condition of a population's or an individual's health as influenced by the intake and utilization of nutrients and nonnutrients (LSRO, 1989). In this report, the term health status is used to refer to a population's status with respect to physical state or disease condition. For nutrition monitoring purposes, it is most useful to describe nutritional status and nutrition-related health status in terms of prevalence—the number of people with impaired nutritional status, a particular disease, or other condition in a given population at a specified point in time—generally expressed as percentage in this report.

It is useful to examine the associations of the entire spectrum of nutritional status, from deficiency to toxicity, with health status. Terms used to describe different aspects of nutritional status—including undernutrition, overnutrition, nutrient deficiency, marginal nutritional status, nutritional imbalance, nutrient excess, and toxicity—are defined in the glossary (app. I).

Available methodologies

Assessment of nutritional status is based on estimates of nutrient intakes of individuals and measurements

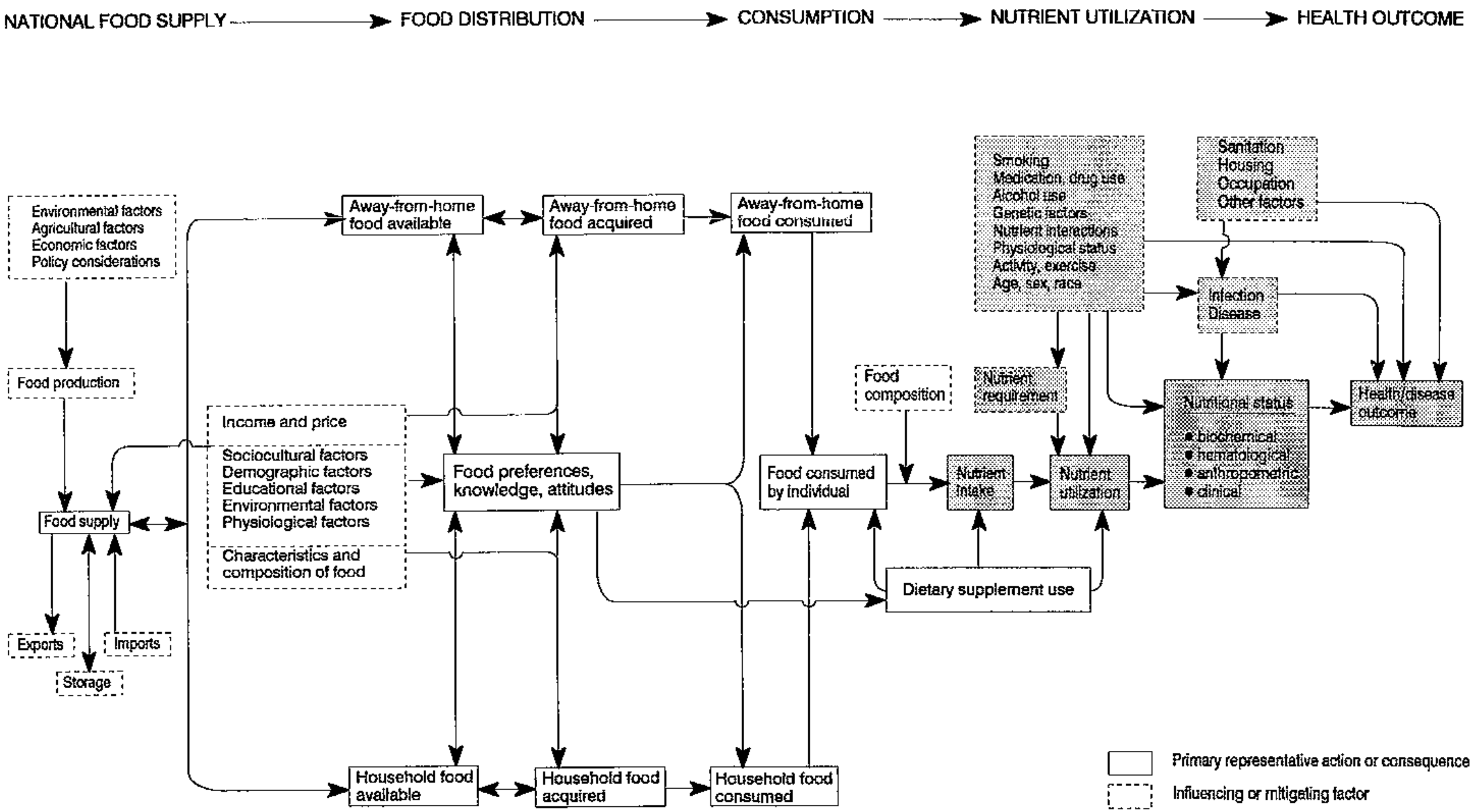

Figure 7-1. General conceptual model for food choice, food and nutrient intake, and nutritional and health status (see text for explanation)

SOURCE: LSRO (1989).

of physiological indicators in those same individuals. The values are used to identify the possible occurrence, nature, and extent of impaired nutritional status. The evaluation of nutritional status in surveys and surveillance systems includes estimating dietary intakes of specific food components and taking anthropometric, biochemical, hematological, and clinical measurements. For a comprehensive review of methodologies for assessing nutritional status, see Gibson (1990).

Nutrition-related health conditions are assessed by measuring nutritional-status indicators and the prevalence of the health conditions of interest in a population. Health-condition assessment typically includes clinical evaluations, such as the measurement of blood pressure, and application of interpretive criteria, such as the reference limits or cutoff values used to define blood pressure status.

Interpretive criteria

Considerations related to response rates, sample sizes, and relative standard errors were discussed in chapter 2. As in all aspects of the interpretation of NNMRRP data, these considerations are of fundamental concern in the interpretation of data on nutritional status and nutrition-related health status. Response rates for surveys are given in appendix IV, and detailed descriptive statistics are given in appendix VA.

To ensure the validity of assessments of nutritional status, all methods used for the assessments should have a predictable relation to nutritional status, be applicable in large-scale surveys, and be standardized and used with appropriate quality-control procedures. It is important to know the forms of a nutrient that are being measured by the method(s) used as well as any compounds that interfere with the biochemical analysis of the nutrient. Likewise, factors other than nutrition and diet that may lead to changes in the indicators and, thereby, confound an analysis should be identified, and their potential effects should be evaluated.

A major consideration in estimating the prevalence of impaired nutritional or health status is how to define reference distributions, reference limits, and cutoff values for the various indicators that are related to the occurrence of impaired nutritional status. Appropriate interpretation of prevalence data requires an understanding of the source and meaning of the values to which the data are compared and their applicability to different methods and across populations (LSRO, 1989). The Expert Consultants and LSRO have used established cutoff values associated with national surveys or published in the scientific literature in their interpretation of the data on nutritional status and nutrition-related health status. Criteria used to evaluate a specific index of nutritional status or nutrition-related health status are discussed in the sections of this chapter that relate to such indices.

Types and sources of data

A vast amount of data on nutrition-related health status was provided for the TRONM. Because the amount of data exceeded what could be included in this chapter, the Expert Consultants and LSRO had to select the most appropriate and representative data for inclusion. The overall criteria for data selection were that the data

- were collected in surveys that targeted nationally representative samples;
- were measured objectively, rather than self-reported;
- used the same cutoff values or reference intervals as those used for surveys that targeted nationally representative samples;
- were reported according to categories suggested by the Interagency Board for Nutrition Monitoring and Related Research (IBNMRR) for age, racial or racial/ethnic, and socioeconomic descriptors; and/or
- were collected recently.

Exceptions or additions were made in some cases when data were available only from a survey or surveillance system in which a special population was targeted or only self-reported data were available. The types and sources of data used in this chapter are shown in table 7-1. Selected data are presented in tables and graphs in this chapter, and more detailed data can be found in tables in appendix VA. The pertinent appendix tables appear in the same order as the graphs and tables in the chapter, and their numbers match the figure or table they support.

Table 7-1. Types and sources of data on nutritional status and nutrition-related health status used in chapter 7 of the *Third Report on Nutrition Monitoring*[1]

Type of data	Source of data
Nutritional status (anthropometric, biochemical, hematologic, and clinical indicators)	NHANES III 1988-91 (CDC, NCHS)
Nutrition-related health status (anthropometric, biochemical, hematologic, and clinical indicators)	NHANES III 1988-91 (CDC, NCHS) HHANES 1982-84 (NCHS) NHANES II 1976-80 (NCHS) NHANES I 1971-74 (NCHS) NHES I 1960-62 (NCHS) National Ambulatory Medical Care Survey, 1989-91 (CDC, NCHS) Pediatric Nutrition Surveillance System, 1973-92 (CDC, NCCDPHP) Pregnancy Nutrition Surveillance System, 1992 (CDC, NCCDPHP) Survey of Heights and Weights of American Indian School Children 1990-91 (IHS and CDC) National Vital Statistics Program, 1991 (CDC, NCHS)

[1]CDC, Centers for Disease Control and Prevention; NCHS, National Center for Health Statistics; NCCDPHP, National Center for Chronic Disease Prevention and Health Promotion; IHS, Indian Health Service.

SOURCE: LSRO, 1994.

Nutritional status

Data on anthropometric, biochemical, hematological, and clinical indicators of nutritional status were collected in NHANES III 1988-91. Anthropometric measurements and biochemical and hematologic assessments included in NHANES III were summarized in the *Plan and Operation of the Third National Health and Nutrition Examination Survey, 1988-94* (NCHS, 1994). Unlike previous NHANES, the physician's examination component of NHANES III 1988-91 did not screen for overt clinical signs of nutritional deficiencies such as keratomalacia, pellagrous dermatitis, or follicular hyperkeratosis, which are uncommon in the United States. Instead, certain nutrition-related health conditions were assessed in NHANES III 1988-91, including overweight, cardiovascular disease and related risk factors, hypertension, diabetes mellitus, osteoporosis, anemia, dental conditions, and gallbladder disease. Analyzing the dietary and nutrition-related data together with the physical-examination data from the entire 6-year period covered by NHANES III 1988-94 may provide further insights into the relationship between nutrition and health in the population and in subgroups at increased risk.

Analyses of NHANES III data included in this report are for Phase 1 of the survey (1988-91). Although the NHANES III 1988-91 population is a nationally representative sample of the U.S. population, Phase 1 provides only half of the data that will be available from the survey. More precise estimates may emerge from analyses of the full 6-year complement of data. The Expert Consultants and LSRO interpreted analyses based on 3 years of data, with the expectation that these data will be combined with Phase 2 data and analyzed for the fourth report on nutrition monitoring.

Data on the prevalence of low serum vitamin A levels and low hemoglobin concentrations in the NHANES III 1988-91 population were examined by the Expert Consultants and LSRO for this report. Data that were collected on other biochemical and hematological indicators will be included in later reports.

Nutrition-related health conditions

The nutrition-related health conditions considered in this report are low birth weight, growth status in children, overweight in adults, elevated blood lipid levels as a risk factor for coronary heart disease, hypertension, and osteoporosis. Data on the occurrence of low birth weight were provided by the National Vital Statistics Program for the general population and by the PNSS for a population of women at higher risk. Data on growth status in children were examined from a nationally representative sample from NHANES III 1988-91, a population of high-risk children from the PedNSS, and American Indian children from the Survey of Heights and Weights of American Indian School Children 1990-91. Growth-status data for Mexican-American children from NHANES III 1988-91 and HHANES 1982-84 were compared. Data on prevalence of overweight (high body mass index (BMI)), elevated blood lipid levels, hypertension in adults, and distributions of mean bone mineral density for the proximal femur for men and women 20 years of age and older were from NHANES III 1988-91. (BMI is defined as weight in kilograms divided by the square of height in meters.)

Linking dietary intake and nutritional status with health status

Establishing reliable links among dietary intake, nutritional status, and health status is possible when data on intake and nutritional and health status have been collected from a single sample of people considered to be representative of the U.S. population. Rarely are dietary and health data collected in the same survey; for example, nutritional- and health-status data are collected in the PNSS and the PedNSS, but dietary data are not. Conversely, extensive dietary data that may be representative of usual dietary intake are collected over multiple days in the CSFII series, but data on nutritional and health status are not. In the HANES series, extensive data on nutritional- and health-status indicators are collected, and dietary data are collected by one 24-hour recall and food frequency questionnaires. Because dietary, nutritional, and health status all represent status achieved over time, a single day's dietary intake is not considered representative of usual dietary intake and must be interpreted very cautiously in attempts to link dietary intake and nutritional status with health status. Although single-day data collected from sufficiently large samples may reasonably estimate the mean intake for a population, data based on a single day's intake usually result in a distribution that is flatter and wider than the population it represents (Beaton et al., 1983; Liu et al., 1978; Todd et al., 1983). Prevalence of high or low intakes is overestimated from this type of distribution (Hegsted, 1972), and associations of nutrition-related health conditions with high or low dietary intakes based on data from 1 day may be misleading.

No single component of the NNMRRP is perfectly suited for linking food consumption to nutrition-related health status. Differences in purposes, designs, and protocols among the program's surveys and surveillance systems limit the feasibility of combining their data. However, by using recommended guidelines for variance estimation and statistical reporting standards coupled with the use of common population descriptors and cutoff values, comparisons among surveys are feasible.

Appropriate uses and limitations of the data

Criteria required to establish causal significance between dietary intakes and disease or health status were identified in chapter 2 (see "Appropriate Uses of Data"). Data from the cross-sectional surveys and continuous surveillance systems in the NNMRRP can be used appropriately to generate the means and distributions of individual variables such as anthropometric or biochemical indicators. These data may be compared with appropriate reference limits or cutoff values to estimate the prevalence of a condition, such as high or low BMI or low serum vitamin A concentration. Although examination of single variables is a useful means of estimating prevalence, examination of a single indicator is rarely, if ever, an adequate basis for assessing any parameter of nutritional status in the U.S. population.

Concurrent examination of multiple indicators of nutritional status is needed to identify and evaluate associations among dietary intakes, indicators of nutritional status, and indicators of nutrition-related health status. Associations between dietary intakes and health status cannot be used to infer causality because of the considerable heterogeneity of diets within the U.S. population and the presence of potentially confounding factors, that is, variables that have real but not causal associations with both diet and health status. For example, diet quality is highly correlated with life-style factors, such as cigarette smoking and alcohol consumption, and with low socioeconomic status, which, in turn, are related to higher risk of disease. Associations identified in analyses that do not account for possible confounding factors may well be misleading. It is also possible that health status has caused a change in dietary intake or that some associations result solely from chance. Finally, large intercorrelations (multicollinearity) among intakes of specific nutrients and food groups often complicate the interpretation of data in attempts to relate dietary intake to health status.

Cross-sectional data collected under similar conditions over time can be used to indicate the direction and magnitude of change in associations between diet and health. However, to demonstrate that a dietary factor associated with a disease is causally related to the development of that disease, a clear temporal relationship must be shown between dietary intake and the subsequent development of the disease in the same individuals. In cross-sectional studies, where associations are made at a single point in time, a temporal relationship cannot be established, and identification or inference of causal relationships is not possible for associations between dietary intake and health status (LSRO, 1989). Data presented in this chapter are cross-sectional and, therefore, apparent associations should be interpreted with caution.

Assessing change over time

As discussed in chapters 2 and 6, assessing change over time requires that definitions of study populations and the measurement procedures used in various surveys be identical from survey to survey and that sampling procedures be equivalent. Within surveys, a major consideration in determining whether comparisons can be made for data collected at different times is whether the methodology used to measure anthropometric, biochemical, hematological, and clinical indices has changed over time. As noted in the second report on nutrition monitoring (LSRO, 1989), it is desirable and appropriate to incorporate improved methods, instrumentation, and standardization procedures into surveys to improve the analytical quality of the data. However, the introduction of new methodology may result in systematic changes in the data that could erroneously suggest that some real change is occurring over time (Yetley and Johnson, 1987). Procedural and methodological differences between surveys or between cycles within surveys should be assessed before data are compared, even when no deliberate changes were made in procedures or methods used at different times in a survey. In this report, change was considered to suggest a trend if the same direction of change was observed over more than two time points.

Update of data on nutritional status and nutrition-related health conditions

In this section, levels of serum vitamin A (retinol) and of hemoglobin in the U.S. population are discussed as indicators of nutritional status. Anthropometric measures—low birth weight, indicators of growth status in children, and overweight in adults—and blood lipids, hypertension, and osteoporosis are evaluated under "Nutrition-Related Health Conditions."

Nutritional status

Biochemical indicator: serum vitamin A

Serum vitamin A concentration is controlled by homeostatic mechanisms over a broad range of body stores, and substantial changes in the concentration found in individuals occur only when vitamin A stores are very high or very low. Nonetheless, distributions of serum vitamin A concentrations are considered useful in evaluating the likely vitamin A status of populations (Joint WHO/UNICEF Consultation, 1994). The percentages of non-Hispanic white, non-Hispanic black, and Mexican-American males and females 4 years of age and older in the U.S. population who have serum vitamin A levels less than 20 µg/dL and between 20 and 29 µg/dL are summarized in table 7-2. These values were used as cutoff values based on guidelines for interpreting serum vitamin A in populations (Pilch, 1985). The cutoff values were derived from information based on vitamin A concentrations determined by a colorimetric method; however, their use also appears to be appropriate for data obtained by the high-performance liquid chromatography (HPLC) method used in NHANES III 1988-91 (Underwood, 1994).

At levels below 20 µg/dL, impairment of function, including impaired dark adaptation, night blindness, ocular lesions, and possibly impaired immune function, is likely, and serum levels of vitamin A are likely to increase with increased intake of vitamin A.

Table 7-2. Percentage of people 4 years of age and older with serum vitamin A <20 µg/dL and between 20 and 29 µg/dL, by sex, age, and race/ethnicity, 1988-91 (%)[1]

	Vitamin A <20 µg/dL			Vitamin A 20-29 µg/dL		
Sex and age in years	Non-Hispanic white	Non-Hispanic black	Mexican American	Non-Hispanic white	Non-Hispanic black	Mexican American
Male						
4-5	—	2.0*	2.0*	22.8	32.1	38.9
6-8	—	—	1.5*	15.8	21.9	21.5
9-11	—	1.2*	0.8*	7.2*	16.2	9.9
12-15	—	—	—	2.1*	5.9*	2.4*
16-19	—	—	—	—	—	0.7*
20-29	—	—	—	—	1.2*	—
30-39	—	0.4*	—	—	0.7*	0.9*
40-49	—	0.9*	—	—	1.2*	0.6*
50-59	0.3*	2.2*	—	0.3*	0.6*	2.8*
60-69	—	0.7*	1.5*	0.9*	1.8*	—
70-79	—	—	0.8*	0.3*	2.8*	0.8*
≥80	—	—	4.3*	0.5*	—	—
Female						
4-5	1.2*	1.0*	—	22.1	29.4	30.8
6-8	2.8*	1.1*	2.6*	14.6	19.4	18.5
9-11	—	—	—	6.9*	9.7*	11.9
12-15	—	—	—	—	2.6*	4.3*
16-19	—	0.9*	—	0.5*	6.6*	7.0*
20-29	—	—	—	0.4*	2.0*	3.5*
30-39	—	—	—	0.3*	5.0*	4.9*
40-49	—	1.0*	0.8*	0.8*	2.7*	2.9*
50-59	—	—	—	1.1*	—	2.1*
60-69	0.3*	—	0.4*	0.5*	2.3*	1.5*
70-79	—	1.4*	—	—	—	2.3*
≥80	—	—	—	0.3*	5.3*	—

[1]Data are from table A.T7-2 in appendix VA. Excludes pregnant females. At levels below 20 µg/dL, impairment of function, including impaired dark adaptation, night blindness, ocular lesions, and possibly impaired immune function, is likely, and serum levels of vitamin A are likely to increase with increased intake of vitamin A. With serum concentrations of 20-29 µg/dL, vitamin A levels may increase with increased intake. An increase is more likely for those with values of 20-24 µg/dL. In adults, but not in children, some impairment of function may occur when serum concentrations are 20-29 µg/dL (Pilch, 1985). An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; a dash (—) indicates that the observed percentage was 0.0.

SOURCE: HHS, NHANES III, 1988-91.

With serum concentrations of 20-29 µg/dL, vitamin A levels may increase with increased intake. An increase is more likely for people with values of 20-24 µg/dL. In adults more likely than in children, some impairment of function may occur when serum concentrations are 20-29 µg/dL (Pilch, 1985).

Serum vitamin A levels below 20 µg/dL were rarely found in any of the age, sex, and racial/ethnic groups in NHANES III 1988-91 (table 7-2). For children 4-11 years of age, serum vitamin A concentrations below 20 µg/dL were found in fewer than 3% of children in any racial/ethnic group. However, relatively high prevalences of vitamin A values of 20-29 µg/dL were found for children across all racial/ethnic groups. Prevalences were highest for children 4-5 years of age and dropped successively with each older age grouping (6-8 and 9-11 years of age). This pattern was previously noted in children in NHANES I 1971-74, NHANES II 1976-80, and HHANES 1982-84 (Pilch, 1985). Normal serum vitamin A levels appear to vary with age; serum levels are lower at birth and rise through childhood, reaching adult levels after puberty (Lewis et al., 1990). Thus, relatively lower concentrations of serum vitamin A in children, particularly younger children, are most likely normal, and different interpretive criteria should be developed to monitor the prevalence of suboptimal serum vitamin A levels in children.

Serum vitamin A levels below 20 µg/dL were very rare in males and females 16 years of age and older, with the possible exception of Mexican-American males 80 years of age and older. Fewer than 3% of males in any age or racial/ethnic category older than 12-15 years of age had serum vitamin A levels of 20-29 µg/dL. For females, serum vitamin A levels of 20-29 µg/dL were found in 5-7% of non-Hispanic black females 16-19, 30-39, and 80 years of age and older and of Mexican-American females 16-19 and 30-39 years of age.

Presence of concurrent infection was not assessed as part of the evaluation of vitamin A status for the TRONM. Vitamin A concentrations are known to be decreased by acute and underlying chronic infections, even in people with relatively normal body stores of vitamin A (Butler, et al., 1993; Filteau et al., 1993; Louw et al., 1992), and the presence of infections can confuse the interpretation of serum vitamin A concentrations. Analyses of vitamin A status controlling for the presence of infections are needed to provide a better basis for interpreting low serum vitamin A levels.

Serum vitamin A distribution curves do not usually correlate closely with concurrent dietary intake (Joint WHO/UNICEF Consultation, 1994). In NHANES III 1988-91, the median vitamin A intakes from food for children were greater than Recommended Dietary Allowance (RDA) values, and for adults, they were less than RDA values. (See ch. 6, "Current Data on Nutrient Intakes from Food.")

Excessive intakes of vitamin A have been associated with toxicity. Serum levels of retinyl esters, which may indicate vitamin A toxicity, were measured in NHANES III 1988-91, but the analyses were not completed in time for inclusion in this report. Analyses of serum levels of retinyl esters together with information on total vitamin A intake from food and dietary supplements are needed to provide useful information about the prevalence of excessive vitamin A intakes in the U.S. population.

Table 7-3. Centers for Disease Control and Prevention (CDC) criteria for low hemoglobin values, by age and sex (g/dL)

Age in years	Male	Female
0.5 - 1.9	11.0	11.0
2 - 4.9	11.2	11.2
5 - 7.9	11.4	11.4
8 - 11.9	11.6	11.6
12 - 14.9	12.3	11.8
15 - 17.9	12.6	12.0
≥18	13.6	12.0

SOURCE: CDC (1989).

Hematological indicator: hemoglobin concentration

Percentages of individuals with low hemoglobin levels in the U.S. population (from NHANES III 1988-91) are presented in this section. CDC criteria for anemia (table 7-3) were applied to age-sex subgroups across all racial/ethnic groups (CDC, 1989). PedNSS adjustment factors for altitude and PNSS adjustment factors for altitude and cigarette smoking were not applied to the NHANES III 1988-91 hemoglobin data presented in this chapter.

As shown in figures 7-2 and 7-3, for children, the percentages of low hemoglobin concentrations were highest for 1- to 2-year-olds, with 20% of non-Hispanic black children, 18% of Mexican-American children, and 12% of non-Hispanic white children having low hemoglobin levels. The percentages of low hemoglobin levels dropped in children 3-5 years of age and again in children 6-11 years of age across racial/ethnic groups but were considerably higher in non-Hispanic black children than in non-Hispanic white or Mexican-American children.

For adolescent males 12-19 years of age, prevalence of low hemoglobin concentrations was highest in non-Hispanic blacks. In females 12-19 years of age, non-Hispanic black females had the highest prevalence of low hemoglobin values (28%), followed by Mexican-American females (11%) and non-Hispanic white females (7%). In males, the age-related decrease in hemoglobin concentrations has been attributed to rapid growth rates and in females,

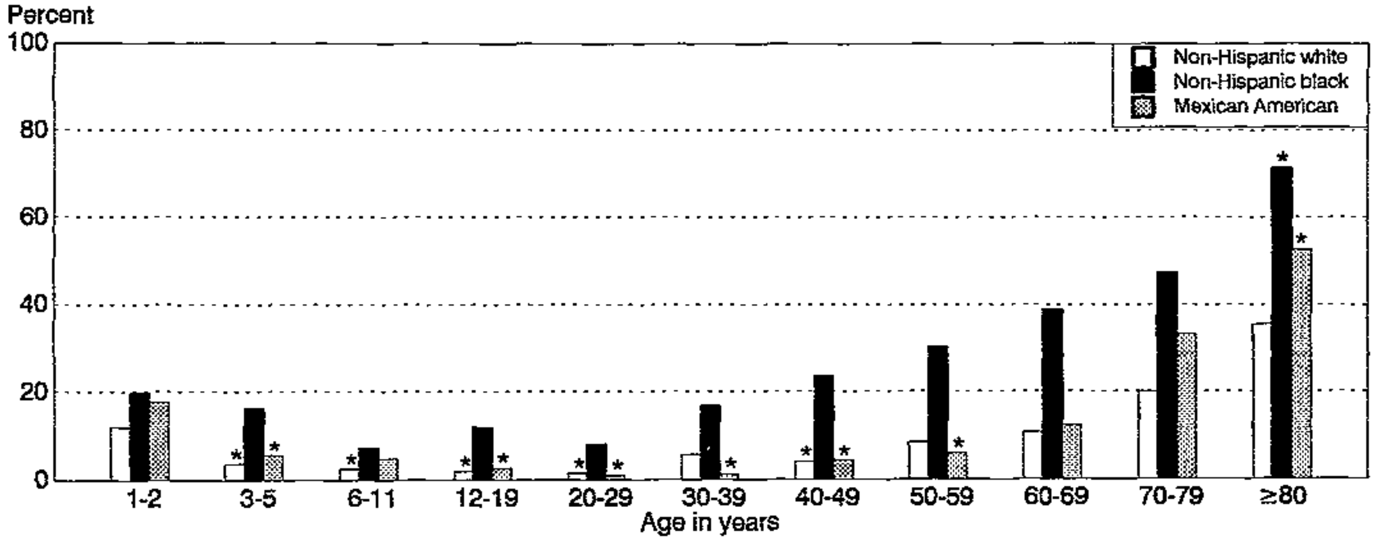

Figure 7-2. Percentage of males 1 year of age and older with low hemoglobin levels, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-2,3 in appendix VA. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

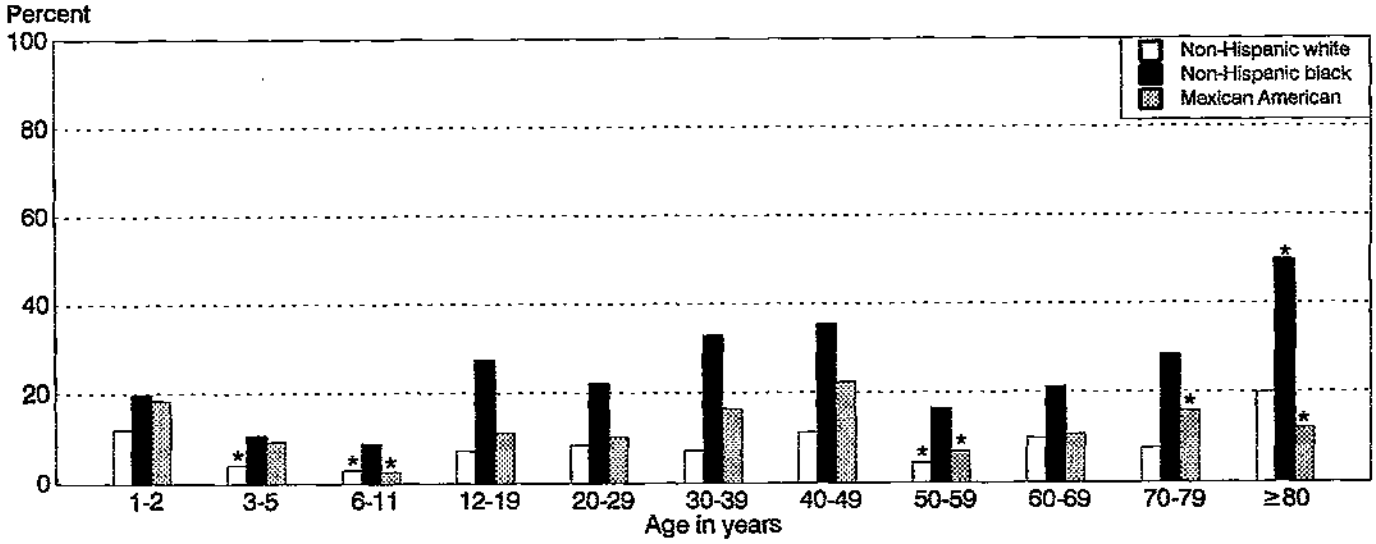

Figure 7-3. Percentage of females 1 year of age and older with low hemoglobin levels, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-2,3 in appendix VA. Excludes pregnant females. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

to increased growth plus the onset of menstruation (Pilch and Senti, 1984).

In non-Hispanic white and Mexican-American males 20-49 years of age, the percentages of low hemoglobin ranged from 1% to 6%; however, in males more than 50 years of age in these racial/ethnic groups, the percentage of low hemoglobin levels increased steadily with each decade of age and consistently exceeded the percentages for females in these age groups. For non-Hispanic black males in each age group, the prevalence of low hemoglobin values was higher than it was for non-Hispanic white and Mexican-American males and showed a steady increase with each decade increment in age, ranging from 8% for non-Hispanic black males 20-29 years of age to 47% for those 70-79 years of age.

Non-Hispanic black females 20-49 years of age had the highest prevalences of low hemoglobin values, ranging from 22% to 36%, compared with 9-11% for non-Hispanic white females and 10-22% for Mexican-American females in the same age range. However, median iron intakes of non-Hispanic black females were only slightly lower than those of other racial/ethnic groups (see ch. 6, table 6-21). In association with the onset of menopause, the prevalence of low hemoglobin values decreased greatly in females 50-59 years of age. The percentages of low hemoglobin values for females 60 years of age and older were higher in non-Hispanic black females than in non-Hispanic white and Mexican-American females. These patterns of changes in hemoglobin values among sex, age, and racial/ethnic groups are consistent with previous reports of results from NHANES II 1976-80 and HHANES 1982-84 (Looker et al., 1989; LSRO, 1989; Pilch and Senti, 1984).

Hemoglobin values must be interpreted with caution because hemoglobin concentration as a single measure is neither a sensitive nor a specific indicator of iron deficiency or of the iron status of the U.S. population. Assessing the iron nutritional status of the U.S. population requires an evaluation of multiple biochemical indicators of iron status, as was done for the NHANES II 1976-80 and HHANES 1982-84 populations (LSRO, 1989; Pilch and Senti, 1984). Multiple biochemical indicators of iron status were also evaluated in the NHANES III 1988-91 population; however, because of the specialized and extensive nature of the assessment of iron nutritional status, evaluation of iron nutritional status should be the subject of a special report, separate from nutrition monitoring update reports.

Although low hemoglobin concentration is associated with the more severe degrees of iron deficiency, it cannot be expected to separate completely normal and iron-deficient individuals (Pilch and Senti, 1984). Estimates suggest that the numbers of iron-deficient people who fall within and who fall below the normal range of hemoglobin concentrations are probably about the same (Cook et al., 1971; Garby et al., 1969). Hemoglobin levels may be decreased or increased in conditions other than nutritional iron deficiency. For example, infection and inflammation, hemorrhage, thalassemia minor, folate or vitamin B_{12} deficiency, hemoglobinopathies, and pregnancy are known to cause reductions in hemoglobin levels. Cigarette smoking, living at increased altitudes, and dehydration can increase hemoglobin concentration (Pilch and Senti, 1984).

Age- and sex-specific cutoff values for hemoglobin levels were used for all racial/ethnic groups in NHANES III 1988-91. In this nationally representative sample, as in other studies (Cresanta et al., 1987; Dallman et al., 1978; Garn et al., 1975, 1981; Johnson-Spear and Yip, 1994; Meyers et al., 1979; Pan and Habicht, 1991; Perry et al., 1992; Yip et al., 1984), a higher percentage of low hemoglobin levels in blacks than in whites was observed consistently. This observation suggests that a single set of cutoff values for hemoglobin concentrations may not be appropriate for all racial/ethnic subgroups, and it emphasizes the need for continued efforts to investigate the use of race-specific cutoff values for hemoglobin concentrations. Distributions of other indicators of iron status, such as serum ferritin concentration and transferrin saturation, do not appear to differ among racial/ethnic subgroups.

Nutrition-related health conditions

Low birth weight

Birth weight of infants is a major determinant of their probability of survival and of their postnatal growth, development, and health. Birth weight is inversely related to the risk of neonatal death (HHS, 1988). Inadequate fetal growth and premature birth can contribute to low birth weight (i.e., below 2,500 g).

Certain medical, social, behavioral, and dietary factors are associated with low birth weight. These include lack of prenatal care or late entry into the prenatal care system, being unmarried, low socioeconomic status, high parity, unintended pregnancy, teenage and older-maternal-age pregnancies, poor obstetrical health history, previous low birth weight, low pregnancy weight gain, anemia, chronic diseases, cigarette smoking, and alcohol and drug abuse (HHS, 1988). Maternal nutrition also affects the birth weight of the infant; however, nutritional effects are difficult to assess because of the interrelationship of nutritional status with the many other factors affecting birth weight (LSRO, 1989).

Data from the PNSS showing associations of maternal prepregnancy weight, smoking, and weight gain during pregnancy with prevalence of low birth weight are presented in this section. In 1992, data were provided by 22 States, including the District of Columbia. These data are not from a nationally representative sample; they illustrate the associations of maternal prepregnancy weight, smoking, and weight gain during pregnancy with prevalence of low birth weight in a low-income, high-risk population of participants in government-supported service programs. Low-birth-weight data in this chapter do not distinguish between infants born prematurely and those born at full term. For a discussion of the associations of low birth weight with racial/ethnic, smoking, and other risk factors in pregnant women between 1978 and 1988, see Fichtner et al. (1990).

As shown in figure 7-4, prevalence of low birth weight among nonsmoking females is highest in women who were very underweight (BMI 10.0-17.9) before pregnancy. Prevalence of low birth weight decreased with increased prepregnancy weight. Smoking during pregnancy was associated with a much higher prevalence of low birth weight across all categories of prepregnancy weight.

Associations of prepregnancy weight and pregnancy weight gain with low-birth-weight prevalence among women who did and did not smoke during pregnancy are shown in figure 7-5. The highest prevalence of low birth weight was associated with less-than-ideal weight gain in women in all prepregnancy-weight-status categories, but prevalence decreased as prepregnancy-weight status increased. Higher prevalences of low birth weight were observed in infants of women who smoked during pregnancy than in infants of nonsmokers across all prepregnancy-weight categories and at all levels of pregnancy weight gain.

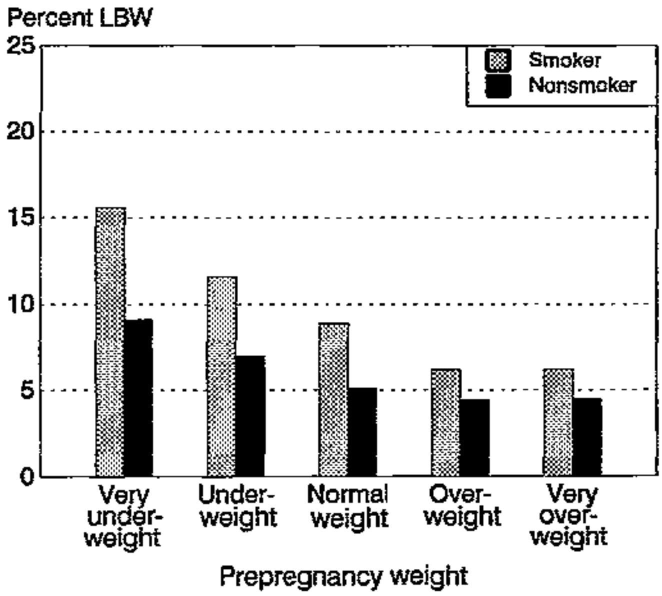

Figure 7-4. Low-birth-weight (LBW) prevalence *among low-income, high-risk females who smoked* and did not smoke during pregnancy, by prepregnancy weight, 1992

NOTE: Data are from table A.F7-4,5 in appendix VA. Data were collected from low-income, high-risk pregnant females who participated in government-funded prenatal nutrition and food-assistance programs. Measured height and prepregnancy weight were used to calculate body mass index (BMI). Prepregnancy weight categories, as specified for this analysis, were very underweight (BMI 10.0-17.9 kg/m^2), underweight (BMI 18.0-19.7 kg/m^2), normal weight (BMI 19.8-27.3 kg/m^2), overweight (BMI 27.4-31.0 kg/m^2), and very overweight (BMI 31.1-74.9 kg/m^2).

SOURCE: HHS, PNSS, 1992.

The relatively low prevalence of low birth weight among women with greater-than-ideal weight gain should not be interpreted as an indication for unrestricted weight gain during pregnancy. Maternal overweight is linked to an increased risk of maternal complications such as hypertensive disorders, gestational diabetes, infections, and surgical deliveries (HHS, 1988). Very high gestational weight gain is associated with an increased prevalence of high birth weight, which, in turn, has been associated with some increase in the risk of fetopelvic disproportion, forceps or cesarean delivery, birth trauma, asphyxia, and mortality (IOM, 1990). In addition, successive

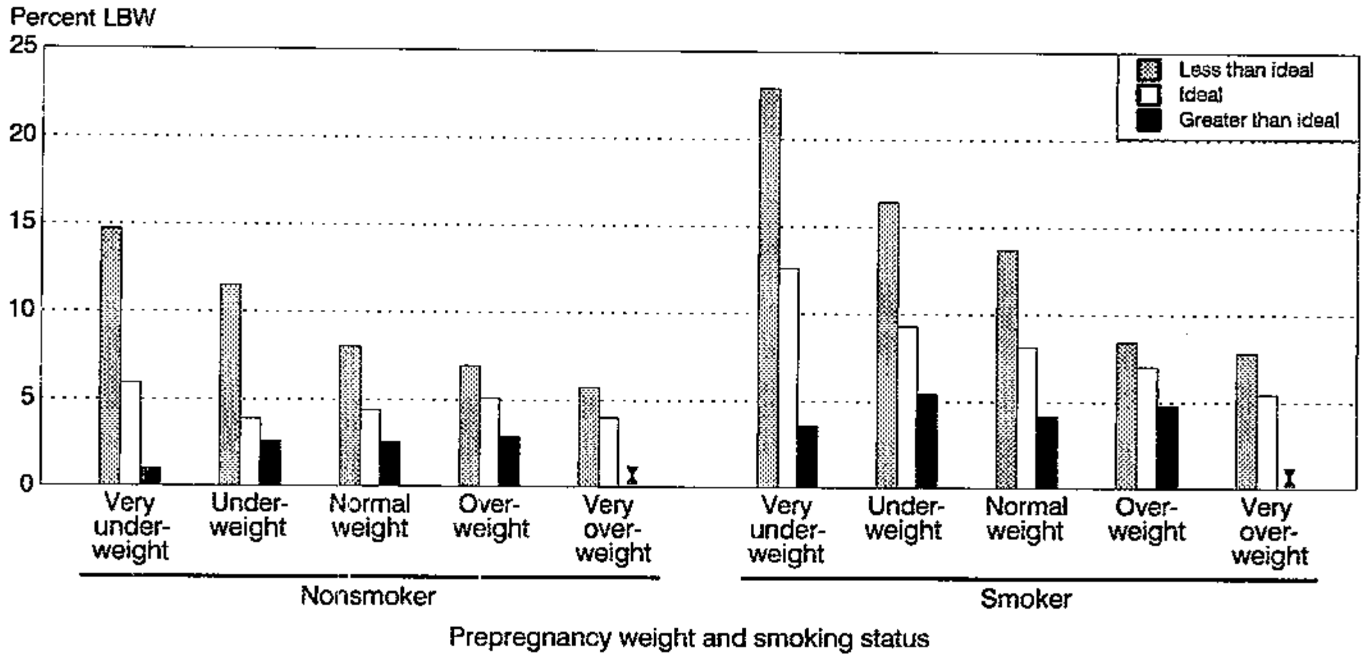

Figure 7-5. Low-birth-weight (LBW) prevalence among low-income, high-risk females who smoked and did not smoke during pregnancy, by prepregnancy weight and weight gain during pregnancy, 1992

NOTE: Data are from table A.F7-4,5 in appendix VA. Data were collected from low-income, high-risk pregnant females who participated in government-funded prenatal nutrition and food-assistance programs. Prepregnancy weight categories, as determined for this report, were very underweight (BMI 10.0-17.9 kg/m^2), underweight (BMI 18.0-19.7 kg/m^2), normal weight (BMI 19.8-27.3 kg/m^2), overweight (BMI 27.4-31.0 kg/m^2), and very overweight (BMI 31.1-74.9 kg/m^2). Ideal gestational weight gains, as set by the Institute of Medicine, were 28-40 lb for very underweight and underweight females, 25-35 lb for normal-weight females, and 15-25 lb for overweight females. A lower limit on weight gain for very overweight females was set at 15 lb, recognizing that many obese women with good pregnancy outcomes do gain less weight (IOM, 1990). Determination of weight-gain category was based on National Academy of Sciences BMI guidelines and weight-gain categories. Ι indicates that the sample size did not meet minimal-sample-size requirements.

SOURCE: HHS, PNSS, 1992.

births each add about 2 lb of postpartum body weight to the mother above that typically gained with age. High gestational weight gain is likely to be associated with greater increments of postpartum body weight gain (IOM, 1990).

The association of maternal anemia with prevalence of low birth weight for all live births in the general population from the National Vital Statistics Program is shown in figure 7-6. In all racial/ethnic groups, prevalence of low birth weight was higher for women with anemia than for those without anemia. The data from the National Vital Statistics Program are based on live births in the total population, whereas the data from the PNSS presented in the following paragraph are based on births to low-income, high-risk women participating in government-sponsored service programs.

The prevalence of anemia (low hemoglobin concentration and/or low hematocrit) in the third trimester in women participating in the PNSS in 1992 is shown in figures 7-7 and 7-8. Cutoff values in the third trimester were 11.5 g/dL for hemoglobin concentration and 33% for hematocrit. These values were further adjusted to account for altitude of residence and smoking status (CDC, 1989). Low hematologic values during the third trimester were most prevalent in non-Hispanic black women (43%) and in pregnant adolescents, particularly those less than 16 years of age, for whom the prevalence was 38%. In other racial/ethnic groups, the values ranged from 22% to 30%. Prevalence of anemia was 28% for pregnant women 20-49 years of age. Taken together, these results suggest that maternal anemia during pregnancy is associated with a higher prevalence of low-birth-weight infants in the general

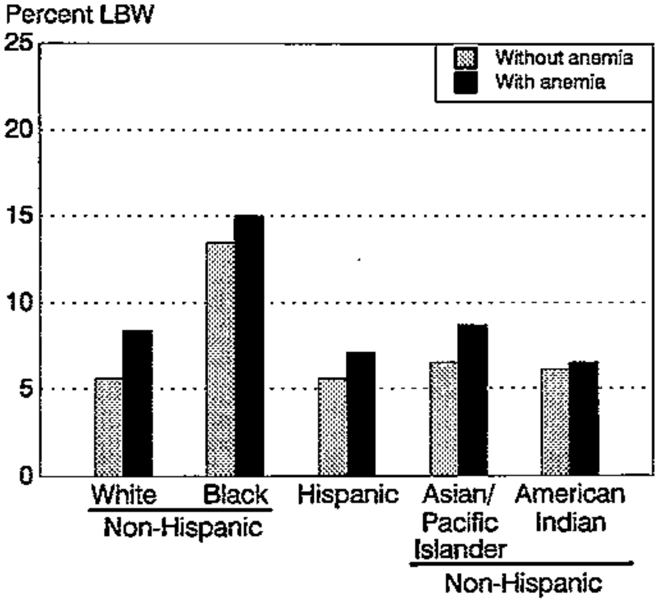

Figure 7-6. Percentage of all live-birth infants who had low birth weight (LBW) among females with and without anemia, by race/ethnicity of mother, 1991

NOTE: Data are from table A.F7-6 in appendix VA. Data represent births from 49 reporting States (excluding New Hampshire) and the District of Columbia.

SOURCE: HHS, National Vital Statistics Program, 1991.

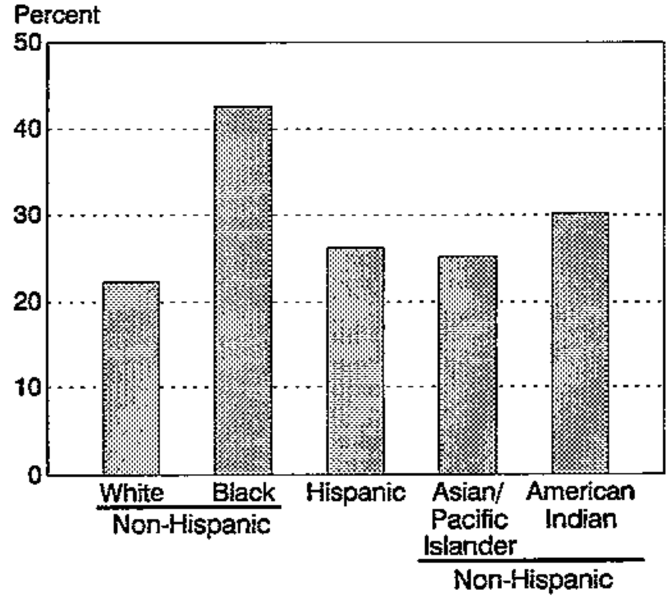

Figure 7-7. Percentage of low-income, high-risk pregnant females 12-59 years of age with low hemoglobin or hematocrit indices in the third trimester, by race/ethnicity, 1992

NOTE: Data are from table A.F7-7,8 in appendix VA. Data were collected from low-income, high-risk pregnant females who participated in government-funded prenatal nutrition and food-assistance programs.

SOURCE: HHS, PNSS, 1992.

population and that in the PNSS population, which is by definition a high-risk population, the prevalence of anemia is highest among non-Hispanic blacks of all ages and adolescents of all racial/ethnic groups.

Growth status in children

Growth status of children is influenced by their nutritional status. Two anthropometric parameters are widely used in the United States as indicators of undernutrition in children: shortness (recumbent length or height for age less than the 5th percentile of the NCHS growth reference) and thinness (weight for recumbent length or height less than the 5th percentile of the NCHS growth reference). The NCHS growth curves used to evaluate suboptimal growth status in this report were published by Hamill et al. (1979). The data used to construct the curves for children from birth to 36 months of age were age- and sex-specific data from the Fels Research Institute, Yellow Springs, Ohio. For the curves for children and adolescents 2-18 years of age, age- and sex-specific data from NHES II 1963-65, NHES III 1966-70, and NHANES I 1971-74 were used. A cubic spline function was used to derive smoothed percentile curves. A drop in the prevalence of low height for age, low weight for height, and high weight for height can be seen at the juncture of the Fels Research Institute data and the NCHS data. This is thought to be an artifactual drop resulting mainly from the discontinuities in the data sets rather than from intrinsic changes in nutritional status in young children (Dibley et al., 1987a,b). Overweight in children and adolescents 6-19 years of age was used as an indicator of overnutrition. Prevalence of overweight in children and adolescents 6-19 years of age was defined as the percentage with BMIs greater than the NHANES I 95th percentile of BMI for age (Must et al., 1991). For children younger than 6 years of age, weight for recumbent length or height greater than the 95th percentile of the NCHS growth reference (Hamill et al., 1979) was reported; however, because the significance of high weight for

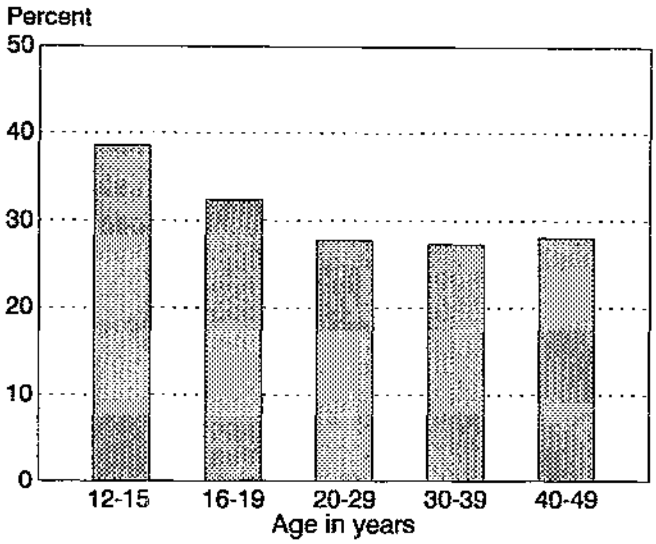

Figure 7-8. Percentage of low-income, high-risk pregnant females 12-49 years of age with low hemoglobin or hematocrit values in the third trimester, by age, 1992

NOTE: Data are from table A.F7-7,8 in appendix VA. Data were collected from low-income, high-risk pregnant females who participated in government-funded prenatal nutrition and food-assistance programs.

SOURCE: HHS, PNSS, 1992.

recumbent length or height in young children is not known, caution should be exercised in interpreting these data.

In this report, data from NHANES III 1988-91, HHANES 1982-84, the Survey of Heights and Weights of American Indian School Children 1990-91, and PedNSS 1973-92 were used to evaluate the growth status of children in the United States. Data from NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 were compared to examine trends over time in the growth of children 2 years of age and older in the total population.

NHANES III 1988-91 data are presented in this chapter for the total population. A full complement of data from NHANES III 1988-94 is needed to evaluate anthropometric data for racial/ethnic groups separately. Data on trends over time for children younger than 2 years of age from NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 are not compared because of differences in methodology among the surveys that may result in misleading interpretation of trend data. In particular, the length of children 2 years of age was not measured in a consistent manner in NHANES I 1971-74. Recumbent length was measured for some children, whereas stature (standing height) was measured for others. Improvements were made in the methodology used in NHANES II 1976-80 and NHANES III 1988-91. As a result, standardization of methods and increased training of personnel have provided more consistent and accurate data for NHANES III 1988-91.

Growth-status indices in children and adolescents in NHANES III 1988-91.—Table 7-4 shows the percentages of children 2-23 months of age from all racial/ethnic groups combined who had recumbent length for age less than the 5th percentile (Hamill et al., 1979). Percentages of children with recumbent length for age less than the 5th percentile were 5% or lower, suggesting that, on a total-population basis, shortness does not appear to occur with greater frequency than expected (5%). Percentages of children of both sexes 2-5 and 6-11 years of age with low height for age were 5% and 4-5%, respectively. Percentages were more variable for adolescents 12-17 years of age, with 6% of males and 2% of females in this age group having low height for age.

The prevalence of thinness in children 2-23 months of age from all racial/ethnic groups combined is also shown in table 7-4. Percentages ranged from 0% to 3% and were somewhat higher in children 12-23 months of age than in younger age groups. Fewer than 5% of children 2-9 years of age had low weight for height. Thinness was not evaluated in children older than 9 years of age because the onset of puberty complicates interpretation of the data (Israelsohn, 1960).

Table 7-4 summarizes the percentages of children 2-23 months of age and 2-5 years of age from all racial/ethnic groups combined who had weight for recumbent length or height above the 95th percentile (Hamill et al., 1979). The prevalence of high weight for recumbent length ranged from 8% to 12% in the group 2-23 months of age, and the prevalence of high weight for height in the group 2-5 years of age ranged from 4% to 8%. However, this may be an artifact of the disjuncture in the two data sets used to construct the growth curves. This disjuncture is greater for higher percentiles than for median or lower percentile values. The meaning of high weight for recumbent length or height in these age groups is unclear, and caution should be exercised in interpreting these findings. The table also shows

Table 7-4. Prevalence of shortness, thinness, high weight for recumbent length, high weight for height, and overweight in children and adolescents in the U.S. population, by age and sex, 1988-91 (%)[1]

Growth-status indicators for selected age groups	Male	Female
Shortness		
Low recumbent length for age		
2-5 months	4.9*	3.7*
6-11 months	4.4	3.9*
12-23 months	3.8	3.5
Low height for age		
2-5 years	5.2	5.1
6-11 years	4.7	4.1
12-17 years	6.1	1.5*
Thinness		
Low weight for recumbent length		
2-5 months	1.3*	—
6-11 months	1.6*	2.7*
12-23 months	3.4	3.2*
Low weight for height		
2-5 years	2.7	0.6*
6-9 years	2.6*	3.6
High weight for recumbent length		
2-5 months	11.9	12.0
6-11 months	8.5	11.5
12-23 months	10.5	10.6
High weight for height		
2-5 years	4.2	7.5
Overweight		
6-11 years	9.4	12.6
12-19 years	10.1	9.0

[1]Data are from table A.T7-4 in appendix VA. Excludes pregnant females. For low recumbent length for age and low weight for recumbent length for children 2-23 months of age, percentages are those below the NCHS growth chart 5th percentiles (Hamill et al., 1979). For high weight for recumbent length for children 2-23 months of age, and for high weight for height for children 2-5 years of age, percentages are those above the NCHS growth chart 95th percentiles (Hamill et al., 1979). For low height for age for children 2-17 years of age and low weight for height for children 2-9 years of age, percentages are those below the NCHS growth chart 5th percentiles (Hamill et al., 1979). For overweight children 6-19 years of age, percentages are those above the NHANES I 95th percentile of body mass index for age (Must et al., 1991). An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; a dash (—) indicates that the observed percentage was 0.0.

SOURCE: HHS, NHANES III, 1988-91.

that 9-13% of males and females 6-19 years of age had high weight for height or high BMI. Increased prevalence of overweight was also found in the adult population in NHANES III 1988-91 compared with earlier HANES. (See "Overweight in Adults," below.)

Overweight in children and adolescents has been associated with increased risk of overweight in adults (Guo et al., 1994). Overweight during adolescence has also been associated with increased mortality and risk of certain diseases in adulthood for men, but not for women; however, functional capacity (i.e., difficulty with personal care and the routine needs in the activities of daily living) was more likely to be impaired in women who had been overweight in adolescence than in women who had not (Must et al., 1992).

In another analysis of data from NHANES III 1988-91, which defined overweight for adolescents as having a BMI above modified age- and sex-specific

85th percentile values from NHANES II 1976-80, the prevalence of overweight in adolescents in NHANES III 1988-91 was estimated to be 20% for males and 22% for females 12-19 years of age (CDC, 1994). In NHANES II 1976-80, the prevalence of overweight in adolescents was 15% by definition. With 20% and 22% of the male and female adolescent population, respectively, being overweight in 1988-91, it is not likely that Healthy People 2000 Objective 2.3 to "reduce overweight to a prevalence of no more than . . . 15 percent among adolescents aged 12-19" will be achieved (HHS, 1991).

Growth-status indices in Mexican-American children and adolescents in NHANES III 1988-91 and HHANES 1982-84.—Growth-status indicators for Mexican-American children who participated in HHANES 1982-84 and NHANES III 1988-91 are shown in table 7-5. Although the populations of Mexican-American participants in the two surveys were not the same, the comparison is considered reasonable because the five southwestern States surveyed in HHANES 1982-84 contain more than 80% of the Mexican-American population in the United States.

Table 7-5. Prevalence of shortness, thinness, high weight for recumbent length, high weight for height, and overweight in Mexican-American children and adolescents, by age and sex, 1982-84 and 1988-91 (%)[1]

	Male		Female	
Growth-status indicators for selected age groups	HHANES 1982-84	NHANES III 1988-91	HHANES 1982-84	NHANES III 1988-91
Shortness				
Low recumbent length for age				
6-11 months	—	1.3*	—	1.3*
12-23 months	9.8*	6.7*	9.4*	4.5*
Low height for age				
2-5 years	10.6	4.8	9.5	7.5
6-11 years	6.3	5.8	6.1	6.0
12-17 years	8.8	14.4	9.3	10.4
Thinness				
Low weight for recumbent length				
6-11 months	3.1*	3.2*	—	—
12-23 months	7.3*	—	2.0*	3.8*
Low weight for height				
2-5 years	1.2*	1.8*	1.5*	1.0*
6-9 years	1.5*	1.6*	2.6*	3.0*
High weight for recumbent length				
6-11 months	4.5*	16.9*	7.3*	16.0*
12-23 months	7.9*	16.7	11.3	9.2*
High weight for height				
2-5 years	5.2	8.6	8.0	13.2
Overweight				
6-11 years	13.9	18.1	13.4	16.7
12-19 years	7.2	10.8	9.3	13.0

[1]Data are from table A.T7-5 in appendix VA. Excludes pregnant females. For low recumbent length for age and low weight for recumbent length for children 6-23 months of age, percentages are those below the NCHS growth chart 5th percentiles (Hamill et al., 1979). For high weight for recumbent length for children 6-23 months of age and for high weight for height for children 2-5 years of age, percentages are those above the NCHS growth chart 95th percentiles (Hamill et al., 1979). For low height for age for children 2-17 years of age and low weight for height for children 2-9 years of age, percentages are those below the NCHS growth chart 5th percentiles (Hamill et al., 1979). For high weight for height for children 6-19 years of age, percentages are those above the NHANES I 95th percentile of body mass index for age (Must et al., 1991). An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; a dash (—) indicates that the observed percentage was 0.0.

SOURCE: HHS, NHANES III, 1988-91; HHANES, 1982-84.

Prevalence of shortness tended to be around 5-14% in Mexican-American children 2-17 years of age. Although these data could indicate mild dietary inadequacy, other factors, both genetic and environmental, should be evaluated as alternative explanations. Prevalence of thinness was less than 5% in Mexican-American children 2-9 years of age. Prevalence of overweight was generally higher in Mexican-American children 6-19 years of age than in the general population and ranged from about 7% to 18% for the various age-sex groups. Taken together, the relatively low prevalence of thinness and the relatively high prevalence of overweight suggest that the weight distribution of Mexican-American children tends to be higher than that of the U.S. population of children as a whole.

BMI in NHANES III 1988-91 and American Indian children in 1990-91.—Comparisons of mean BMIs of American Indian males and females 5-18 years of age in 1990-91 and children of the same ages in the general population in NHANES III 1988-91 are shown in figures 7-9 and 7-10. At each year of age, American Indian males and females have higher mean BMIs than do children in the NHANES III 1988-91 population. These data are consistent with an earlier report comparing BMIs in children from NHANES II 1976-80 and American Indian children in 1990-91, in which overweight was found to be more prevalent in American Indian children than in children in the general population in 1976-80 (Jackson, 1993).

Trends in growth status for children in the total population and in low-income children.—Mean heights of males and females 2-19 years of age in all racial/ethnic groups who participated in the NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 are shown in table A.T7b and figures A.F7a and A.F7b in appendix VA. Overall, these values show no secular change, or change over time, in height for males or females during the two decades covered by the three surveys.

Figures 7-11, 7-12, and 7-13 show the prevalence of shortness, thinness, and high weight for height in children in certain age groups in NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91. Figure 7-13 also shows the prevalence of overweight in children and adolescents 6-19 years of age. Overall, the percentage of children with height for age below the NCHS growth chart 5th percentile has remained approximately 5% for both males and females 2-17 years of age. In one instance, the prevalence was as high as about 7% or 8% (males and females 2-5 years of age in NHANES II

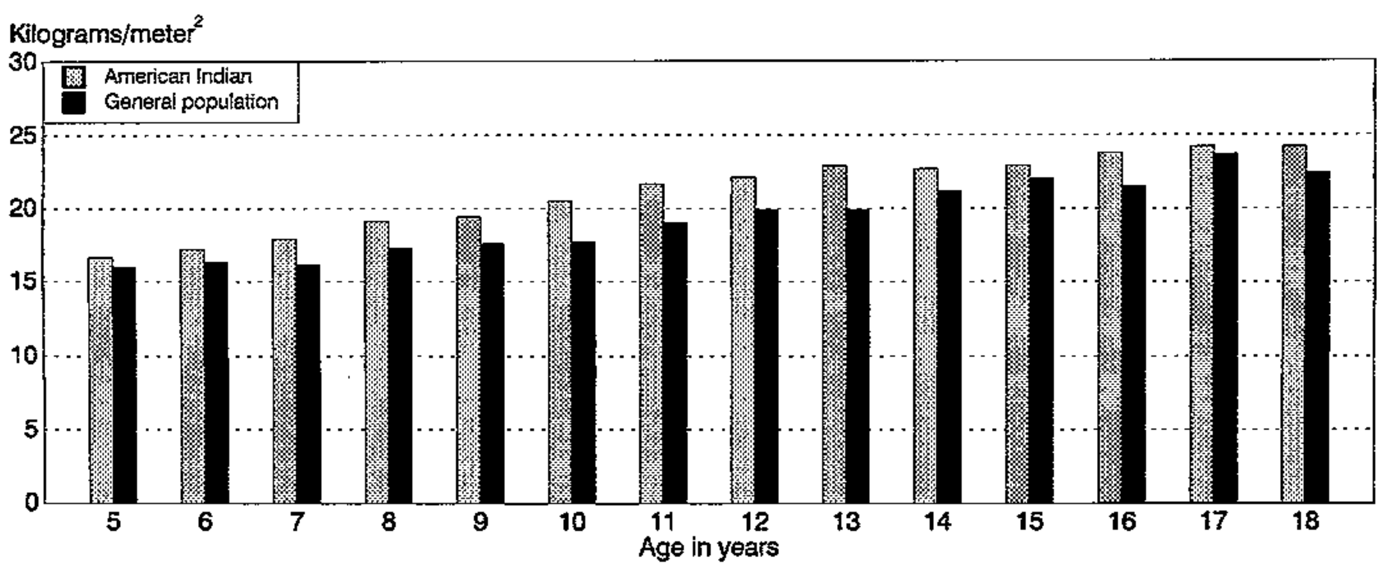

Figure 7-9. Mean body mass index (BMI) of American Indian males 5-18 years of age, 1990-91, compared with mean BMI of males 5-18 years of age in the U.S. population, 1988-91

NOTE: Data are from tables A.F7-9,10a and A.F7-9,10b in appendix VA.

SOURCE: HHS, Survey of Heights and Weights of American Indian School Children, 1990-91 (Jackson, 1993); NHANES III, 1988-91.

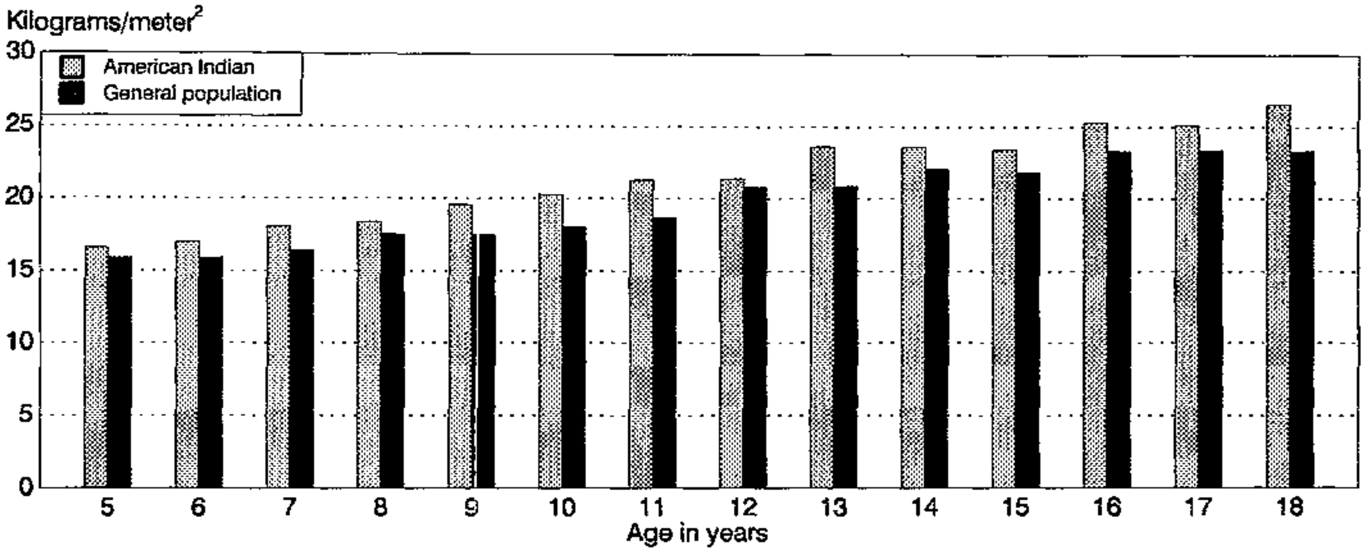

Figure 7-10. Mean body mass index (BMI) of American Indian females 5-18 years of age, 1990-91, compared with mean BMI of females 5-18 years of age in the U.S. population, 1988-91

NOTE: Data are from tables A.F7-9,10a and A.F7-9,10b in appendix VA. Pregnant females were excluded from analyses.

SOURCE: HHS, Survey of Heights and Weights of American Indian School Children, 1990-91 (Jackson, 1993); NHANES III, 1988-91.

1976-80); that level of prevalence was not observed for the NHANES III 1988-91 subgroups of children in any age group. Prevalence of weight for height below the NCHS growth chart 5th percentile was consistently less than 5%. In contrast, prevalence of BMI greater than the 95th percentile in children 6-19 years of age was higher in all age-sex subgroups in NHANES III 1988-91 than in NHANES II 1976-80. Taken together, the findings of low prevalence of thinness and the higher prevalence of overweight in children 6-19 years of age suggest an overall shift upward in the distribution of body weight in children. These findings are consistent with the increase in prevalence of overweight in adults between NHANES II 1976-80 and NHANES III 1988-91.

Time trends for shortness, thinness, and high weight for recumbent length or height for low-income infants, children, and adolescents who participated in PedNSS 1973-92 are shown in figure 7-14. These data suggest that between 1973 and 1992, the prevalence of shortness ranged from 9% to 11% and tended to show an overall downward trend. The finding that 9% of children and adolescents in this population in 1992 were at or below the 5th percentile for height for age may reflect in part the racial and ethnic composition of low-income families who participated in government-supported service programs. Thinness also showed a slight downward trend. Over this 20-year period, about 4% of children and adolescents measured in the PedNSS were at or below the 5th percentile for weight for height, suggesting that thinness, or underweight, was not very prevalent in this population. The percentage of children and adolescents with high weight for recumbent length or height in this group ranged from about 7% in 1973 to 10% in 1992 (the 1992 percentage was approximately twice that of underweight individuals in 1992 and about the same as that of overweight children and adolescents in the overall U.S. population). This finding suggests that there is a greater tendency toward high weight for height than underweight in this low-income population. More detailed information from the PedNSS on prevalence of shortness, thinness, and high weight for height in specific racial/ethnic groups was reported by Parvanta et al. (1994).

Overweight in adults

Overweight is associated with chronic diseases, including coronary heart disease, diabetes mellitus, hypertension, and some cancers and is considered to be a major public health problem in the United

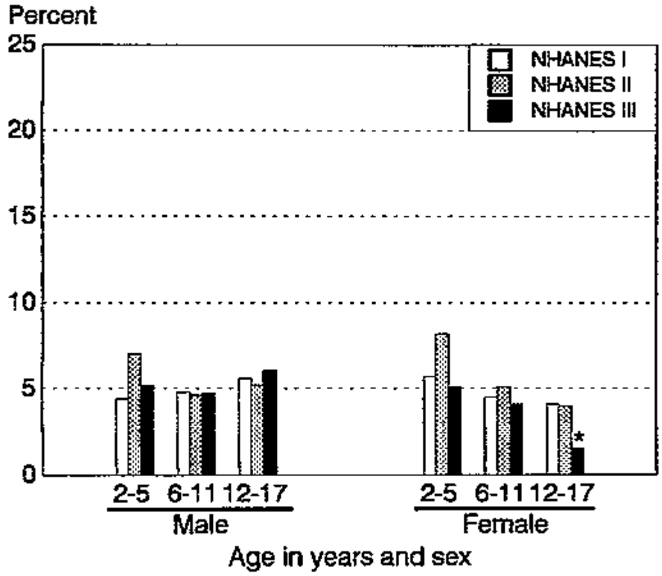

Figure 7-11. Percentage of children and adolescents 2-17 years of age who are short (low height for age), by age and sex, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-11,12,13 in appendix VA. Percentages were based on height for age less than the NCHS growth chart 5th percentile (Hamill et al., 1979). An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation. Excludes pregnant females.

SOURCE: HHS, NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

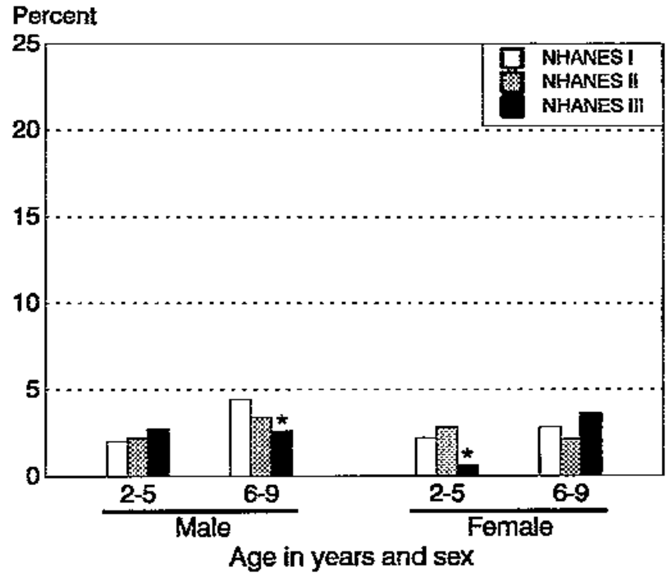

Figure 7-12. Percentage of children 2-9 years of age who are thin (low weight for height), by age and sex, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-11,12,13 in appendix VA. Percentages were based on weight for height less than the NCHS growth chart 5th percentile for age (Hamill et al., 1979). An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

States. For this reason, Healthy People 2000 Objective 2.3 aims to "reduce overweight to a prevalence of no more than 20 percent among people aged 20 and older . . . " as a means of improving the health of the American population (HHS, 1991).

The prevalence of overweight in people 20 years of age and older (NHANES III 1988-91) was assessed by calculating BMI. Overweight was defined as having a BMI ≥ 27.8 kg/m^2 for men and ≥ 27.3 kg/m^2 for women, the 85th percentile values for men and women 20-29 years of age from NHANES II 1976-80 (Najjar and Rowland, 1987).

In the total population 20 years of age and older in all racial/ethnic groups combined, the prevalence of overweight unadjusted for age was 31% for males and 35% for females. For non-Hispanic whites, the prevalence of overweight was similar for both sexes; however, for non-Hispanic blacks, the prevalence of overweight was much higher in females than in males.

Data on the percentage of people 20 years of age and older who were overweight in 1988-91, by age, sex, and racial/ethnic group, are shown in figure 7-15. For the various population subgroups, prevalence of overweight ranged from a low of less than 20% for non-Hispanic white males and females 20-29 years of age and non-Hispanic white and non-Hispanic black males 80 years of age and older to greater than 50% for Mexican-American males 40-69 years of age, non-Hispanic black and Mexican-American females 40-69 years of age, and non-Hispanic white females 50-59 years of age.

Among males, the prevalence of overweight tended to increase across age groups from 20-29 years of age through 60-69 years of age for non-Hispanic whites and Mexican Americans. Except for a decreased percentage of overweight males 30-39 years of age, the prevalence of overweight increased across age groups through 50-59 years of age for non-Hispanic blacks. The prevalence of

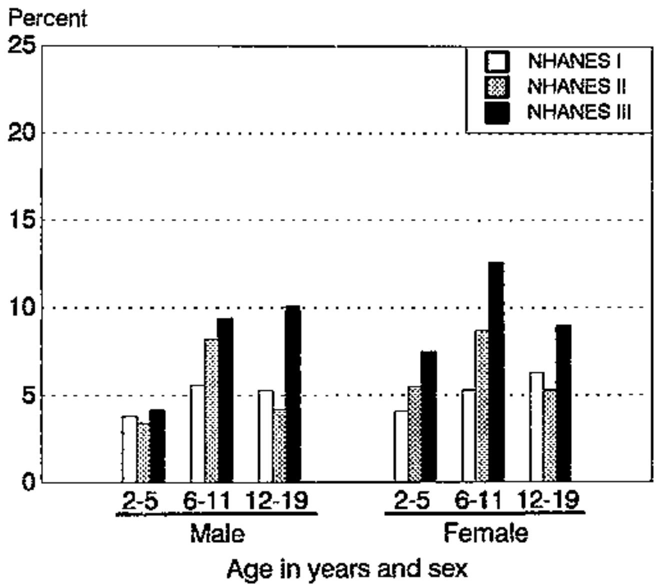

Figure 7-13. Percentage of children and adolescents 2-19 years of age who have high weight for height (2-5 years of age) or are overweight (6-19 years of age), by age and sex, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-11,12,13 in appendix VA. Percentages for children 2-5 years of age were based on weight for height greater than the NCHS growth chart 95th percentile for age (Hamill et al., 1979). Percentages for children and adolescents 6-19 years of age were based on body mass index greater than the NHANES I 95th percentile for age (Must et al., 1991). Excludes pregnant females.

SOURCE: HHS, NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

overweight was generally lower in older males in the three racial/ethnic groups. Except for the 20-29-year age group, in which the highest prevalence (30%) of overweight was in non-Hispanic black males, the prevalence of overweight was highest in Mexican-American males, followed by non-Hispanic white males and non-Hispanic black males.

Among females, the prevalence of overweight was considerably higher than it was for males at all ages except for non-Hispanic white females 20-29, 40-49, and 60-69 years of age. The prevalence of overweight also increased with age by decade from 20-29 years of age through 40-49 years of age for Mexican-American females, through 50-59 years of age for non-Hispanic white females, and through 60-69 years of age for non-Hispanic black females. Non-Hispanic black females had the highest prevalence of overweight (53% for women 60-69 years of age) of any racial/ethnic group.

The prevalence of overweight was lowest for non-Hispanic white females in all age groups. In females 20-49 years of age, the prevalence of overweight in non-Hispanic blacks and Mexican Americans (over 30%) was much higher than it was in non-Hispanic whites. In non-Hispanic white and Mexican-American females, the highest prevalence of overweight occurred in those 50-59 years of age, whereas in non-Hispanic black females, the highest prevalence did not occur until 60-69 years of age.

For both sexes, the prevalence of overweight decreased with age beginning in the subgroups 50-59 or 60-69 years of age. This may be related in part to decreases in BMI that occur because of loss of fat-free mass in older individuals (Forbes, 1987) or, possibly, to increased mortality rates in overweight people.

Age-adjusted percentages of overweight adult males and females by race/ethnicity and income level are shown in figure 7-16. For non-Hispanic blacks and Mexican-Americans, males with incomes at or below 130% of poverty had the lowest prevalence of overweight and males with incomes at or above 350% of poverty had the highest prevalence of overweight. In non-Hispanic white males, the opposite was observed: non-Hispanic white males with incomes above 350% of poverty had the lowest prevalence of overweight.

In women, a different pattern is seen. For all racial/ethnic groups, prevalence of overweight was highest in females with incomes at or below 130% of poverty, ranging from 45% for non-Hispanic whites to 50% for Mexican Americans and 51% for non-Hispanic blacks. The largest decreases in the prevalence of overweight were observed among non-Hispanic white females with each increment in income. Smaller decreases were observed for non-Hispanic black and Mexican-American women. Prevalences of overweight for females in groups with incomes above 350% of poverty were 46% for non-Hispanic blacks, 40% for Mexican Americans, and 26% for non-Hispanic whites.

Age-specific percentages of males and females 20-74 years of age who were overweight in NHES I 1960-62, NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 are shown in figures 7-17 and 7-18, by age and race. For white males of all ages, the prevalence of overweight has increased since NHES I 1960-62. For black males, the trend

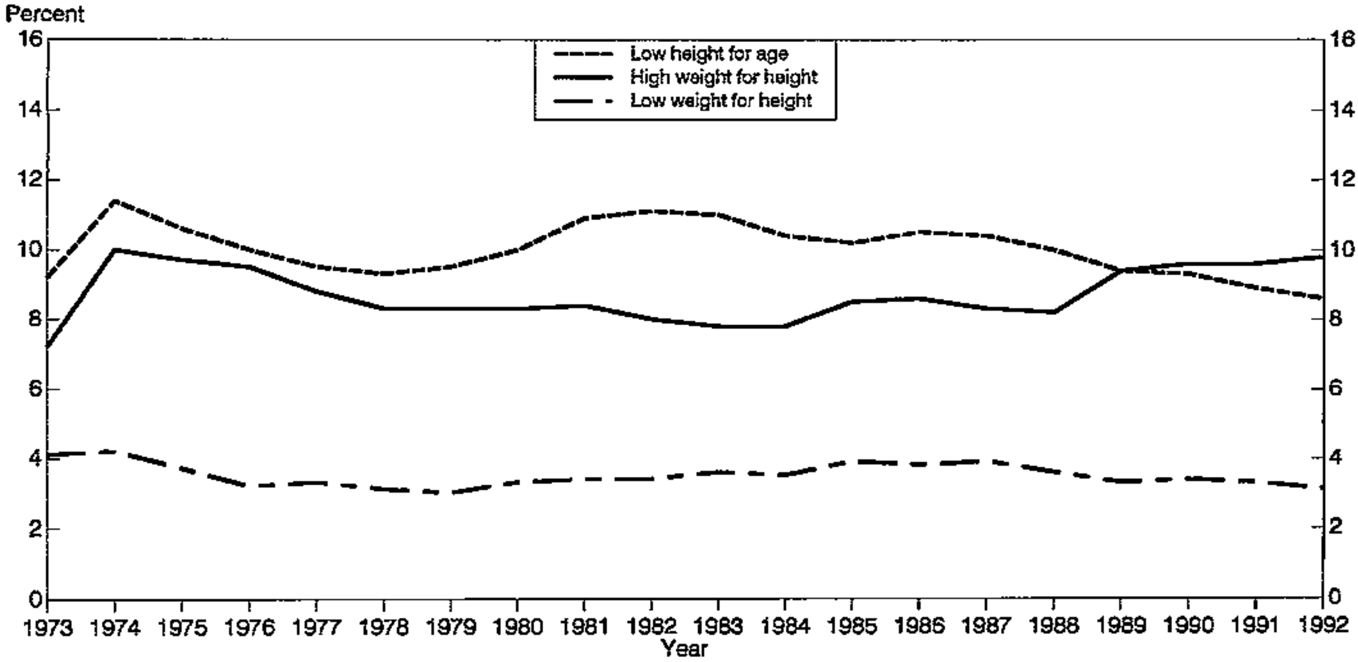

Figure 7-14. Percentage of low-income, high-risk infants less than 1 year of age and children and adolescents 1-19 years of age who are short (low height for age), are thin (low weight for height), or have high weight for recumbent length or for height, 1973-92

NOTE: Data are from table A.F7-14 in appendix VA. Data were collected from low-income, high-risk infants, children, and adolescents who participated in government-funded nutrition and food-assistance programs. Percentages for low height for age and low weight for height are based on data less than the NCHS growth chart 5th percentile (Hamill et al., 1979). Percentages for high weight for height are based on data greater than the NCHS growth chart 95th percentile (Hamill et al., 1979).

SOURCE: HHS, PedNSS, 1973-92.

was less pronounced, although overweight in males in NHANES III 1988-91 appeared more prevalent than in the earlier surveys. For white females 20-59 years of age, the prevalence of overweight increased, but the prevalence in women 60-74 years of age remained about the same over time. For black females, the prevalence of overweight increased in the 20-59-year age group from 1960-62 through 1988-91, but for the 60-74-year age group, the prevalence of overweight showed little change over that period. Little change in the prevalence of overweight occurred in any of the four groups between NHES I 1960-62 and NHANES II 1976-80 (fig. 7-19). The major portion of the change appeared to occur between NHANES II 1976-80 and NHANES III 1988-91. At all four time points, the prevalence was much higher for black women than for any of the other three groups.

The prevalence of overweight in the total population and age, sex, and racial subgroups from NHANES III 1988-91 was compared with the prevalence of overweight in age, sex, and racial subgroups in NHES I 1960-62, NHANES I 1971-74, and NHANES II 1976-80 by Kuczmarski et al. (1994). Their analyses indicated that age-adjusted prevalence of overweight in people 20-74 years of age was higher in females than males over the period 1960-1980 and remained constant (about 24% in males and 26% in females). However, between NHANES II 1976-80 and NHANES III 1988-91, age-adjusted prevalence of overweight in people 20-74 years of age increased to 32% in males and to 35% in females. Similar increases in the prevalence of overweight over this approximate time period were reported in other studies (Chung et al., 1992; Kuskowska-Wolk et al., 1989; Piani and Schoenborn, 1993; Rowland, 1990; Schoenborn, 1985, 1987; Shah et al., 1991). This trend suggests that it is not likely that the Healthy People 2000 objective of reducing the prevalence of overweight in adults to no more

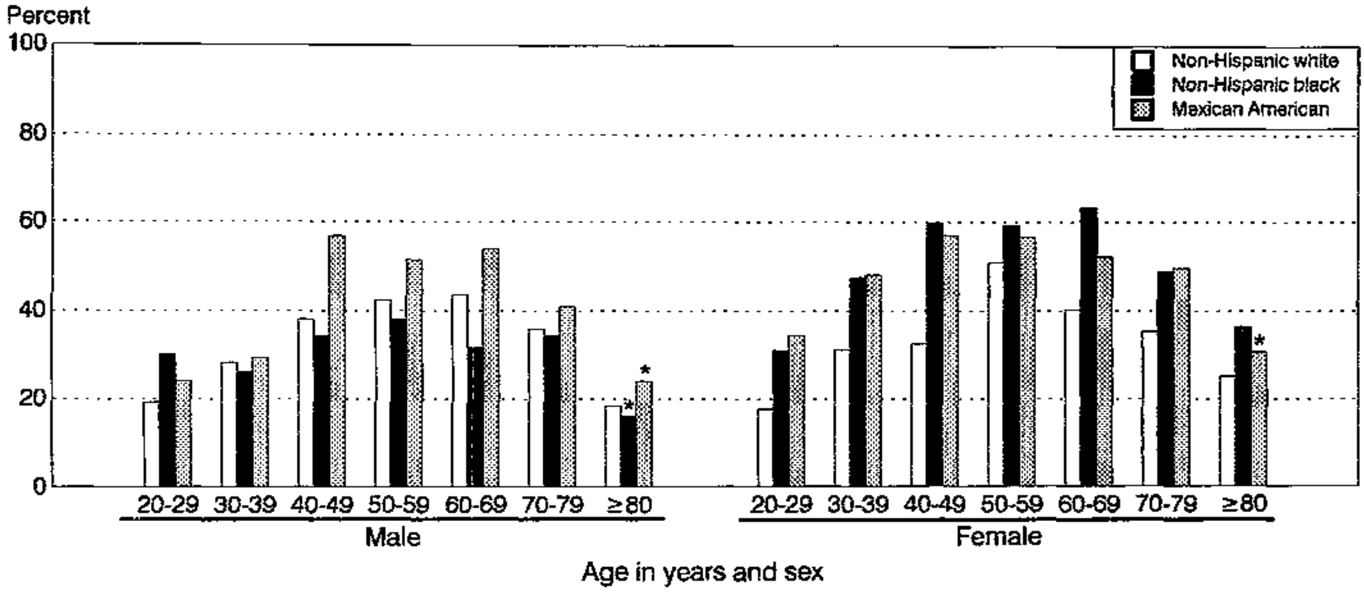

Figure 7-15. Percentage of people 20 years of age and older who are overweight (high BMI), by age, sex, and race/ethnicity, 1988-91

NOTE: *Data are from table A.F7-15 in appendix VA.* "Overweight" was defined for males as body mass index (BMI) ≥27.8 kg/m² and for females as BMI ≥27.3 kg/m². Pregnant females were excluded from analyses. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

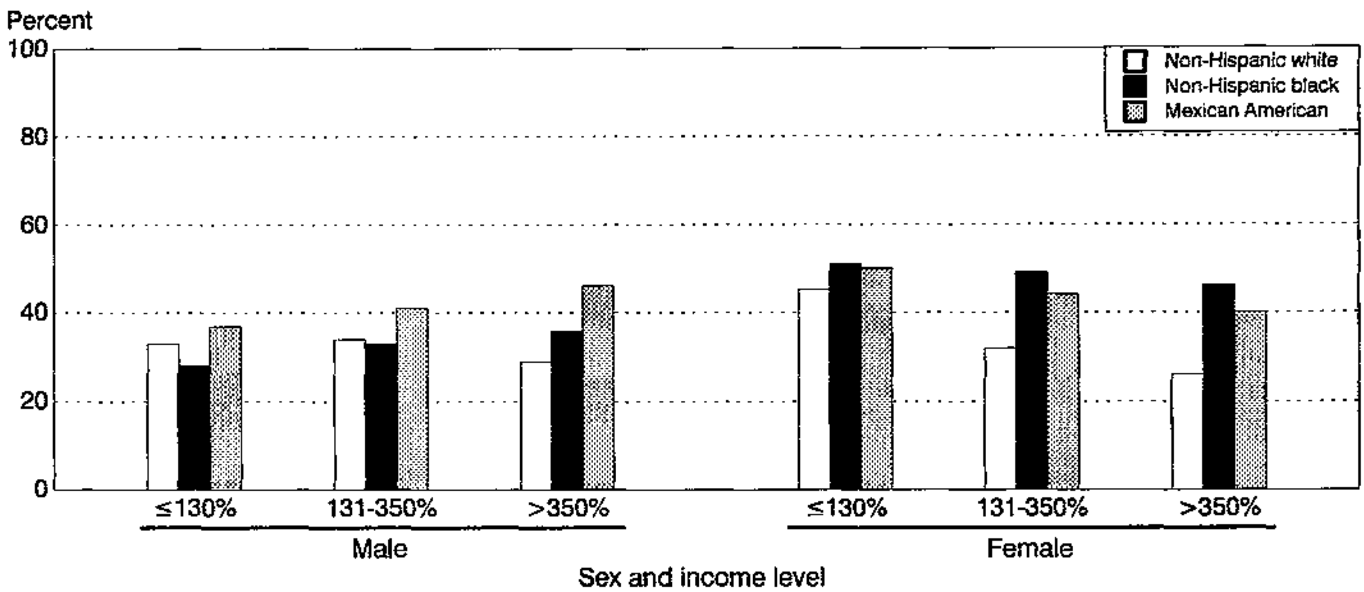

Figure 7-16. Age-adjusted percentage of people 20 years of age and older who are overweight (high BMI), by sex, race/ethnicity, and income level, 1988-91

NOTE: Data are from table A.F7-16 in appendix VA. "Overweight" was defined for males as body mass index (BMI) ≥27.8 kg/m² and for females as BMI ≥27.3 kg/m². Pregnant females were excluded from analyses. Income level was determined by dividing income by the appropriate Federal Poverty Income guideline.

SOURCE: HHS, NHANES III, 1988-91.

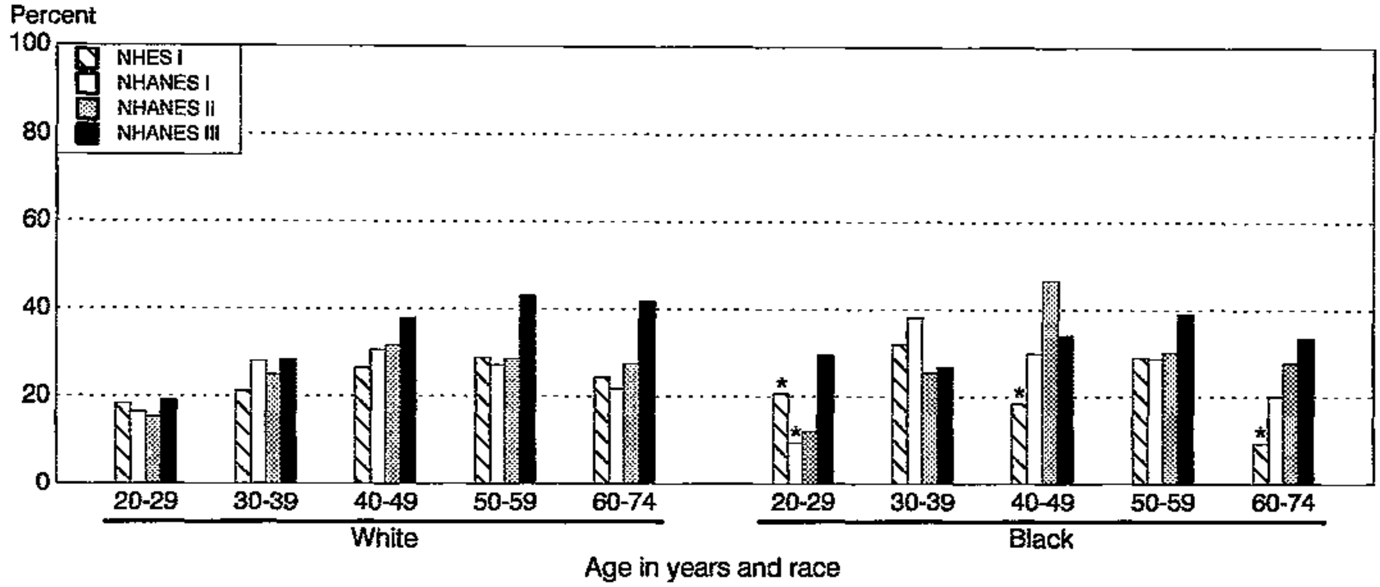

Figure 7-17. Percentage of males 20-74 years of age who are overweight (high BMI), by age and race, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-17,18,19 in appendix VA. "Overweight" was defined as body mass index ≥27.8 kg/m^2. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

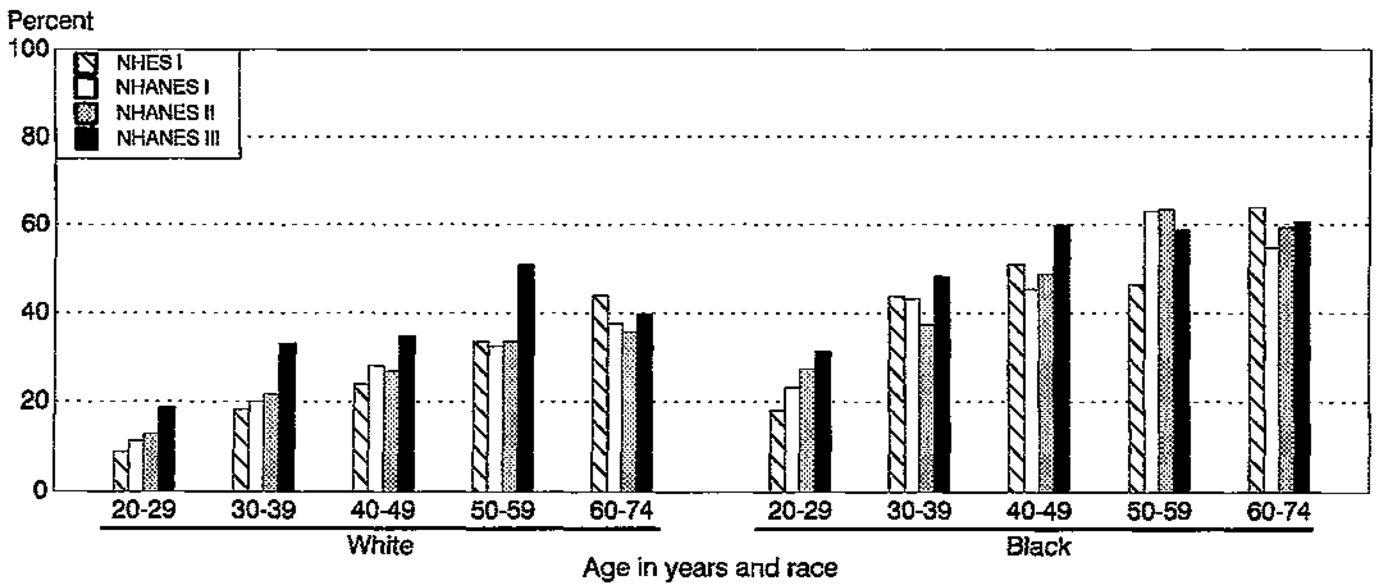

Figure 7-18. Percentage of females 20-74 years of age who are overweight (high BMI), by age and race, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-17,18,19 in appendix VA. "Overweight" was defined as body mass index ≥27.3 kg/m^2. Pregnant females were excluded from analyses.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

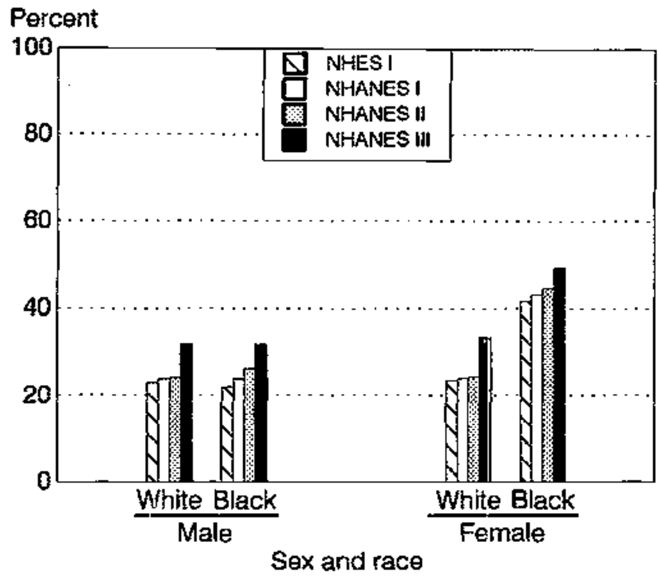

Figure 7-19. Age-adjusted percentage of people 20-74 years of age who are overweight (high BMI), by sex and race, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-17,18,19 in appendix VA. "Overweight" was defined for males as body mass index (BMI) ≥27.8 kg/m^2 and for females as BMI ≥27.3 kg/m^2. Pregnant females were excluded from analyses.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

than 20% will be met by the year 2000 (Kuczmarski et al., 1994). Reasons for the increase in prevalence of overweight are not clear. Factors influencing prevalence of overweight may include sedentary life-style, cultural and social factors, and socioeconomic factors (Kuczmarski et al., 1994).

Blood lipids as a risk factor for coronary heart disease

Several risk factors are associated with the development of coronary heart disease. Nonlipid risk factors include age, male sex, family history of premature coronary heart disease, cigarette smoking, hypertension, obesity, physical inactivity, and diabetes mellitus. High blood cholesterol level, particularly a higher level of low-density-lipoprotein (LDL) cholesterol, increases risk for coronary heart disease. In addition, low levels of high-density-lipoprotein (HDL) cholesterol appear to increase risk

Table 7-6. Classification of serum levels of total, low-density-lipoprotein (LDL), and high-density-lipoprotein (HDL) cholesterol with respect to risk of coronary heart disease in adults

Classification	Level
Total cholesterol	
Desirable total cholesterol	<200 mg/dL
Borderline-high-risk total cholesterol	200-239 mg/dL
High total cholesterol	≥240 mg/dL
LDL cholesterol	
Desirable LDL cholesterol	<130 mg/dL
Borderline-high-risk LDL cholesterol	130-159 mg/dL
High LDL cholesterol	≥160 mg/dL
HDL cholesterol	
High HDL cholesterol[1]	≥60 mg/dL
Low HDL cholesterol	<35 mg/dL

[1]Negative risk factor.

SOURCE: Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II) (1993).

for coronary heart disease, but high HDL cholesterol appears to be a protective factor. Lowering serum total cholesterol and LDL-cholesterol levels reduces risk of coronary heart disease (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II), 1993).

Data from NHANES III 1988-91 on mean serum total cholesterol levels, the prevalence of high serum total cholesterol levels, the prevalence of high LDL-cholesterol levels, and the prevalence of low HDL-cholesterol levels are discussed below. In addition, time trends in the prevalence of high, borderline-high-risk, and desirable serum cholesterol levels are presented for the period 1960-62 to 1988-91. Prevalence estimates in all instances are based on the classifications of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (1993) shown in table 7-6.

Mean serum total cholesterol levels for males and females 20 years of age and older are shown in table A.T7c and figures A.F7c and A.F7d in appendix VA for non-Hispanic whites, non-Hispanic blacks, and Mexican Americans. For males, mean serum total cholesterol levels increased with age, peaking in the 50-59-year age group for non-Hispanic whites (222 mg/dL) and Mexican Americans (224 mg/dL) and in the 60-69-year age group for non-Hispanic blacks (218 mg/dL). Mean serum total cholesterol levels in males decreased with each decade of age thereafter. For females, mean serum total cholesterol level also increased with age but peaked at 60-69 years of age. In females 60-69 years of age, mean serum total cholesterol levels were 237 mg/dL for non-Hispanic whites, 239 mg/dL for non-Hispanic blacks, and 231 mg/dL for Mexican Americans. Mean serum total cholesterol values decreased less in females than in males in succeeding decades of age and were similar among racial/ethnic groups. The prevalence of elevated serum total cholesterol levels in males and females 20 years of age and older and treatment implications were discussed in greater detail by Johnson et al. (1993) and Sempos et al. (1993).

The age-adjusted prevalence of high, borderline-high-risk, and desirable serum total cholesterol levels in adults 20-74 years of age were reported by Sempos et al. (1993) based on NHANES III 1988-91 data. Their analyses indicated that 19% of males and 20% of females had high serum cholesterol (at or above 240 mg/dL), 32% of males and 30% of females had borderline-high-risk levels (200-239 mg/dL), and 49% of males and 50% of females had desirable serum cholesterol levels (below 200 mg/dL).

As shown in figure 7-20, comparison of age-adjusted prevalence of high serum total cholesterol by poverty level indicated that non-Hispanic white males with incomes below poverty had a higher prevalence of high serum total cholesterol levels than did non-Hispanic black and Mexican-American males. The age-adjusted prevalence of high serum total cholesterol levels in non-Hispanic white, non-Hispanic black, and Mexican-American females was similar whether incomes were below poverty or at or above poverty. The prevalence of elevated serum total cholesterol levels in males and females 20 years of age and older and treatment implications were discussed in greater detail by Johnson et al. (1993) and Sempos et al. (1993).

The prevalence of LDL-cholesterol levels at or above 160 mg/dL for males and females 20 years of age

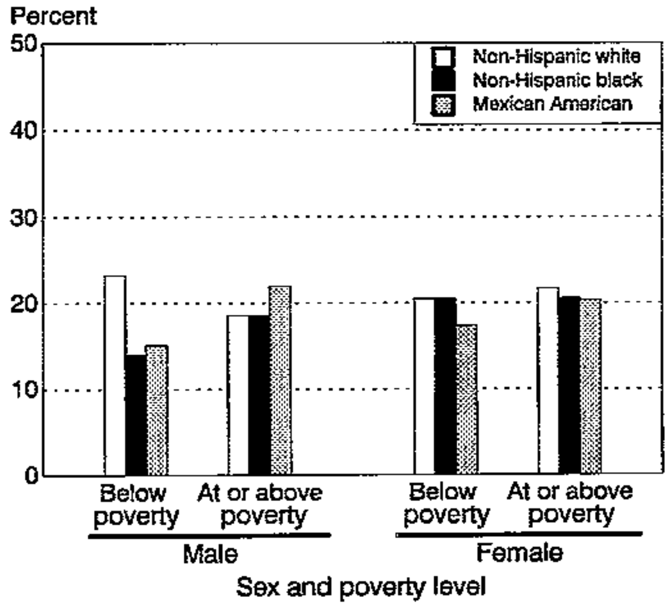

Figure 7-20. Age-adjusted percentage of people 20 years of age and older with high serum total cholesterol levels, by sex, race/ethnicity, and poverty level, 1988-91

NOTE: Data are from table A.F7-20 in appendix VA. "High" serum total cholesterol levels were defined as ≥240 mg/dL.

SOURCE: HHS, NHANES III, 1988-91.

and older is shown in figures 7-21 and 7-22. In males and females 20-59 years of age from all racial/ethnic groups, the prevalence tended to be higher at each successive decade of age. The prevalence was higher for males 20-49 years of age than for females in that age group, and it was quite similar for both sexes 50-59 years of age. At 60-69 years of age and for each decade of age beyond, the prevalences of LDL cholesterol at or above 160 mg/dL decreased for both sexes but were generally higher in females than males.

The prevalence of HDL-cholesterol levels below 35 mg/dL for males and females 20 years of age and older is shown in figures 7-23 and 7-24. Males had a higher prevalence of HDL-cholesterol levels below 35 mg/dL than did females in all age groups. For non-Hispanic white males, the prevalence increased in an age-related manner through 40-49 years of age. For non-Hispanic black males, the prevalence generally increased with each succeeding decade of age. The prevalence in Mexican-American males showed no consistent pattern across age groups.

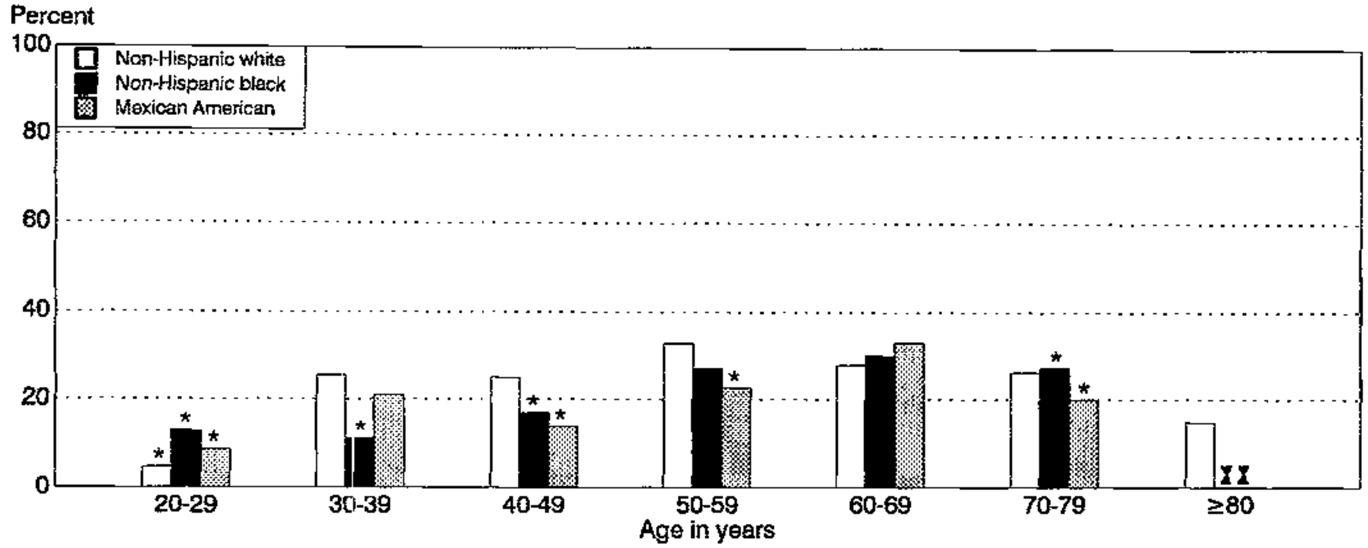

Figure 7-21. Percentage of males 20 years of age and older with high-risk levels of serum low-density-lipoprotein (LDL) cholesterol, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-21,22 in appendix VA. "High-risk" serum LDL-cholesterol levels were defined as ≥160 mg/dL. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; ⌶ indicates that the sample size did not meet minimum-sample-size requirements.

SOURCE: HHS, NHANES III, 1988-91.

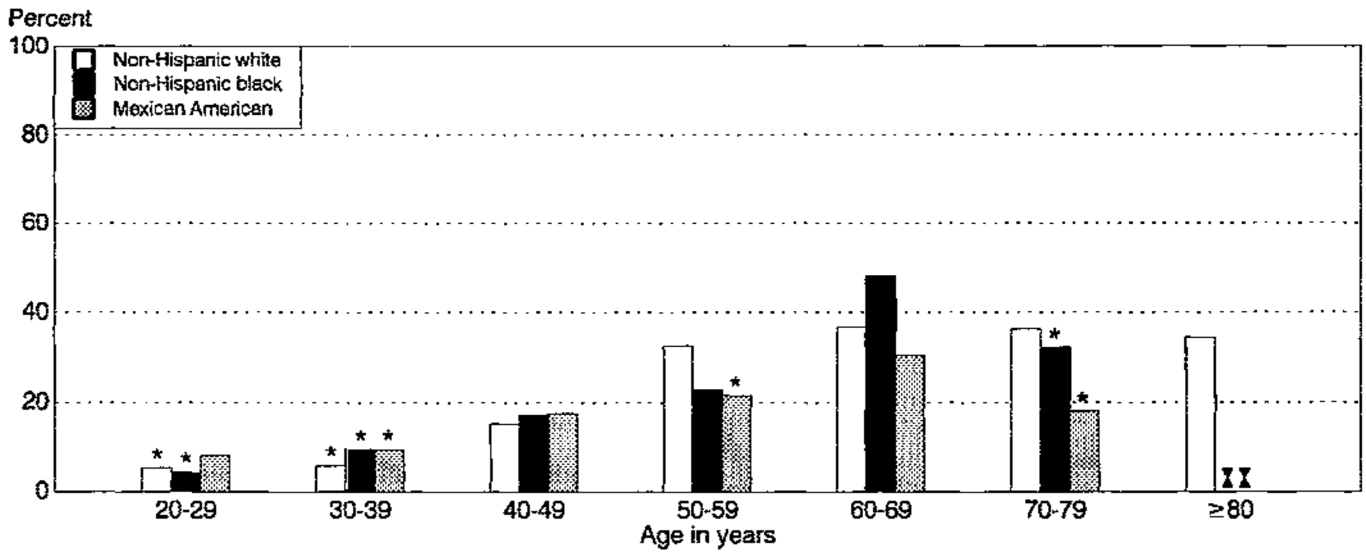

Figure 7-22. Percentage of females 20 years of age and older with high-risk levels of serum low-density-lipoprotein (LDL) cholesterol, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-21,22 in appendix VA. "High-risk" serum LDL-cholesterol levels were defined as ≥160 mg/dL. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; ⌶ indicates that the sample size did not meet minimum-sample-size requirements.

SOURCE: HHS, NHANES III, 1988-91.

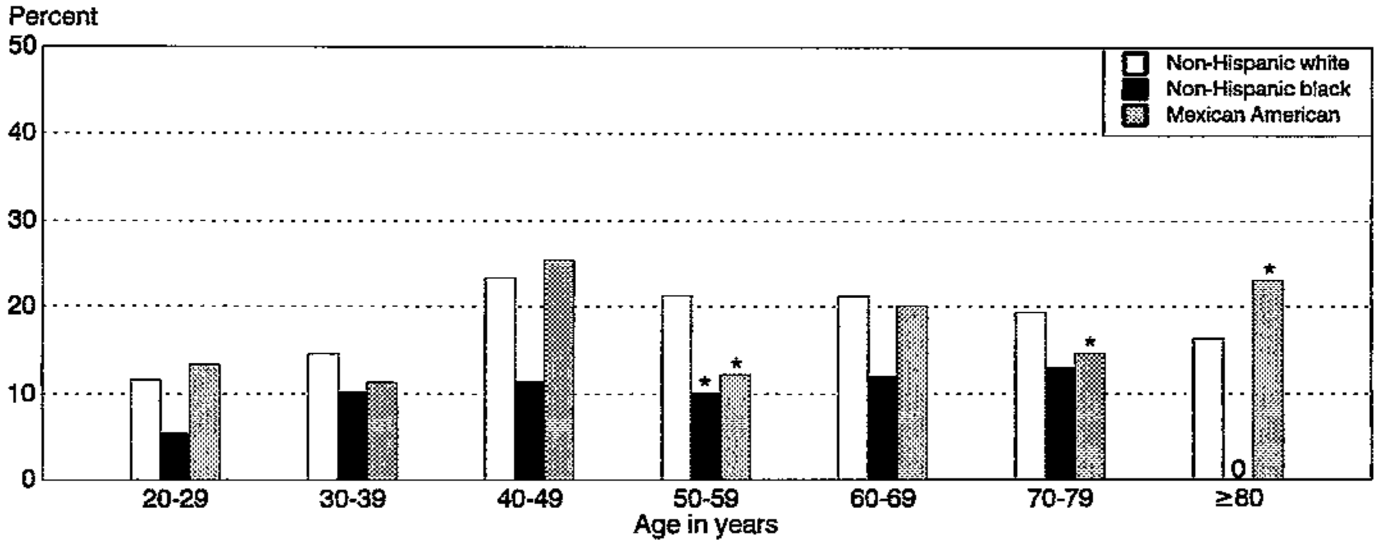

Figure 7-23. Percentage of males 20 years of age and older with low levels of serum high-density-lipoprotein (HDL) cholesterol, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-23,24 in appendix VA. "Low" serum HDL-cholesterol levels were defined as <35 mg/dL. The percentage for non-Hispanic black males 80 years of age and older was 0%. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

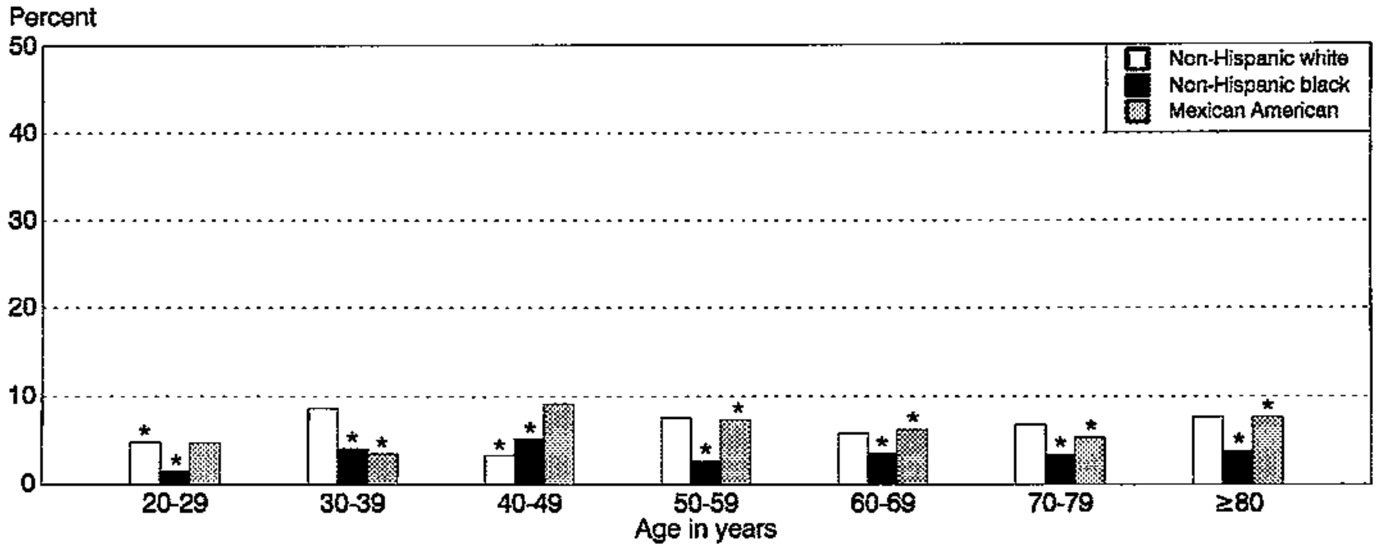

Figure 7-24. Percentage of females 20 years of age and older with low levels of serum high-density-lipoprotein (HDL) cholesterol, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-23,24 in appendix VA. "Low" serum HDL-cholesterol levels were defined as <35 mg/dL. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

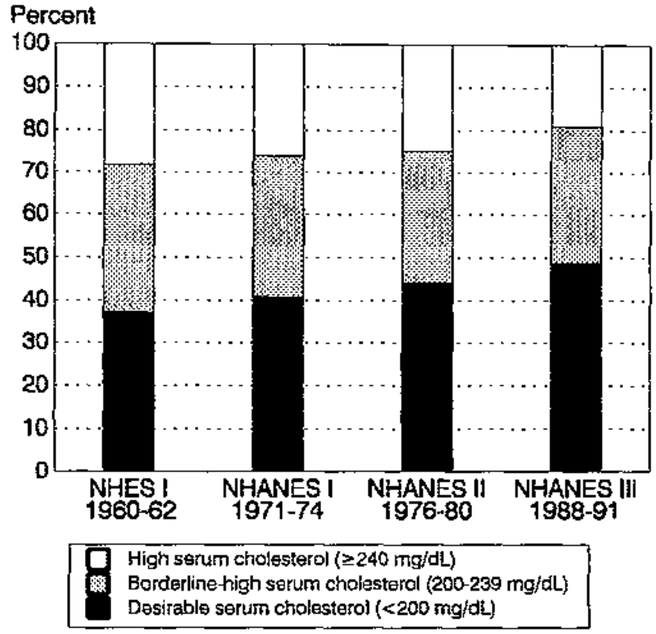

Figure 7-25. Age-adjusted percentage of males 20-74 years of age with desirable, borderline-high-risk, and high serum total cholesterol levels, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from tables A.F7-25,26a, A.F7-25,26b, and A.F7-25,26c in appendix VA.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

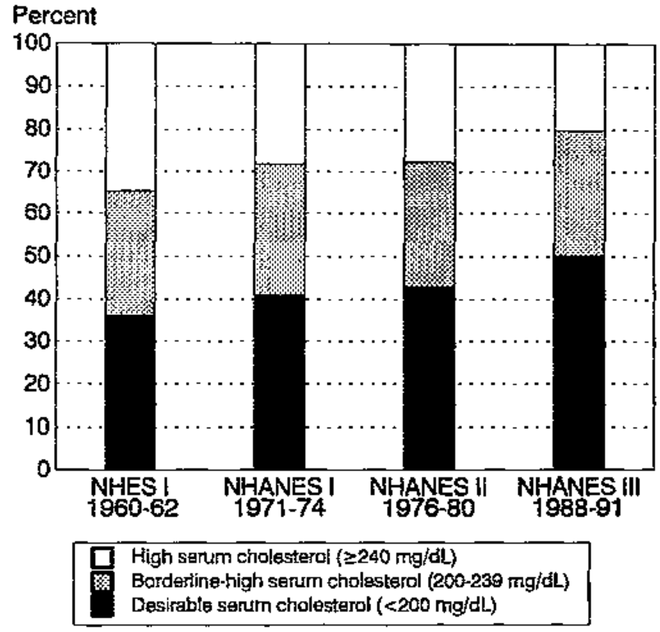

Figure 7-26. Age-adjusted percentage of females 20-74 years of age with desirable, borderline-high-risk, and high serum total cholesterol levels, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from tables A.F7-25,26a, A.F7-25,26b, and A.F7-25,26c in appendix VA.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

Non-Hispanic black males had lower prevalences of HDL-cholesterol levels below 35 mg/dL than did non-Hispanic white males in each age group.

Secular trends in age-adjusted prevalence of high (at or above 240 mg/dL), borderline-high-risk (200-239 mg/dL), and desirable (below 200 mg/dL) serum total cholesterol levels in the NHES I 1960-62, NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 populations are shown in figures 7-25 and 7-26 for males and females 20-74 years of age, respectively. Issues concerning the comparability of the laboratory data collected in this series of surveys were examined in detail by Johnson et al. (1993), who concluded that the data appeared to be comparable. Secular trends in prevalence of high LDL cholesterol and low HDL cholesterol should be examined after the comparability of the data is confirmed.

For both sexes, a steady increase over time in the percentage of individuals with desirable serum total cholesterol levels was observed. In NHANES III 1988-91, 49% of males and 50% of females had serum total cholesterol levels below 200 mg/dL compared with 37% and 36% of males and females, respectively, in NHES I 1960-62. For both sexes, the percentages of individuals with high serum total cholesterol levels also decreased steadily from 1960-62 through 1988-91. The percentage of men with high serum total cholesterol levels dropped from 28% to 19% over this time span. The percentage of women with serum total cholesterol at or above 240 mg/dL fell from 35% in 1960-62 to 20% in 1988-91. For men, borderline-high-risk serum cholesterol levels decreased from 35% in 1960-62 to 32% in 1988-91, and for women, percentages of borderline-high-risk serum cholesterol stayed constant at about 30%. The decline in serum total cholesterol levels over the period 1960-62 through 1988-91 was analyzed and discussed in greater detail by Johnson et al. (1993).

The decrease in prevalence of serum total cholesterol levels at or above 240 mg/dL between 1976-80 and 1988-91 is puzzling in light of the increased prevalence of overweight during this same period. As shown in chapter 6, median intakes of cholesterol were generally below 300 mg/d, median total fat intakes were about 34% of calories, and median saturated fatty acid intakes were about 12% of calories in 1988-91. Lower dietary intakes of cholesterol and fat may be associated with a decreased prevalence of high serum total cholesterol between 1976-80 and 1988-91; however, further analyses will be required to examine associations between dietary intake and serum cholesterol status.

Hypertension

Hypertension (high blood pressure) is the single most important risk factor for cerebrovascular diseases and one of the major risk factors associated with coronary heart disease (table 7-7). Although hypertension is a serious risk factor, it can be modified by dietary and life-style changes and pharmacologic treatment. As many as 50 million people in the United States have elevated blood pressure or are taking antihypertensive medications (Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure, 1993).

Table 7-7. Percentage of people 20 years of age and older who have hypertension, by sex, age, and race/ethnicity, 1988-91 (%)[1]

Sex and age in years	All groups	Non-Hispanic white	Non-Hispanic black	Mexican American
Overall population				
Total, crude	25.4	25.8	30.9	15.6
Total, age-adjusted	25.4	24.5	34.0	23.8
Male				
20-29	5.1	4.3*	8.2	3.3
30-39	13.0	12.8	20.9	9.3
40-49	24.4	23.4	36.8	22.4
50-59	42.2	41.8	55.9	36.0
60-69	52.1	51.3	63.6	53.8
70-79	60.7	60.3	68.0	52.1
≥80	60.5	60.3	62.4	70.5*
Total, crude	25.7	26.4	31.6	15.5
Total, age-adjusted	27.0	26.4	35.3	24.4
Female				
20-29	1.0*	0.8*	2.4*	1.1*
30-39	6.2	5.0	12.1	6.5
40-49	14.4	12.7	30.5	10.7
50-59	38.8	36.8	47.9	33.5
60-69	53.5	50.9	77.8	59.3
70-79	67.6	66.9	72.6	67.0
≥80	74.7	74.3	80.5	71.0
Total, crude	25.1	25.3	30.2	15.7
Total, age-adjusted	23.7	22.4	32.6	22.9

[1]Data are from table A.T7-7 in appendix VA. Excludes pregnant females. "All groups" includes data for racial/ethnic groups not shown separately. "Hypertension" was defined as mean systolic blood pressure ≥140 mm Hg, mean diastolic blood pressure ≥90 mm Hg, or under current treatment for hypertension with a prescription medication. These values represent the mean of six or fewer blood pressure measurements. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

In NHANES III 1988-91, six blood pressure readings were taken, three during the home interview and three during the medical examination at the mobile examination center (MEC), using blood pressure cuffs of the most appropriate size for the body size of the individual. Six blood pressure measurements were available for 9,194 adults. Hypertension was defined as mean systolic blood pressure greater than or equal to 140 mm Hg, mean diastolic blood pressure greater than or equal to 90 mm Hg, or under current treatment for hypertension with a prescription medication.

The prevalence of hypertension for males and females 20 years of age and older in the total population and in three racial/ethnic categories is shown in table 7-7. In the total population, the age-adjusted prevalence of hypertension was 25%. Overall, it was higher in males (27%) than in females (24%). Among racial/ethnic groups analyzed in NHANES III 1988-91, non-Hispanic blacks had the highest age-adjusted prevalence of hypertension—35% for males and 33% for females.

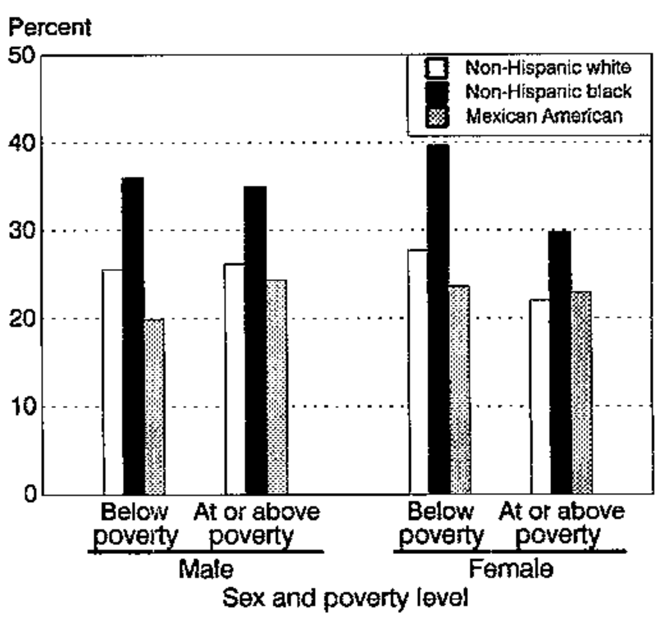

Figure 7-27. Age-adjusted percentage of people 20 years of age and older who have hypertension, by sex, race/ethnicity, and poverty level, 1988-91

NOTE: Data are from table A.F7-27 in appendix VA. "Hypertension" was defined as mean systolic blood pressure ≥140 mm Hg, mean diastolic blood pressure ≥90 mm Hg, or under current treatment for hypertension with a prescription medication. Excludes pregnant females.

SOURCE: HHS, NHANES III, 1988-91.

Except where noted, data were age-adjusted to the total adult population for 1980 by use of the direct method (Johnson, 1994).

In each of the racial/ethnic groups and in the total population, the prevalence of hypertension tended to be higher at each successive decade of age for both males and females (table 7-7). The prevalence was higher for males than for females in the total population for individuals 20-29 through 50-59 years of age. For people 60-69 years of age and older, the prevalence of hypertension was higher in females, reaching a prevalence of about 75% in females 80 years of age and older compared with 60% in males of this age. More detailed analyses of these data are described by Burt et al. (1995). Small differences in prevalence values reported here and by Burt et al. (1995) result from the age-adjustment of data to the 1990 census by Burt et al. and from slightly different age groupings for the analyses.

Prevalence of hypertension may be associated with poverty status in some subgroups of the population (figure 7-27). For non-Hispanic white and non-Hispanic black females, the age-adjusted prevalence of hypertension was higher when incomes were below the poverty level (28% and 40%, respectively) than when incomes were at or above the poverty level (22% and 30%, respectively). In Mexican-American males, the age-adjusted prevalence was slightly higher when incomes were at or above the poverty level (24%) than when they were below the poverty level (20%). No differences in age-adjusted prevalence of hypertension associated with poverty status were observed for non-Hispanic black and non-Hispanic white males or Mexican-American females.

Secular trends in the prevalence of hypertension, using the definition for hypertension given above, in the U.S. population for NHES I 1960-62, NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 are shown by decade of age for males in figure 7-28 and for females in figure 7-29. The prevalence increased with each decade of age for both sexes in each of the surveys. For NHES I 1960-62, NHANES I 1971-74, and NHANES II 1976-80, prevalences were similar for each 10-year age group. However, for NHANES III 1988-91, the prevalence of hypertension appears to be much lower for each 10-year age group than it was in the previous surveys. This finding was unexpected in

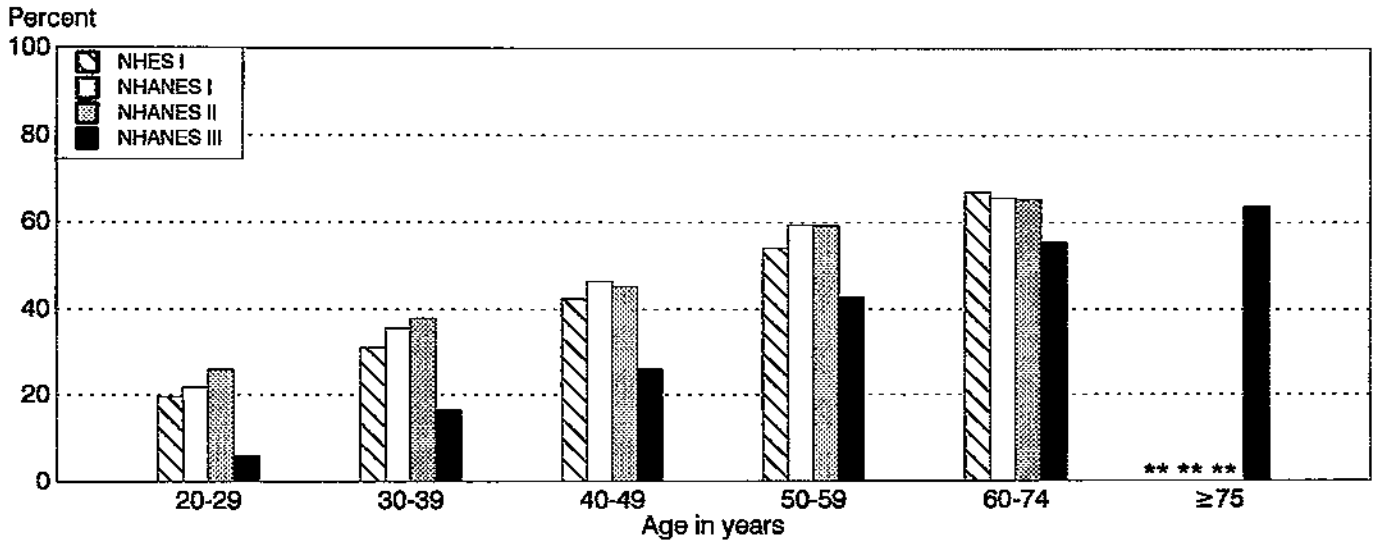

Figure 7-28. Percentage of males 20 years of age and older who have hypertension, by age, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-28,29,30 in appendix VA. "Hypertension" was defined as systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or under current treatment for hypertension with a prescription medication. A double asterisk (**) indicates that data are not available for this survey.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

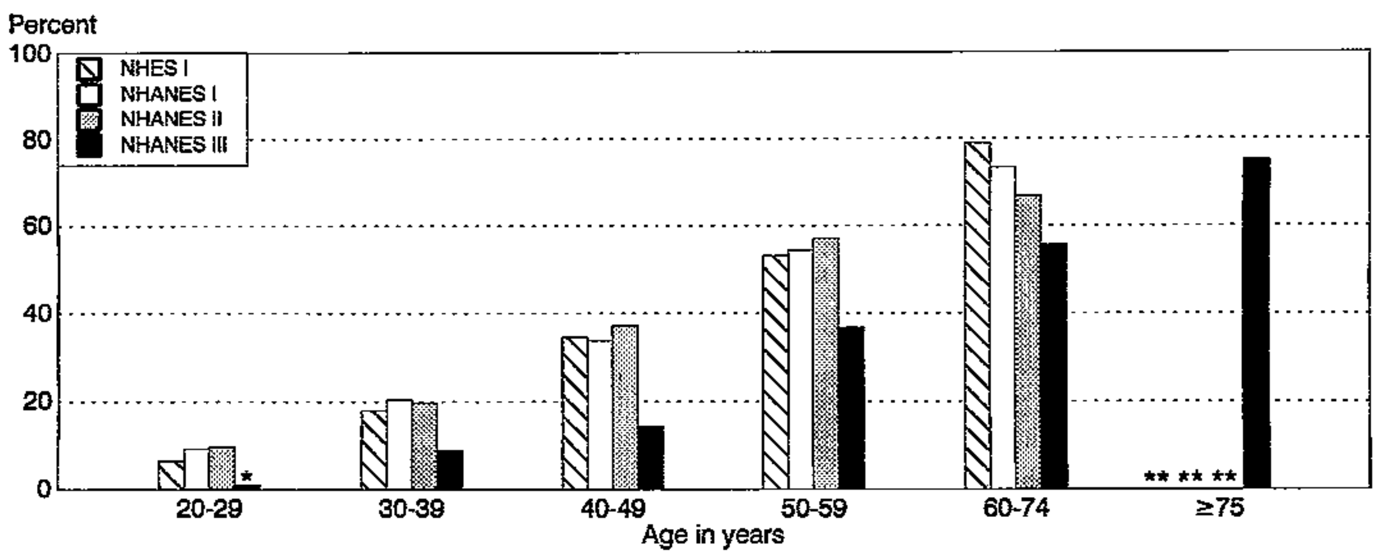

Figure 7-29. Percentage of females 20 years of age and older who have hypertension, by age, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-28,29,30 in appendix VA. "Hypertension" was defined as systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or under current treatment for hypertension with a prescription medication. Excludes pregnant females. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or a large coefficient of variation. A double asterisk (**) indicates that data are not available for this survey.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

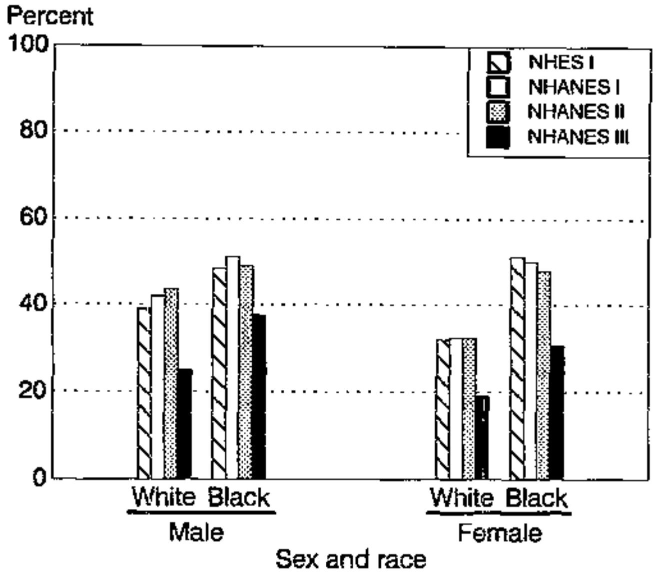

Figure 7-30. Age-adjusted percentage of people 20-74 years of age who have hypertension, by sex and race, 1960-62, 1971-74, 1976-80, and 1988-91

NOTE: Data are from table A.F7-28,29,30 in appendix VA. "Hypertension" was defined as systolic blood pressure ≥140 mm Hg, diastolic blood pressure ≥90 mm Hg, or under current treatment for hypertension with a prescription medication. Excludes pregnant females.

SOURCE: HHS, NHES I, 1960-62; NHANES I, 1971-74; NHANES II, 1976-80; NHANES III, 1988-91.

light of the increased prevalence of overweight in the U.S. population over the same period.

Changes in the age-adjusted prevalence of hypertension for white males and females and for black males and females 20-74 years of age from these surveys are shown in figure 7-30. Age-adjusted prevalences of hypertension were higher for black males and females than for white males and females at all time points. White females had the lowest age-adjusted prevalence of hypertension in all of the surveys. Age-adjusted prevalences remained fairly constant for each race and sex group in NHES I 1960-62, NHANES I 1971-74, and NHANES II 1976-80 but appeared to show a large and consistent decrease in NHANES III 1988-91. Age-adjusted prevalences of hypertension were highest and virtually identical for black males and females in NHES I 1960-62, NHANES I 1971-74, and NHANES II 1976-80. In NHANES III 1988-91, black males had the highest age-adjusted prevalence of hypertension, followed by black females, white males, and white females.

The number of blood pressure measurements, the location where the measurements were taken (home and MEC), and the procedures used (in particular, whether or not cuff size was adjusted) differed among NHES I 1960-62 and the three NHANES. In NHES I 1960-62, only one blood pressure measurement was made in the MEC, and no adjustment in cuff size was made for larger individuals. In NHANES I 1971-74, one blood pressure reading was also made, again in the MEC and without cuff-size adjustment for larger individuals. In NHANES II 1976-80, three blood pressure readings were made, all in the MEC and with cuff-size adjustment. In NHANES III 1988-91, six blood pressure measurements were made (three in the home and three in the MEC). Cuff-size adjustments were made for larger individuals, which allows for more accurate readings in overweight individuals. The number of measurements taken affects the mean value because blood pressure readings have been observed to decrease as more measurements are made.

The values indicating secular trends in hypertension in figures 7-28, 7-29, and 7-30 are based on one blood pressure measurement. For NHES I 1960-62 and NHANES I 1971-74, this was the single blood pressure measurement made in the MEC. For NHANES II 1976-80 and NHANES III 1988-91, it was the first of the three measurements made in the MEC. For NHANES III 1988-91 subjects, three measurements of blood pressure had been made previously in the home interview. Lower prevalence values of hypertension would be expected for the NHANES III 1988-91 population because the value used was not the first measurement, which is usually higher than subsequent measurements, and cuff size was adjusted for body size. Each procedural difference would be expected to decrease the percentage of high blood pressure values obtained in NHANES III 1988-91. It is not possible to separate the portion of the decrease in prevalence of hypertension observed in NHANES III 1988-91 that represents a real change in prevalence from the earlier NHES I 1960-62, NHANES I 1971-74, and NHANES II 1976-80 surveys from the portion that may be the result of methodological improvements. Expert committees evaluating methodologic changes in blood pressure measures over time in HES and HANES have concluded that some of the decrease is due to primary prevention but that it is not possible to establish the proportion of the decline that is due to methodologic improvements.

Prevalence of hypertension in populations has been associated with dietary intakes of certain essential minerals. Observational data and intervention trials have shown consistent positive associations between higher dietary salt (sodium chloride) intake and blood pressure. Inverse associations of dietary intakes of calcium and potassium with blood pressure have been reported both within and among populations. Few epidemiological studies have examined the association of magnesium intake with prevalence of hypertension. Inverse associations between serum magnesium and blood pressure have been reported, but serum and dietary magnesium levels are not correlated. For comprehensive reviews of these subjects, see Cappuccio and MacGregor (1991), Hamet (1995), INTERSALT Cooperative Research Group (1988), Kotchen (1991), NRC (1989), and Reusser and McCarron (1994).

Data from NHANES III 1988-91 on intakes of sodium, potassium, calcium, and magnesium from food indicate that median intakes of sodium were above recommended intakes, whereas median intakes of potassium, calcium, and magnesium were generally below recommended intakes for these minerals (see ch. 6, "Current Data on Nutrient Intakes from Food"). Analyses of the NHANES III 1988-91 data that examine associations of dietary intakes with the prevalence of hypertension have not yet been conducted.

Osteoporosis

Development of osteoporosis (decreased bone mass) is associated with loss of bone mineral, including calcium. Peak bone mass, which appears to be related to calcium intake during the years of bone accretion, is attained between 20 and 35 years of age and contributes to the risk of developing osteoporosis. Achieving the highest peak bone mass possible within genetic constraints may be the best protection against late-life fractures caused by the inevitable bone loss that occurs with aging (Heaney, 1991).

The first quantitative estimates of total femur bone mineral density for the U.S. population 20 years of age and older and estimates of age-related changes in total femur bone mineral density for males and females in racial/ethnic subgroups were made in NHANES III 1988-91. Median values for total femur bone mineral density of males and females 20 years of age and older for the non-Hispanic white, non-Hispanic black, and Mexican-American populations from NHANES III 1988-91 are shown in figures 7-31 and 7-32. The total femur region used here is the sum of the femur neck, trochanter, and intertrochanter; it does not include the femur shaft.

The highest values of median total femur bone mineral density were observed in males 20-29 years of age. For each racial/ethnic group, total femur bone mineral density was generally lower in males at each successive decade of age after 20-29 years. At all ages, males in the three racial/ethnic groups had greater median total femur bone mineral density than females in the same racial/ethnic groups. Median total femur bone mineral density of non-Hispanic white females was highest at 20-29 years of age and decreased at each succeeding decade of age, with larger decreases after 40-49 years of age. Median total femur bone mineral density showed little change in non-Hispanic black and Mexican-American females until 50-59 years of age, with decreases with each 10-year age increment thereafter. Data from the full 6-year cycle of NHANES III may confirm whether loss of total femur bone mineral density in non-Hispanic black and Mexican-American females is delayed compared with the loss in non-Hispanic white females.

Median total femur bone mineral density differed among racial/ethnic subgroups. For both sexes, median total femur bone mineral density was higher in non-Hispanic blacks than in non-Hispanic whites and Mexican Americans. It was similar for the latter two racial/ethnic subgroups. The occurrence of higher bone mineral mass in non-Hispanic blacks, particularly in non-Hispanic black females, is puzzling in light of their low calcium intakes (see ch. 6) and relatively low rate of formation of vitamin D in skin (Holick et al., 1981).

Estimates of the prevalence of femoral osteopenia and osteoporosis in females 50 years of age and older in NHANES III 1988-91 were made by Looker et al. (1995) based on the criteria proposed by the World Health Organization (WHO). Osteopenia was defined by WHO as bone mineral density values between 1 and 2.5 standard deviations below the mean for young adults; osteoporosis was defined as bone mineral density values more than 2.5 standard deviations below the mean for young adults

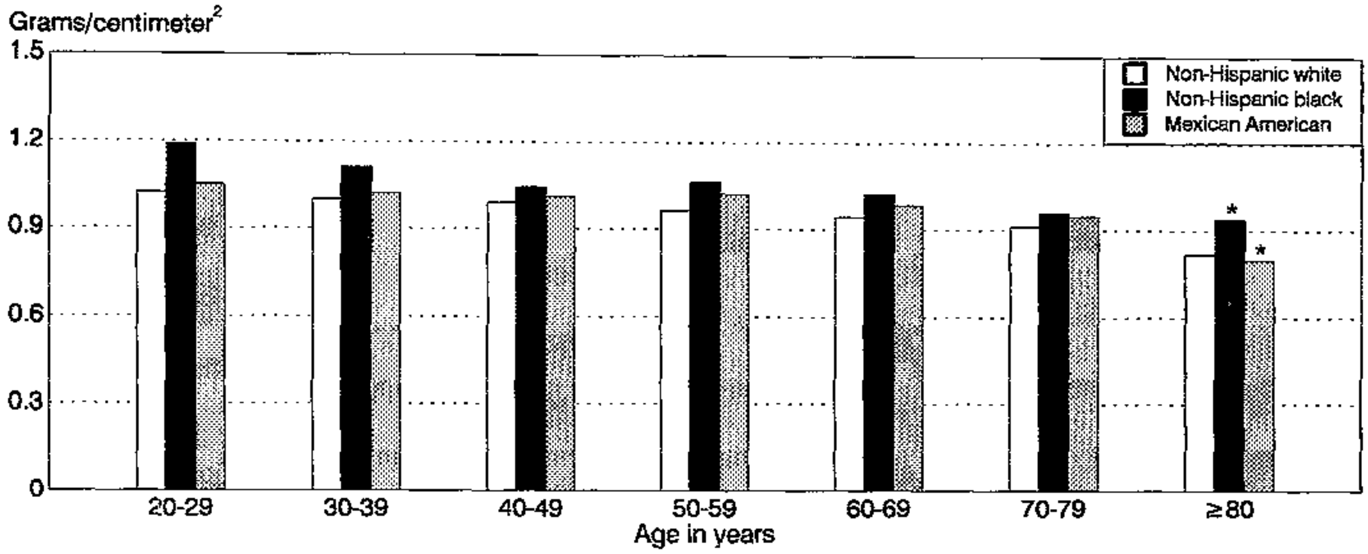

Figure 7-31. Median total femur bone mineral density of males 20 years of age and older, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-31,32 in appendix VA. For this analysis, the total femur region included the femur neck, trochanter, and intertrochanter. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

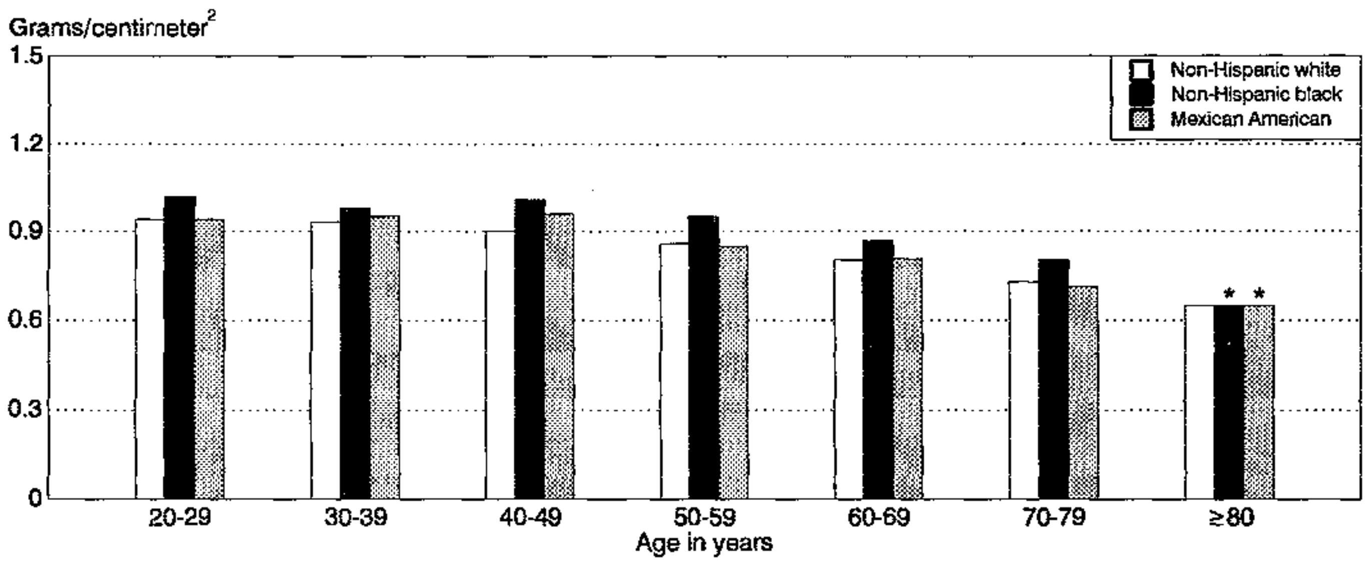

Figure 7-32. Median total femur bone mineral density of females 20 years of age and older, by age and race/ethnicity, 1988-91

NOTE: Data are from table A.F7-31,32 in appendix VA. For this analysis, the total femur region included the femur neck, trochanter, and intertrochanter. Pregnant females were excluded from analyses. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

(Kanis et al., 1994). For the NHANES III 1988-91 analysis, non-Hispanic white females 20-29 years of age served as the reference group. The prevalence of osteopenia was 39% in non-Hispanic white females, 29% in non-Hispanic black females, and 36% in Mexican-American females. The prevalence of osteoporosis was 21%, 10%, and 16% in females in the three racial/ethnic groups, respectively.

Prevalence estimates of osteopenia and osteoporosis were made for non-Hispanic white females by decade of age (figure 7-33). Thirty-five percent or more of females 50-59, 60-69, 70-79, and 80 years of age and older had osteopenia. The prevalence of osteopenia peaked in females 70-79 years of age. The prevalence of osteoporosis was relatively low (6% in females 50-59 years of age) but increased steadily with each succeeding decade of age. For females 80 years of age and older, the prevalence of osteoporosis was 52% (Looker et al., 1995).

Data on calcium intakes from food in NHANES III 1988-91 suggest that low adult peak bone mass and, possibly, osteoporosis will continue for the foreseeable future. Except for non-Hispanic white males 16-19 years of age, calcium intakes were below RDA values during adolescence, a time when significant bone accretion should occur. Median calcium intakes were lower for adolescent females (51-67% of the RDA) than for males (60-105% of the RDA). RDA values for calcium for adolescents (1,200 mg/d) are at the lower limit of the dietary-intake-threshold range of 1,200-1,500 mg/d that might result in higher peak adult bone mass (NIH Consensus Development Panel on Optimal Calcium Intake, 1994). The consequences of low calcium intake during this crucial period of bone accretion have raised concerns that the attainment of optimal peak adult bone mass may be seriously compromised (NIH Consensus Development Panel on Optimal Calcium Intake, 1994).

Median calcium intakes ranging from 62% to 81% of the RDA value (800 mg/d) were observed for non-Hispanic white, non-Hispanic black, and Mexican-American females 20-59 years of age and in non-Hispanic black males in this age group. Inadequate calcium intake in adults 25-50 years of age may also be associated with reduced bone mass, and a calcium intake of 1,000 mg/d for both males and females has been suggested as optimal (NIH Consensus Development Panel on Optimal Calcium Intake, 1994). Median calcium intakes for males and

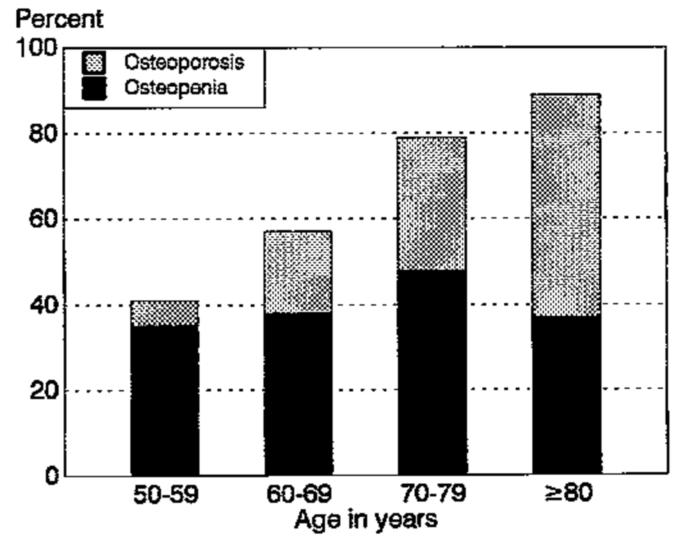

Figure 7-33. Percentage of non-Hispanic white females who have osteopenia and osteoporosis, by age, 1988-91

NOTE: Data are from table A.F7-33 in appendix VA. "Osteopenia" was defined as total bone mineral density between 1 standard deviation (SD) and 2.5 SD below the mean of a reference group (young non-Hispanic white females in NHANES III, 1988-91). "Osteoporosis" was defined as total bone mineral density >2.5 SD below the mean of the reference group (Kanis et al., 1994; WHO, 1994).

SOURCE: HHS, NHANES III, 1988-91.

females 60 years of age and older in all of the racial/ethnic groups were below the RDA value of 800 mg/d and were considered insufficient to prevent calcium-related loss of bone mass (NIH Consensus Development Panel on Optimal Calcium Intake, 1994).

Summary of findings

Biochemical and hematological indicators of nutritional status

Serum vitamin A levels in NHANES III 1988-91 suggest that vitamin A deficiency is very rare in the U.S. population. The finding that serum vitamin A levels of young children were relatively lower than those of adolescents and adults was consistent with data from earlier HANES surveys. These findings suggest the need for separate cutoff values for young children. Serum vitamin A levels suggesting marginal status were found in 5-7% of some age groups of non-Hispanic black and Mexican-American females 16 years of age and older. In these groups, serum vitamin A levels may increase with increased intake. Before these data are interpreted as indicating marginal status in non-Hispanic black and Mexican-American females, analyses controlling for the presence of concurrent acute or underlying chronic infections, which reduce serum vitamin A levels even when body stores are relatively normal, should be conducted.

Low hemoglobin concentrations indicative of anemia were found in 12-20% of children 1-2 years of age. Percentages of low hemoglobin levels were lower in children 3-5 or 6-11 years of age. In adolescents, the prevalence of low hemoglobin levels rose again, particularly in females. Low hemoglobin levels were found in about 7-36% of females 20-49 years of age. The prevalence of low hemoglobin levels was higher for both elderly males and females than for younger adults. At all ages, the prevalence of low hemoglobin levels was highest for non-Hispanic blacks. These results, together with other reports of a higher prevalence of low hemoglobin levels in blacks than in whites despite similar values for specific indices of iron status, suggest that different cutoff values may be needed to evaluate hemoglobin levels in blacks. Because conditions other than low dietary iron intakes can also cause reductions in hemoglobin levels, these findings should not necessarily be interpreted as evidence of iron deficiency. Analyses of multiple biochemical indicators of iron status will be needed to evaluate iron status in the U.S. population.

Nutrition-related health conditions

Low birth weight

Maternal nutrition, in association with medical, social, and behavioral factors, affects the birth weight of infants. In turn, birth weight of infants affects survival and postnatal growth, development, and health. Data from the PNSS and the National Vital Statistics Program indicated that higher prevalence of low birth weight was associated with low prepregnancy weight, less-than-ideal weight gain during pregnancy, maternal anemia during pregnancy, and maternal cigarette smoking during pregnancy. Of these factors, low prepregnancy weight, less-than-ideal gestational weight gain, and anemia may be related to maternal dietary intake. The latter two factors can be influenced by effective prenatal care.

Growth status in children and adolescents

Analysis of NHANES III 1988-91 data suggests that the prevalence of shortness and thinness was not higher than the expected occurrence of 5% in children and adolescents in the U.S. population. However, percentages of children 6-11 years of age and adolescents 12-19 years of age who were overweight were much higher than 5% and were higher than they were in NHANES I 1971-74. Data from PedNSS 1973-92 for low-income infants, children, and adolescents followed the same patterns as data from NHANES II 1976-80 and NHANES III 1988-91. These data, together with other analyses of overweight in adolescents in NHANES II 1976-80 and NHANES III 1988-91, indicate that the prevalence of overweight has increased in adolescents. Thus, it is not likely that Healthy People 2000 Objective 2.3 to reduce the prevalence of overweight in adolescents aged 12-19 years to no more than 15% will be achieved.

Overweight in adults

The overall prevalence of overweight for the U.S. population 20 years of age and older was 31% for males and 35% for females in NHANES III 1988-91. These prevalences were more than twice what was expected (15%). For non-Hispanic blacks and Mexican Americans but not for non-Hispanic whites, prevalence of overweight was much higher in females than in males. For both sexes in these racial/ethnic groups, the decreased prevalence of overweight beginning in the subgroups 50-59 or 60-69 years of age may be related in part to decreases in BMI that occur because of loss of fat-free mass in older individuals or, possibly, to increased mortality rates in overweight people. Income exerted a variable influence across racial/ethnic groups in males, but in females in all racial/ethnic groups, the prevalence of overweight was higher at lower income levels, with the strongest association in non-Hispanic white females.

Comparison of the prevalence of overweight in adults 20-74 years of age in NHANES III 1988-91 and earlier surveys (NHES I 1960-62, NHANES I

1971-74, and NHANES II 1976-80) indicated that age-adjusted prevalence of overweight was higher in females than males from 1960 to 1980 and remained constant (about 23-26%) over that period. Between NHANES II 1976-80 and NHANES III 1988-91, age-adjusted prevalence of overweight increased to 32% in males and 35% in females. Reasons for the increase are not clear but may include sedentary life-style, cultural and social factors, and socioeconomic factors. This trend suggests that it is not likely that the Healthy People 2000 Objective 2.3 to reduce the prevalence of overweight in adults to no more than 20% will be met by 2000. The association of overweight with chronic diseases, including coronary heart disease, hypertension, and diabetes mellitus, as well as some cancers, suggests that health consequences of overweight may become a cause for even greater public health concern in the future.

Blood lipids as a risk factor for coronary heart disease

Analyses of the age-adjusted prevalence of serum total cholesterol levels in adults 20-74 years of age in NHANES III 1988-91 indicated that 19% of males and 20% of females had high serum total cholesterol levels (above 240 mg/dL), 32% of males and 30% of females had borderline-high-risk levels (200-239 mg/dL), and 49% of males and 50% of females had desirable serum total cholesterol levels (below 200 mg/dL).

The prevalence of serum LDL-cholesterol levels indicative of high-risk LDL cholesterol (at or above 160 mg/dL) tended to be higher at each successive decade of age for both sexes 20-59 years of age. The prevalence tended to be higher for males than females 20-49 years of age, very similar for both sexes 50-59 years of age, and higher for females 60 years of age and older. The prevalence of HDL-cholesterol levels below 35 mg/dL was higher in males than in females in all age groups, and it was lower in non-Hispanic black males than in non-Hispanic white or Mexican-American males of all ages. Non-Hispanic black females over 50 years of age also had lower HDL-cholesterol levels than non-Hispanic white and Mexican-American females in the same age group.

Analysis of serum total cholesterol levels in NHES I 1960-62, NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 showed a steady decrease over time in the age-adjusted percentages of males and females 20-74 years of age who had high serum total cholesterol levels and a steady increase in the percentages who had desirable serum total cholesterol levels. The decrease in prevalence of serum total cholesterol levels at or above 240 mg/dL between 1976-80 and 1988-91 is puzzling in light of the increased prevalence of overweight during this same time period. As shown in chapter 6, median intakes of cholesterol were generally below 300 mg/d, median total fat intakes were about 34% of calories, and median saturated fatty acid intakes were about 12% of calories in 1988-91. Lower dietary intakes of cholesterol and fat may be associated with a decreased prevalence of high serum total cholesterol between 1976-80 and 1988-91; however, further analyses will be required to examine associations between dietary intake and serum cholesterol status.

Hypertension

The overall age-adjusted prevalence of hypertension was 25% in the U.S. population 20 years of age and older in 1988-91. The age-adjusted prevalence of hypertension was 27% for males and 24% for females. Among racial/ethnic groups analyzed in NHANES III 1988-91, non-Hispanic blacks had the highest age-adjusted prevalence of hypertension—35% for males and 33% for females. The prevalence of hypertension increased with each decade of age for both sexes in those racial/ethnic groups.

Analysis of changes in the prevalence of hypertension in the U.S. population for NHES I 1960-62, NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91 indicated that the prevalence increased with each successive decade of age for both sexes in each of the surveys. In 1960-62, 1971-74, and 1976-80, prevalence rates were similar for each 10-year age group. In 1988-91, the prevalence of hypertension appeared much lower for each 10-year age group than it was in the earlier surveys. Age-adjusted prevalences of hypertension were higher for black males and females than for white males and females in all of the surveys. Such prevalences were similar for each race and sex group in 1960-62, 1971-74, and 1976-80 but appeared to show a large and consistent decrease in 1988-91 despite a concurrent increase in the prevalence of overweight. Procedural differences among the surveys may account for part of the decrease in prevalence.

Expert committees evaluating methodologic changes in blood pressure measures over time in HES and HANES (in particular, NHANES III 1988-91) have concluded that some of the decrease is due to primary prevention but that it is not possible to establish the proportion of the decrease that is due to methodologic improvements. Analyses of associations of sodium, potassium, calcium, and magnesium intakes with the prevalence of hypertension remain to be conducted.

Osteoporosis

The level of peak bone mass attained affects the risk of developing osteoporosis. The first population-based estimates from NHANES III 1988-91 indicated that the highest total femur bone mineral density was usually attained in males and females during the third decade of life, and decreased thereafter with age for both sexes. For both sexes, median total femur bone mineral density was higher for non-Hispanic blacks than for non-Hispanic whites and Mexican Americans. Data on calcium intakes from food by adolescents and adults suggest that current calcium intakes may be insufficient for attaining optimal peak adult bone mass and for preventing age-related loss of bone mass.

The prevalence of femoral osteopenia in females 50 years of age and older was 39% in non-Hispanic whites, 29% in non-Hispanic blacks, and 36% in Mexican Americans. The prevalence of osteoporosis was 21%, 10%, and 16%, respectively. For non-Hispanic white females, the prevalence of osteoporosis was 6% for females 50-59 years of age and rose with each succeeding decade, reaching 52% for non-Hispanic white females 80 years of age and older.

Gaps in knowledge

Data from nationally representative surveys provide valuable information to use in examining associations of diet with health and disease on a population basis. However, meaningful interpretation of the data depends on the reliability and validity of dietary and laboratory methodology. For dietary, biochemical, and hematological data to be useful in assessing secular changes, identical or very similar methodologies must be employed.

Several limitations were identified by the Expert Consultants and LSRO in their examination of NNMRRP data:

- lack of valid measures of food energy consumption and physical activity on a population basis,
- lack of information on total intake of nutrients,
- difficulty with interpreting data on serum levels of nutrients, and
- limited experience in adjusting for differences in methodology among and within surveys.

Because of the lack of valid measures of food energy consumption and physical activity on a population basis, the reasons for the increase in prevalence of overweight in the U.S. population remain uncertain. Additionally, it is difficult to relate food-intake information to body weight status because food consumption is measured on a short-term basis and weight accumulation occurs over a longer period.

Information on total intake of nutrients was not available. Knowledge of total nutrient intakes (e.g., sodium intake from foods plus discretionary salt (sodium) use and nutrient intakes from foods plus dietary supplements) is needed to improve studies of the associations between diet and health status.

The serum concentrations of many nutrients have not been reliably linked with functional consequences. Such information is essential to establish valid cutoff values that can be used to identify high-risk populations. In addition, the Expert Consultants and LSRO questioned the adequacy of reliance on single indices as sole determinants of inadequate status for individual nutrients. Corroborative and confirmatory measures in addition to serum nutrient concentrations are needed to determine the prevalence of nutrient inadequacies. For example, no single hematological indicator is sufficient to evaluate iron status; multiple indicators characterizing different aspects of iron metabolism must be examined.

Experience is limited regarding appropriate adjustments for the differences in laboratory and clinical methodology used in different surveys or different cycles of the same survey. For example, methodologies used to measure blood pressure differed among NHES I 1960-62, NHANES I

1971-74, NHANES II 1976-80, and NHANES III 1988-91 (Burt et al., 1995). With these methodological differences, reasons for the observed decrease in prevalence of hypertension over time in the U.S. population cannot be identified.

Recommendations

In chapter 5, recommendations are made for ways to improve food composition data. In chapter 6, recommendations are made for ways to improve collection of food consumption data and to gain more useful information by conducting different types of analyses. These improvements are also needed for better assessment of nutritional status and of associations between diet and health. In addition, the Expert Consultants and LSRO make the following recommendations regarding nutritional status and nutrition-related health status.

- Identify and implement the use of additional functional indicators of nutritional status that can be used in large surveys.
- Identify additional indicators of health-related conditions, such as assessment of visceral body fat, and incorporate measures of these indicators into surveys.
- To interpret biochemical data, establish cutoff values for serum concentrations of nutrients that indicate suboptimal function. This will aid in the estimation of prevalence of nutritional risk in populations and population subgroups.
- Increase biochemical analyses to include nutrients that are of potential public health concern and develop acceptable methodologies.
- Evaluate the need for age-specific cutoff values for serum vitamin A levels in children and race-specific cutoff values for hemoglobin levels in blacks.
- Whenever possible, obtain corroborative and confirmatory measures in addition to serum nutrient concentrations to determine prevalence of nutrient inadequacies.
- Continue to improve the capacity to compare results obtained by different analytical methods used in different surveys or different cycles of the same survey. These developments are essential for the exploration of secular trends. Information about adjustment factors should be published.
- Establish better measures for evaluating the amount of physical activity and use data collected on physical activity to create indices for evaluation.
- Provide existing banked blood samples to use in extramural research studies, assess storage conditions, test new methods, and examine secular changes.
- Explore links between nutritional status, particularly anthropometric indicators, and food insufficiency.

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Chapter 8

Knowledge, Attitudes, and Behavior Assessments

Introduction

Knowledge and attitudes related to diet, nutrition, and health can influence the willingness and ability of individuals to put dietary recommendations into practice and to follow healthier life-styles. Because knowledge and attitudes and subsequent food- and health-related behaviors are inextricably linked to health outcomes, understanding the roles that knowledge and attitudes play in determining dietary and other health-related behaviors is essential for nutrition monitoring purposes. With this information, effective public health interventions at Federal, State, and local levels can be developed to improve food choices, promote health, and reduce the risk of chronic disease (HHS and USDA, 1993). Figure 8-1 highlights the relationship of knowledge, attitudes, and behavior to the other components of the conceptual model used for the TRONM.

Available methodologies

Data on knowledge, attitudes, and behavior are collected in national and State surveys and surveillance systems of the NNMRRP by telephone and personal interviews and used to track public awareness of nutrition and health; attitudes related to diet, nutrition, and health; and patterns of physical activity and other food- and health-related behaviors. Although these data are valuable in and of themselves, the primary reason for collecting them is to examine the relationship between the knowledge, attitudes, and behavior of individuals with known socioeconomic and demographic characteristics and the dietary, nutritional, and health status of these same individuals. The data can then be used to create a multidimensional profile of the population and of various subgroups, which, in turn, can be used to design health-promotion strategies that are appropriate and relevant for the target audience.

Types and sources of data

Until recently, national surveys have included few data about the knowledge, attitudes, and behavior of Americans related to diet, nutrition, and health. As a result, little is known about the knowledge, attitudes, and behavior of the general population compared with what is known about their food consumption patterns and nutritional status. However, several recent surveys in the NNMRRP have contributed much information pertinent for nutrition monitoring purposes (table 8-1).

The Health and Diet Survey (HDS) provides data on consumer awareness of diet and health relationships and on health-related knowledge and attitudes. The Behavioral Risk Factor Surveillance System (BRFSS) assesses the prevalence among adults of self-reported health behaviors, such as participating in physical activity and alcohol use. The Youth Risk Behavior Survey (YRBS) collects information on the prevalence of self-reported health behaviors, such as exercise patterns, body-image perception, and alcohol use, of students in grades 9-12. The 1989-91 Diet and Health Knowledge Survey (DHKS) provides data on the knowledge and attitudes of main meal planners and preparers about dietary guidance, use of the nutrition panel on food labels, food-safety concerns, and awareness of diet and health relationships. Information about the accuracy of perceptions about one's own diet in relation to current dietary guidance and on attitudes toward the importance of dietary guidance is also available from DHKS 1989-91. Because the sample size for male main meal planners and preparers was much smaller

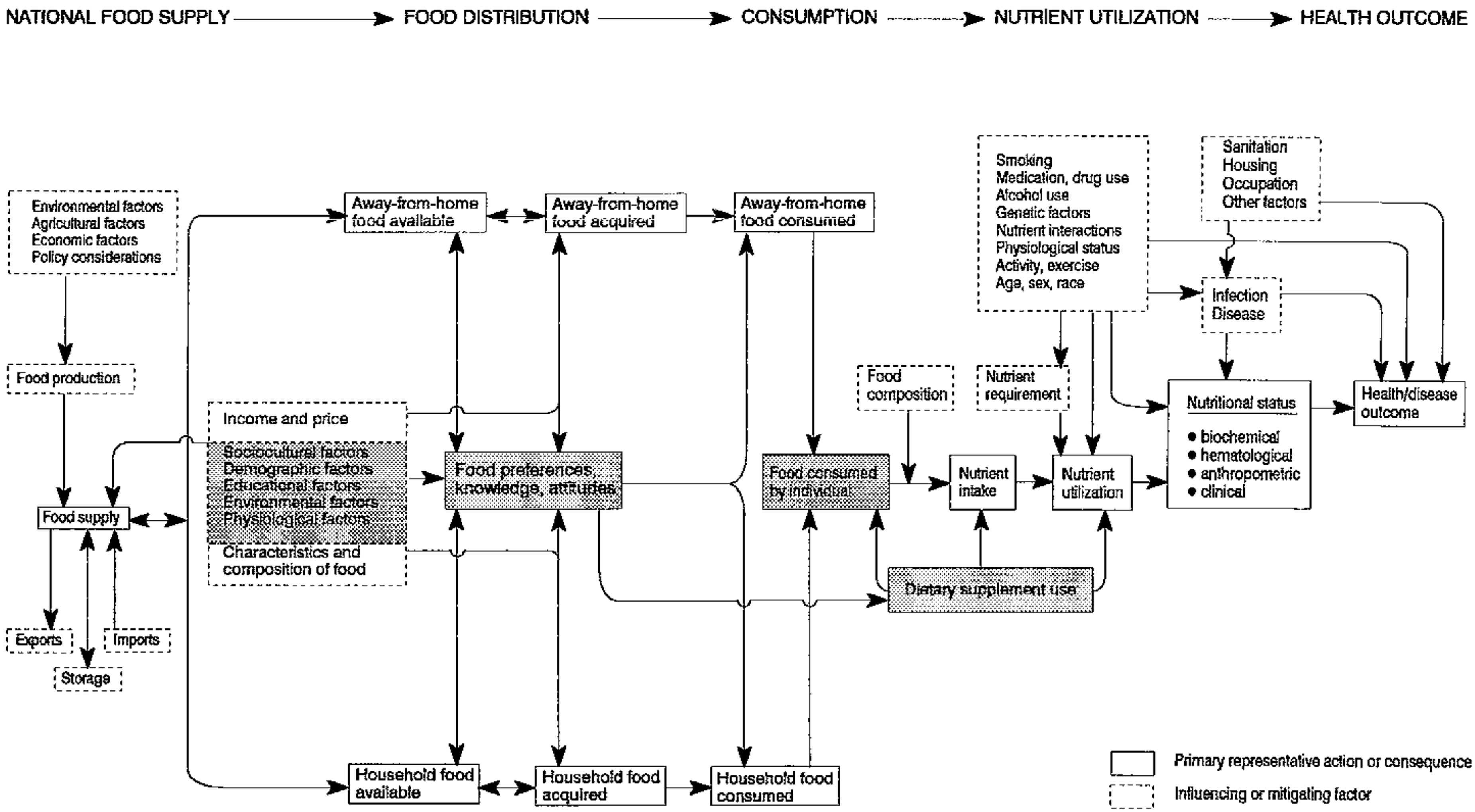

Figure 8-1. General conceptual model highlighting food preferences, knowledge, and attitudes in the relationship of food to health (see text for explanation)

SOURCE: LSRO (1989).

Table 8-1. Types and sources of data on knowledge, attitudes, and behavior used in chapter 8 of the *Third Report on Nutrition Monitoring*

Type of data	Source of data[1]
Knowledge and attitudes	Diet and Health Knowledge Survey 1989-91 (USDA, HNIS)[2]
	NHANES III 1988-91 (CDC, NCHS)
	Survey of Army Female Basic Trainees, 1993 (DOD, U.S. Army Research Institute of Environmental Medicine)
	Youth Risk Behavior Survey, 1991 (CDC, NCCDPHP)
	Health and Diet Survey, 1983 and 1990 (FDA; cosponsored by NIH, NHLBI)
Behavior	Nationwide Food Consumption Survey 1987-88 (USDA, HNIS)
	Diet and Health Knowledge Survey 1989-91 (USDA, HNIS)
	Continuing Survey of Food Intakes by Individuals, 1989-91 (USDA, HNIS)
	NHANES III 1988-91 (CDC, NCHS)
	Weight Loss Practices Survey 1991 (FDA; cosponsored by NIH, NHLBI)
	Behavioral Risk Factor Surveillance System, 1992 (CDC, NCCDPHP)
	Youth Risk Behavior Survey, 1990 and 1991 (CDC, NCCDPHP)
	National Survey of Family Growth, 1982 and 1988 (CDC, NCHS)

[1]USDA, U.S. Department of Agriculture; HNIS, Human Nutrition Information Service; CDC, Centers for Disease Control and Prevention; NCHS, National Center for Health Statistics; DOD, U.S. Department of Defense; NCCDPHP, National Center for Chronic Disease Prevention and Health Promotion; NIH, National Institutes of Health; NHLBI, National Heart, Lung, and Blood Institute.
[2]Legislation passed on Feb. 20, 1994, transferred the functions and staff of USDA's Human Nutrition Information Service (HNIS) to the existing Agricultural Research Service (ARS) of that department.

SOURCE: LSRO, 1994.

than that for female main meal planners and preparers, most planner-preparer data in this chapter are presented only for females. When data for males were provided and were deemed appropriate for comparison with data from females by the Expert Consultants and LSRO, they are discussed in this chapter. Data about sources of nutrition information used by households were collected in the 1987-88 Nationwide Food Consumption Survey (NFCS).

NHANES III 1988-91 provides information on self-perception of body weight status by adults, dieting attempts by adults, levels of physical activity among adolescents and adults, and awareness of and actions taken to control high blood cholesterol and hypertension. Data on attitudes about body weight status of female enlisted trainees in the U.S. Army are available from the 1993 Survey of Army Female Basic Trainees. Detailed information about the types of weight-loss practices used by individuals trying to lose weight is available from the Weight Loss Practices Survey (WLPS) conducted by the Food and Drug Administration (FDA) and cosponsored by the National Heart, Lung, and Blood Institute (NHLBI). The 1982 and 1988 cycles of the National Survey of Family Growth (NSFG) provide information about patterns of breastfeeding. Data on breastfeeding were included in this chapter because breastfeeding is a behavior of the mother that influences the nutritional status of her infant.

Criteria for assessment

General statistical criteria for assessing information about knowledge, attitudes, and behavior are discussed in chapter 2. Interpreting data collected by interview depends on the validity and reliability of the questions, the structure of the questions and the context in which they are asked, interview protocols, and interviewer training, in addition to survey design and data analysis. Comparability of information from different surveys depends on the similarity of the sample designs, the questions asked, the formats of the surveys, the estimation procedures, and the target populations (Laurent and Kapferer, 1985; Pitts and Woodside, 1984).

Linking knowledge and attitudes with behavior and health outcomes

Linking behavior with dietary, nutritional, and health measurements depends on the use of standardized approaches, including how the sample was designed and what estimation procedures and population descriptors were used. Until recently, food consumption surveys have included little information about respondents' food-related knowledge, attitudes, and behavior. Conversely, nationally representative consumer surveys of food-specific knowledge, attitudes, and practices have not included data on food consumption. The introduction of the DHKS component into CSFII 1989-91 provided for the first time information on knowledge, attitudes, and behavior from the same group of individuals (main meal planners and preparers) from whom food consumption data were collected. The application of complex statistical models that incorporate latent variables (i.e., variables constructed from measured variables) constructed from interrelated measures included in the DHKS and other NNMRRP surveys provides valuable information that may permit identification of cognitive variables that are more likely to mediate desirable dietary behavior. Although valuable for research purposes, consideration of these analyses is beyond the scope of this report.

Collecting behavioral information from NHANES III 1988-91 subjects from whom food consumption and biochemical, anthropometric, and clinical data were also gathered permits behavior to be linked with nutrition-related health status. These links can then be explored to examine the relationship of knowledge and attitudes to behavior and health status.

Appropriate uses and limitations of the data

Data presented in this chapter can be used to examine the role of awareness about dietary recommendations and diet and health relationships in food choice and, ultimately, nutrient intake and health status. Examining single variables may be useful for comparing a population's behavior with the recommended behavior. However, in some cases, examining single variables may be misleading or provide incomplete information unless other contributing and confounding factors are adequately considered. Multivariate analyses, in which two or more predictor variables are used, may provide valuable information on the relative influence of the independent variables on the outcome of interest.

Current data

Breastfeeding

Breast milk is the optimal food for infants because it provides them with some immunity against infection, helps protect against iron deficiency, is inexpensive and readily available, and enhances bonding between mother and infant (HHS, 1988). The 1982 and 1988 cycles of the NSFG present nationally representative data on the prevalence of breastfeeding among mothers 15-44 years of age. Among infants born in 1978-80 and 1984-86, the percentage of white mothers who reported that they breastfed was more than double that of black mothers (table 8-2). The prevalence of breastfeeding was higher among infants born to white mothers in 1984-86 than in 1978-80, but it stayed about the same among infants born to black mothers during these years. The prevalence of breastfeeding for 4 or more months remained about the same for infants born to white mothers in 1978-80 and 1984-86 and decreased for infants born to black mothers between 1978-80 and 1984-86.

A higher prevalence of breastfeeding was found among mothers 20-44 years of age who were more educated. Among infants born in 1978-80, mothers who completed 13 or more years of education were more likely to report ever breastfeeding (63%) than mothers who graduated from high school (43%), mothers who completed 9 to 11 years of education (34%), and mothers with fewer than 9 years of education (26%). For infants born in 1984-86 compared with those born in 1978-80, increases in the prevalence of breastfeeding were seen among mothers with fewer than 9 years of education and 12 years or more of education. No change was seen for infants born in 1984-86 to mothers with 9-11 years of education.

Table 8-2. Prevalence of breastfeeding among mothers 15-44 years of age and proportion of their babies who were breastfed for 4 or more months, by year of baby's birth and selected characteristics of the mothers, 1978-80 and 1984-86 (%)[1]

	Ever breastfed		Breastfed for ≥4 months	
Characteristics of mother	1978-80	1984-86	1978-80	1984-86
Overall population	46.1	55.0	65.3	61.9
Race				
White	50.3	59.9	65.4	62.6
Black	22.8	23.4	60.1	50.1
Educational level[2]				
<9 years	26.4*	49.1	I	52.3
9-11 years	33.7	34.5	72.2	66.5
12 years	42.8	51.9	57.8	55.5
≥13 years	63.4	75.0	71.7	66.9
Age				
<20 years	25.0	16.6	50.7	46.2
20-29 years	48.4	57.2	61.3	58.7
30-39 years	52.1	66.7	83.1	71.0
40-44 years	I	I	I	I
Region of residence				
Northeast	38.4	63.5	59.3	69.1
South	49.8	45.6	64.4	55.5
Midwest	35.5	51.3	64.0	56.6
West	65.7	68.8	70.4	68.0
Poverty status				
<100% poverty	30.7	27.3	54.4	55.5
≥100% poverty	50.0	62.3	66.9	62.7

[1]Data are from tables A.T8-2a and A.T8-2b in appendix VA. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; I indicates that minimum-sample-size requirements were not met.
[2]Analyses limited to women 20-44 years of age.

SOURCE: HHS, NSFG, 1982 and 1988.

Age of the mother also was associated with prevalence of breastfeeding. Compared with infants born in 1978-80, the prevalence of ever breastfeeding decreased from 25% to 17% among infants born in 1984-86 to mothers less than 20 years of age and increased from 48% to 57% among infants born to mothers 20-29 years of age and from 52% to 67% among infants born to mothers 30-39 years of age. For infants born in 1978-80 and 1984-86, about 60% of mothers 20-29 years of age who reported ever breastfeeding did so for 4 months or longer. For infants born to mothers 30-39 years of age, 71% of infants born in 1984-86 who were ever breastfed were breastfed for 4 or more months, down from 83% of infants born in 1978-80.

For infants born in 1978-80 and 1984-86, the prevalence of breastfeeding was higher among those born to mothers from households at or above the poverty level than among those born to mothers from households below the poverty level. The prevalence of breastfeeding decreased from 31% to 27% for infants born to mothers from households below the poverty level, but it increased from 50% to 62% for infants born to mothers from households at or above poverty. During both time periods, about two-thirds of mothers from households at or above the poverty level who ever breastfed did so for 4 months or longer. In contrast, about one-half of mothers from households below the poverty level who ever breastfed reported doing so for 4 months or longer.

Although it appears that the overall prevalence of breastfeeding is increasing slightly over time, it is still below the goal set in Healthy People 2000 Objective 2.11, which states that at least 75% of mothers breastfeed their babies in the early postpartum period. On the basis of findings from the NSFG, 55% of infants born in 1984-86 were ever breastfed, up from 46% of infants born in 1978-80. Among infants who were ever breastfed, more than 60% were breastfed for 4 or more months. Objective 2.11 also states that at least 50% of all mothers breastfeed until their babies are 5-6 months of age. Approximately 30% and 34% of all infants born in 1978-80 and 1984-86, respectively, were breastfed for 4 months or longer (data not shown). Although there has been some increase in the percentage of infants who are breastfed, greater emphasis is needed to encourage more mothers to initiate breastfeeding and to breastfeed longer.

Self-perception of body weight

Perception of body weight status was examined for high school students in grades 9-12 in YRBS 1991. About half of non-Hispanic black females compared with 44% of non-Hispanic white females and about 40% of Hispanic females and females of other racial/ethnic groups (non-Hispanic) thought that their body weight was about right (fig. 8-2). Thirty-eight percent of non-Hispanic white females and 40% of females who were Hispanic and of other racial/ethnic groups (non-Hispanic) thought of themselves as slightly overweight, compared with 24% of non-Hispanic black females. Although these data are difficult to interpret because the actual weight status of the respondents is not known, the data do suggest that non-Hispanic black females tend to be more satisfied with their weight than non-Hispanic white females. This finding was reported previously for white and black females (Rand and Kuldau, 1990). Compared with female high school students, male high school students in YRBS 1991 were more likely to perceive themselves as being about the right weight or as slightly underweight and less likely to perceive themselves as slightly overweight or very overweight (fig. 8-3). These data support findings that females tend to be more preoccupied with weight than males (Rodin, 1993).

Data from the 1993 Survey of Army Female Basic Trainees showed that a fairly high percentage of female enlisted basic trainees who are relatively lean reported that they wanted to lose weight. Almost 30% of the women with a body fat content of 20-24% reported that they wanted to lose weight, compared with 42% of a less lean group of women (body fat content of 25-29%). (See table A.8a in

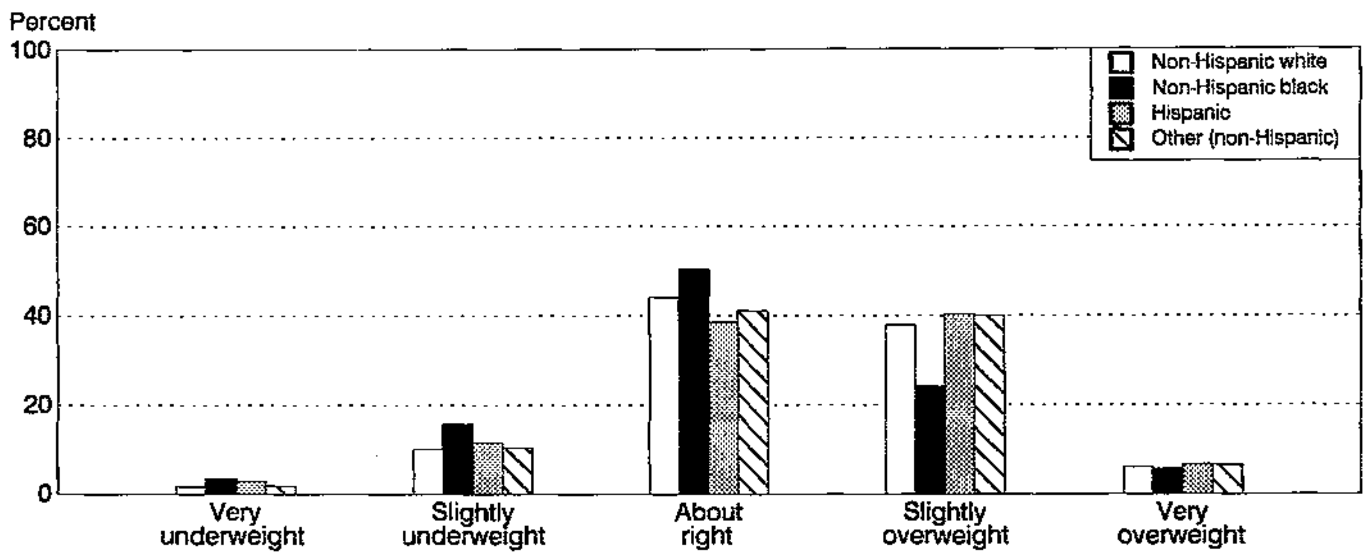

Figure 8-2. Self-perceived body weight status of female high school students, by race/ethnicity, 1991

NOTE: Data are from table A.F8-2,3 in appendix VA.

SOURCE: HHS, YRBS, 1991.

app. VA.) For adult women, the average body fat content is 28% (Forbes, 1990).

Self-perception of being overweight was examined in NHANES III 1988-91 and compared with actual body mass index (BMI) status based on measured height and weight. (See ch. 7 for a description of the derivation of the BMI cutoff values used in this report.) High percentages of people 20 years of age and older who were overweight by BMI classification (BMI ≥27.8 kg/m^2 for males and ≥27.3 kg/m^2 for females) thought of themselves as overweight (fig. 8-4). Overweight females were more likely than overweight males in all age categories to think of themselves as overweight. Among females 20-39 years of age who were overweight, 97% of non-Hispanic whites, 91% of non-Hispanic blacks, and 87% of Mexican Americans thought of themselves as overweight. Percentages in each of the racial/ethnic groups were similar for females 40-59 years of age. Fewer overweight women who were 60 years of age and older thought that they were overweight. Similarly, overweight males 60 years of age and older were less likely than younger males to think of themselves as overweight.

The percentage of individuals who were not overweight but thought of themselves as being overweight is shown in figure 8-5. Among non-Hispanic white females, 51% of women 20-39 years of age, 60% of those 40-59 years of age, and 39% of those 60 years of age and older who were not overweight thought that they were overweight. Percentages were lower (41-46%) for non-Hispanic black and Mexican-American females 20-39 and 40-59 years of age. Only 23% of Mexican-American women and 14% of non-Hispanic black women 60 years of age and older who were not overweight thought that they were overweight, compared with 39% of non-Hispanic white females of the same age. Lower percentages of males than females in all age categories who were not overweight perceived that they were overweight.

A similar pattern was observed in a sample of 3,511 female and 759 male main meal planners and preparers participating in DHKS 1989-91 (figs. 8-6 and 8-7). In this survey, BMI was calculated from self-reported height and weight. For female main meal planners and preparers, 96% of those who were severely overweight (BMI ≥32.3 kg/m^2) and 84% of those who were overweight (BMI 27.3-32.2 kg/m^2) thought of themselves as overweight. For female main meal planners and preparers who were not overweight but who thought of themselves as overweight, 34% had body weights in the acceptable category (BMI 19.1-27.2 kg/m^2) and 5% were underweight (BMI <19.1 kg/m^2). Of female main

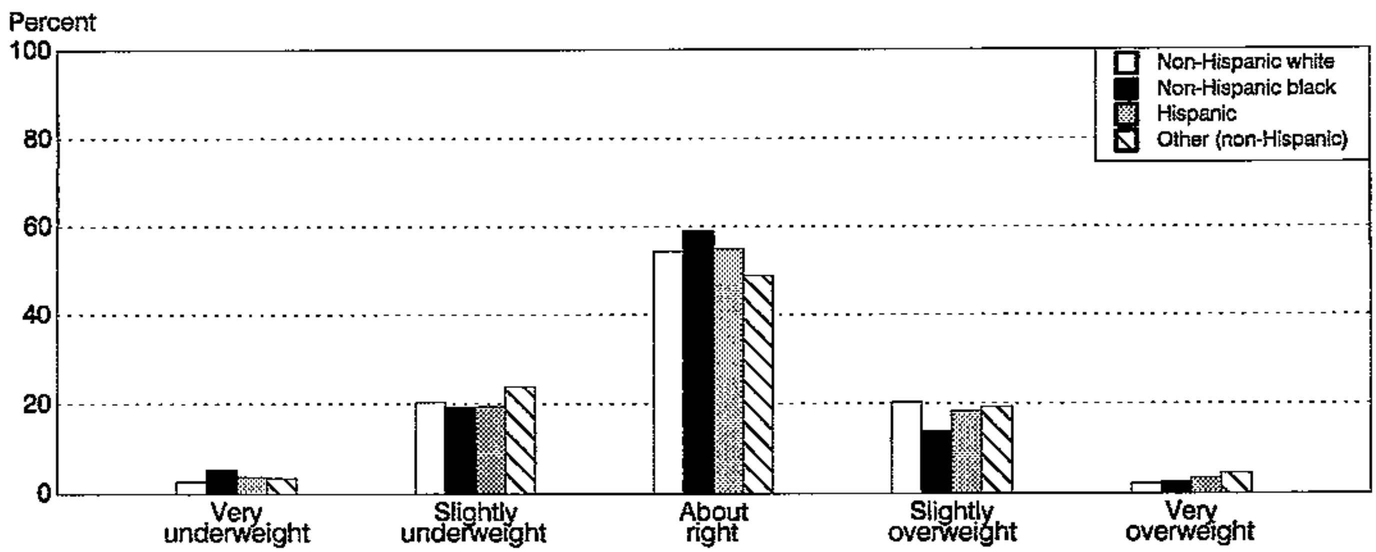

Figure 8-3. Self-perceived body weight status of male high school students, by race/ethnicity, 1991

NOTE: Data are from table A.F8-2,3 in appendix VA.

SOURCE: HHS, YRBS, 1991.

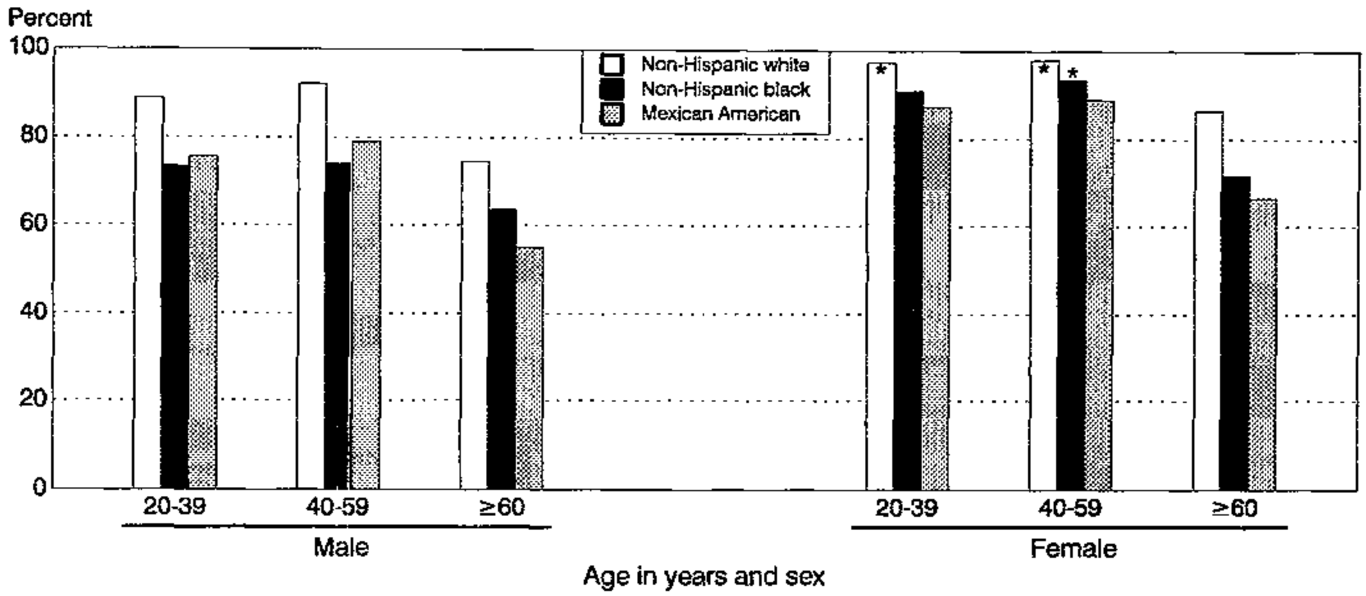

Figure 8-4. Self-perceived overweight: percentage of overweight people 20 years of age and older who think they are overweight, by age, sex, and race/ethnicity, 1988-91

NOTE: Data are from table A.F8-4,5 in appendix VA. "Overweight" was defined for males as body mass index (BMI) ≥27.8 kg/m^2 and for females as BMI ≥27.3 kg/m^2. Excludes pregnant females. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

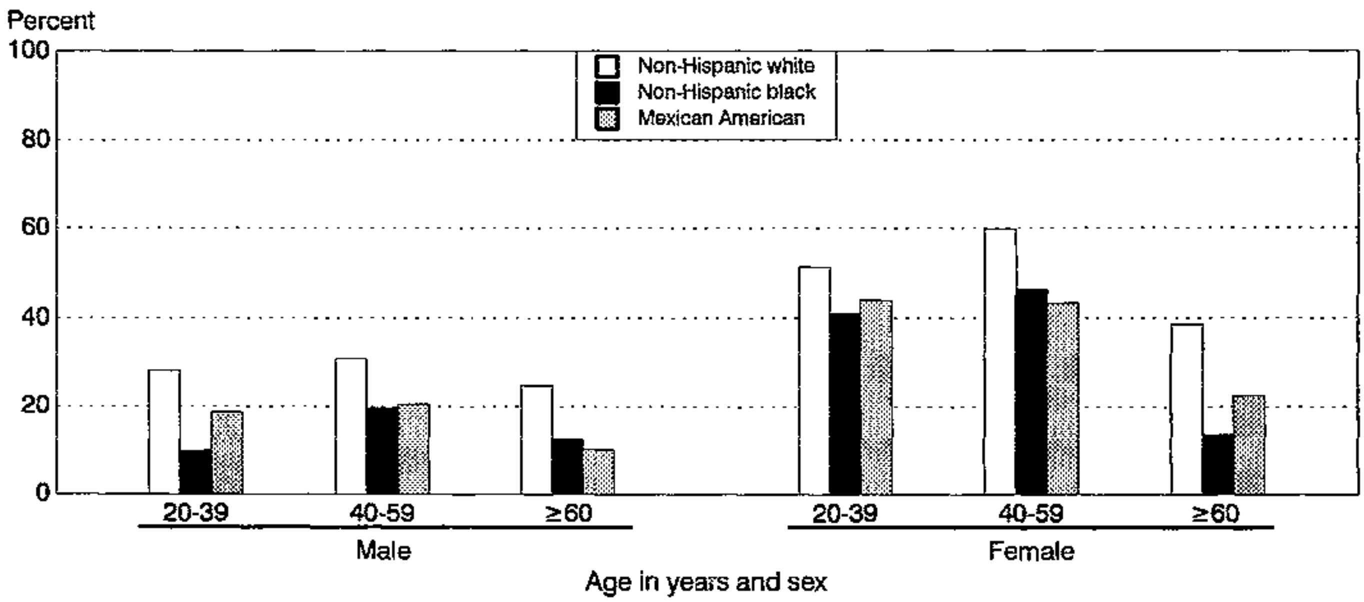

Figure 8-5. Self-perceived overweight: percentage of people 20 years of age and older who think they are overweight but are not overweight, by age, sex, and race/ethnicity, 1988-91

NOTE: Data are from table A.F8-4,5 in appendix VA. "Overweight" was defined for males as body mass index (BMI) ≥27.8 kg/m^2 and for females as BMI ≥27.3 kg/m^2. Male and female respondents had a measured BMI <27.8 and <27.3 kg/m^2, respectively. Excludes pregnant females.

SOURCE: HHS, NHANES III, 1988-91.

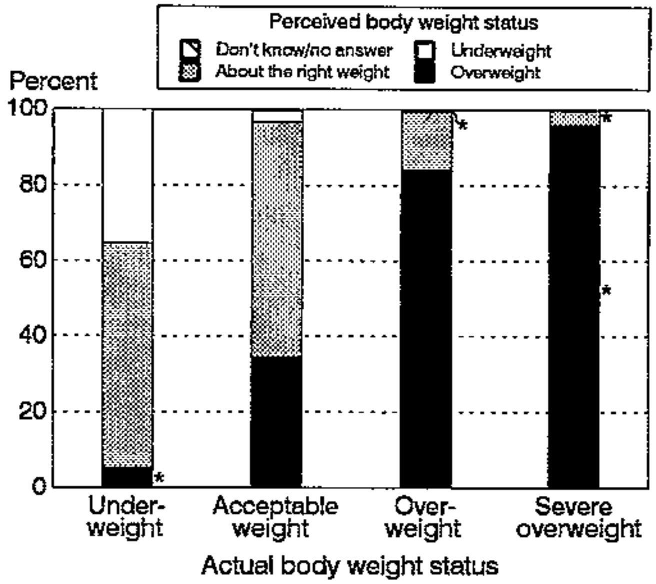

Figure 8-6. Self-perceived compared with actual body weight status of female main meal planners and preparers, 1989-91

NOTE: Data are from table A.F8-6,7 in appendix VA. To determine actual body weight status, self-reported height and weight were used to calculate body mass index (BMI). BMI measured as "underweight" (<19.1 kg/m²) was defined as less than the NHANES II 15th percentile. BMI measured as "acceptable weight" (19.1-27.2 kg/m²) was defined as greater than or equal to the NHANES II 15th percentile and less than the 85th percentile. BMI measured as "overweight" (27.3-32.2 kg/m²) was defined as greater than or equal to the NHANES II 85th percentile and less than the 95th percentile. BMI measured as "severe overweight" (≥32.3 kg/m²) was defined as greater than or equal to the NHANES II 95th percentile. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, DHKS, 1989-91; CSFII, 1989-91.

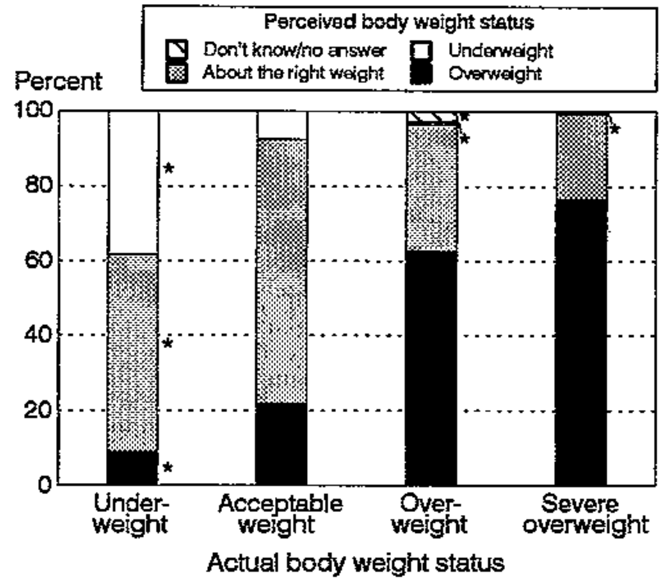

Figure 8-7. Self-perceived compared with actual body weight status of male main meal planners and preparers, 1989-91

NOTE: Data are from table A.F8-6,7 in appendix VA. To determine actual body weight status, self-reported height and weight were used to calculate body mass index (BMI). BMI measured as "underweight" (<20.7 kg/m²) was defined as less than the NHANES II 15th percentile. BMI measured as "acceptable weight" (20.7-27.7 kg/m²) was defined as greater than or equal to the NHANES II 15th percentile and less than the 85th percentile. BMI measured as "overweight" (27.8-31.0 kg/m²) was defined as greater than or equal to the NHANES II 85th percentile and less than the 95th percentile. BMI measured as "severe overweight" (≥31.1 kg/m²) was defined as greater than or equal to the NHANES II 95th percentile. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, DHKS, 1989-91; CSFII, 1989-91.

meal planners and preparers who were classified by BMI as underweight, 34% considered themselves to be underweight and 62% considered themselves to be about the right weight. For male main meal planners and preparers, 76% of those who were severely overweight (BMI ≥31.1 kg/m²) and 63% of those who were overweight (BMI 27.8-31.0 kg/m²) considered themselves to be overweight. Almost one-fourth of male main meal planners and preparers who were of an acceptable weight (BMI 20.7-27.7 kg/m²) thought of themselves as overweight. These data suggest that recognition of overweight may not be as great a problem as misrecognition of underweight among those who are underweight or misrecognition of overweight among those whose weight is normal. This misrecognition of weight status appears to be more common among females than males and among younger than older people.

Dieting and weight control

Because of the increasing prevalence of overweight in this country, the subject of weight control is of public health interest. In NHANES III 1988-91, people 20 years of age and older were asked whether they tried to lose weight in the past 12 months. On average, 30% of males and 53% of females reported that they tried to lose weight in the past 12 months. In every age group, higher percentages of non-Hispanic white females reported trying to lose weight than males or non-Hispanic black or Mexican-American females (fig. 8-8). As reported in chapter 7, the lowest prevalence of overweight was found among non-Hispanic white females in each age group, whereas the highest prevalence of overweight for females was found among non-Hispanic blacks. Lower percentages of non-Hispanic black females reported that they tried to lose weight in the past 12 months than of non-Hispanic white or Mexican-American females.

For males, the lowest prevalence of overweight was found among non-Hispanic blacks (see ch. 7). The highest prevalence of overweight among males, except in those 20-29 years of age, was among Mexican Americans, whose percentages of trying to lose weight fell between those of non-Hispanic white and non-Hispanic black males in each age group except the highest (≥80 years of age).

Additional analyses of the NHANES III 1988-91 data compared the current weight-loss practices of respondents with their BMIs. BMI cutoffs for various categories of body weight status, for males and females, respectively, were as follows: underweight, BMI <20.7 and <19.1 kg/m^2; acceptable weight, BMI 20.7-27.7 and 19.1-27.2 kg/m^2; and overweight, BMI ≥27.8 and ≥27.3 kg/m^2. The underweight category corresponded to values less than the NHANES II 15th percentile for BMI, whereas the overweight category corresponded to values greater than the NHANES II 85th percentile for BMI. More females than males reported that they were currently trying to lose weight regardless of their weight status (figs. 8-9 and 8-10). Higher percentages of overweight males and females reported that they were currently trying to lose weight than people in other weight categories. A higher percentage of females than males in the acceptable-weight category reported currently trying to lose weight. Percentages were highest for non-Hispanic white females 20-59 years of age; 42% reported that they were trying to lose weight compared with about one-third of non-Hispanic black females and 29-36% of Mexican-American females of the same age range.

Specific weight-loss practices used by people 18 years of age and older are shown in table 8-3 for participants who reported that they were currently trying to lose weight in WLPS 1991. More than 70% of males and females across racial/ethnic groups replied that they dieted and/or exercised to lose

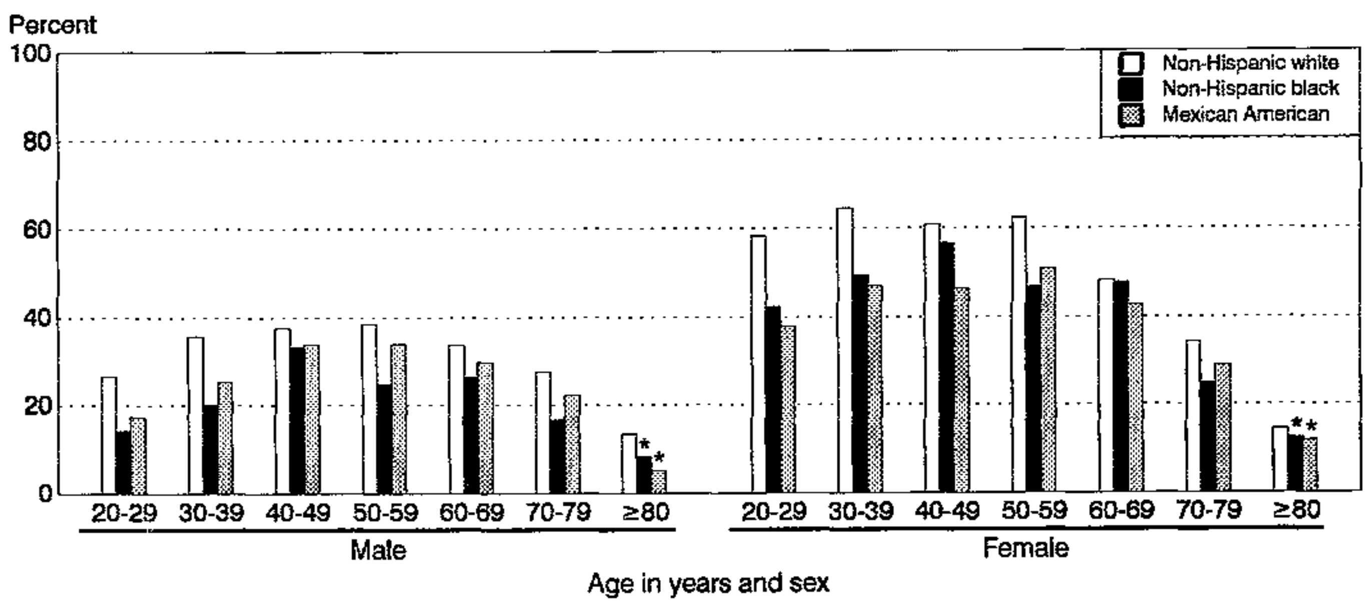

Figure 8-8. Percentage of people 20 years of age and older who have tried to lose weight during the past 12 months, by age, sex, and race/ethnicity, 1988-91

NOTE: Data are from table A.F8-8 in appendix VA. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: HHS, NHANES III, 1988-91.

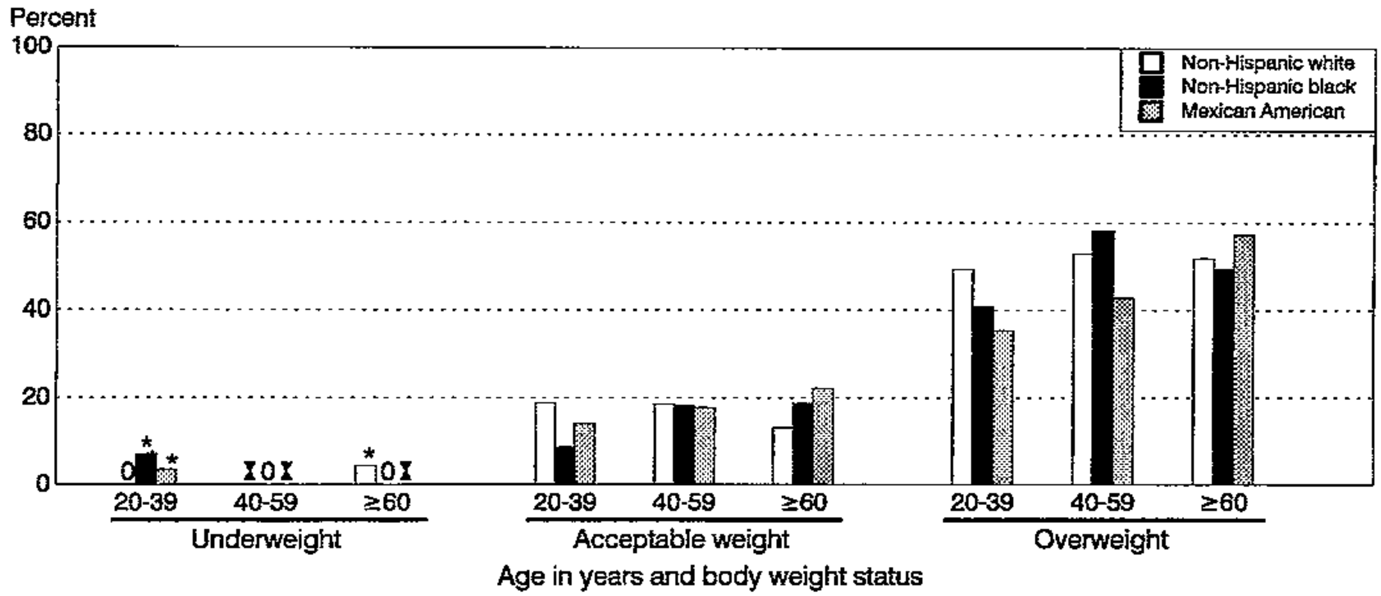

Figure 8-9. Percentage of males 20 years of age and older who are currently trying to lose weight, by age, race/ethnicity, and body weight status, 1988-91

NOTE: Data are from table A.F8-9,10 in appendix VA. Measured height and weight were used to calculate body mass index (BMI). Based on BMIs for males 20-29 years of age, "underweight" was defined as a BMI less than or equal to the NHANES II 15th percentile (<20.7 kg/m^2), "acceptable weight" as a BMI between the NHANES II 16th and 84th percentiles (20.7-27.7 kg/m^2), and "overweight" as a BMI greater than or equal to the NHANES II 85th percentile (≥27.8 kg/m^2). Percentages for non-Hispanic white males 20-39 years of age, non-Hispanic black males 40-59 and 60 years of age and older in the "underweight" category were 0%. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size; I indicates that minimum-sample-size requirements were not met.

SOURCE: HHS, NHANES III, 1988-91.

weight. Females were more likely than males to use over-the-counter products, meal replacements, and vitamins for weight loss and to participate in organized weight-loss programs. Use of fasting, laxatives, body wraps, vomiting, and surgery was reported by small percentages of the population.

The weight-loss practices of students in grades 9-12 were assessed in YRBS 1991. Higher percentages of females than males reported that they dieted to lose weight or to keep from gaining weight, whereas higher percentages of males than females reported that they exercised to lose weight or to keep from gaining weight (fig. 8-11). A combination of diet and exercise was the most commonly reported practice for losing weight or for avoiding gaining weight for females. About one-third of non-Hispanic white females reported that they followed these practices compared with 26% of Hispanic females, 11% of non-Hispanic black females, and 23% of females of other racial/ethnic groups (non-Hispanic). In contrast, 12% or less of males reported that they dieted and exercised to lose weight or to maintain their weight.

In NHANES III 1988-91, data on the current weight-loss practices of adolescents 12-19 years of age were collected (see table A.8b in app. VA). Among adolescents 12-15 years old, 19% reported that they were currently trying to lose weight, compared with 26% of adolescents 16-19 years old. Among overweight adolescents 12-15 and 16-19 years old, 44% and 56%, respectively, reported that they were making an effort to lose weight. The relatively high percentages of acceptable-weight adolescents 12-15 and 16-19 years of age who reported that they were trying to lose weight—12% and 19%, respectively—are of concern.

Exercise behavior

Participation in regular physical activity provides important health benefits, including lower risk for

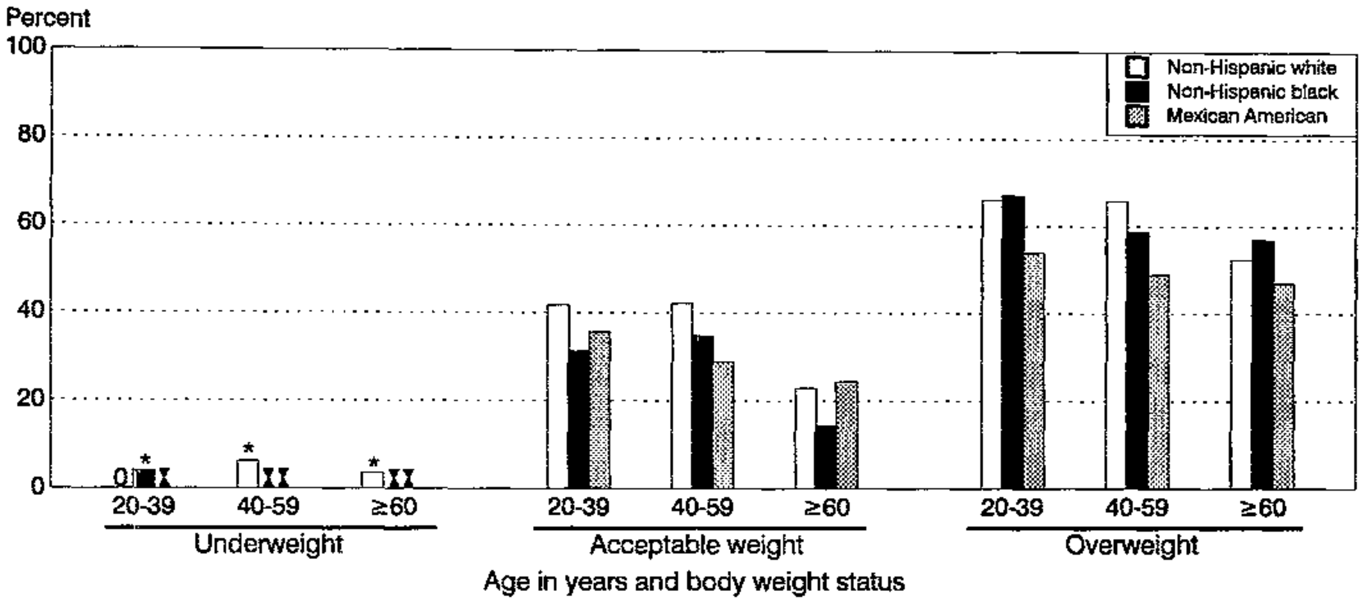

Figure 8-10. Percentage of females 20 years of age and older who are currently trying to lose weight, by age, race/ethnicity, and body weight status, 1988-91

NOTE: Data are from table A.F8-9,10 in appendix VA. Measured height and weight were used to calculate body mass index (BMI). Based on BMIs for females 20-29 years of age, "underweight" was defined as a BMI less than or equal to the NHANES II 15th percentile (<19.1 kg/m^2), "acceptable weight" as a BMI between the NHANES II 16th and 84th percentiles (19.1-27.2 kg/m^2), and "overweight" as a BMI greater than or equal to the NHANES II 85th percentile (≥27.3 kg/m^2). Percentage for non-Hispanic white females 20-39 years of age in the "underweight" category was 0%. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size; I indicates that minimum-sample-size requirements were not met. Pregnant females were excluded from analyses.

SOURCE: HHS, NHANES III, 1988-91.

Table 8-3. Prevalence of specific weight-loss practices followed by people 18 years of age and older who reported that they were currently trying to lose weight, by sex and race, 1991 (%)[1]

	Male			Female		
Weight-loss practice	White (*n*=294)	Black (*n*=83)	Other (*n*=22)	White (*n*=727)	Black (*n*=263)	Other (*n*=32)
Diet	82	85	73	86	89	86
Exercise	77	85	83	83	84	81
Vitamins	27	25	15	34	30	26
Meal replacements	13	11	15	15	21	21
Organized programs	4	6	4	13	12	17
Diet supplements	2	7	7	4	7	2
Over-the-counter products	7	11	8	13	18	15
Fasting	5	9	4	5	11	11
Laxatives	1	7	0	2	10	0
Body wraps	1	5	0	1	4	0
Vomiting	0	0	0	0	0	8
Surgery	3	0	0	0	0	0

[1]Meal replacements include products such as Ultra Slim-Fast® in powder, liquid, tablet, or wafer form. Diet supplements include products such as high-protein or high-fiber supplements in powder, liquid, tablet, or wafer form. Over-the-counter products include diet pills or appetite suppressants purchased over the counter without a prescription. Surgery includes liposuction, wired jaw, gastric bubble, and other medical procedures.

SOURCE: FDA, WLPS, 1991.

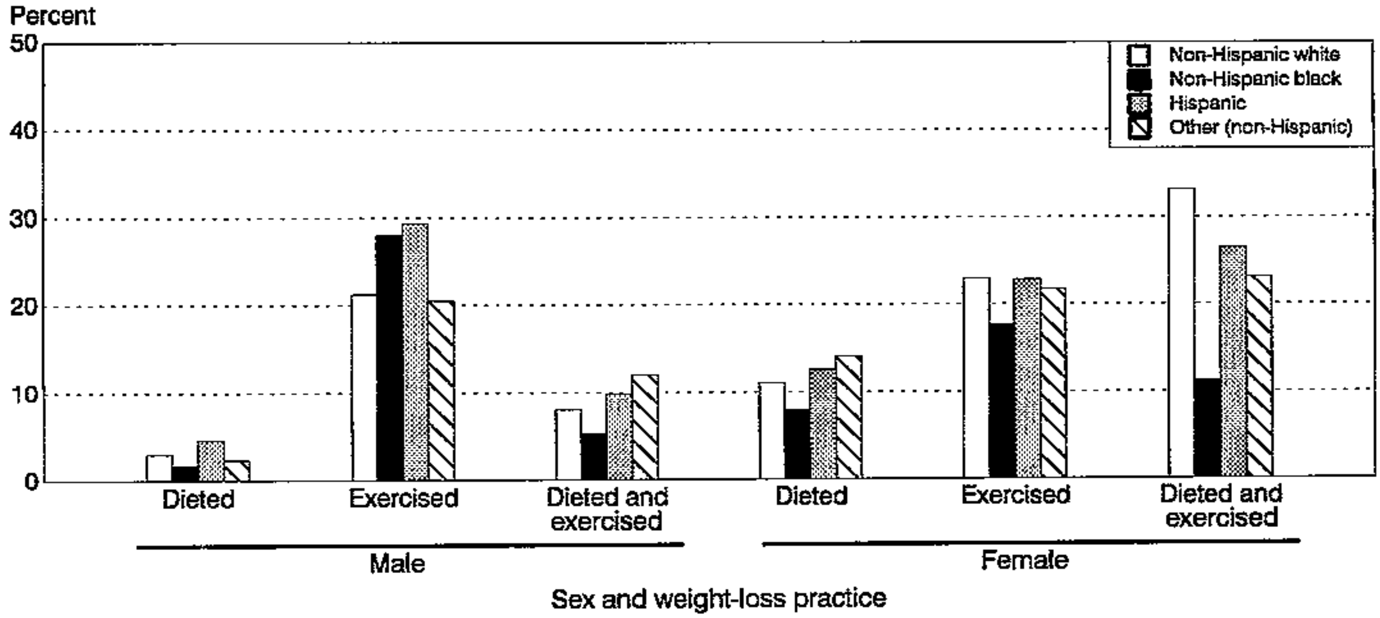

Figure 8-11. Percentage of high school students who dieted, exercised, and dieted and exercised to lose weight or keep from gaining weight, by sex and race/ethnicity, 1991

NOTE: Data are from table A.F8-11 in appendix VA.

SOURCE: HHS, YRBS, 1991.

coronary heart disease, stroke, hypertension, non-insulin-dependent diabetes mellitus, osteoporosis, obesity, some cancers, and mental health problems such as depression and anxiety (HHS, 1991). Patterns of physical activity established during childhood and adolescence place an adult at lower risk of chronic disease. However, despite the benefits of exercise, the majority of the population maintains a sedentary life-style.

Frequency and intensity of physical activity

The most recent data available on the frequency and intensity of exercise behaviors among adults are from BRFSS 1992. In this survey, adults 20 years of age and older were asked about the frequency, duration, and intensity of their leisure-time physical activities during the preceding month. Responses were grouped into one of three categories: 1) "no physical activity" (no physical activity in the past month), 2) "irregular physical activity" (any physical activity or pair of activities done for less than 20 minutes or less than three times a week), and 3) "regular physical activity" (any physical activity or pair of activities done for a total of 20 minutes or more per occasion three or more times a week at less than 50% of maximal cardiorespiratory capacity). Overall, 30% of males and 27% of females reported that they participated in regular physical activity (fig 8-12). Frequency of participating in regular exercise decreased with age, from 37% of people 20-29 years of age to 25% of people 60-69 years of age and 21% of people 70-79 years of age.

Data on leisure-time physical activity among adults 20 years of age and older during the past month were also collected in NHANES III 1988-91 and were similar to those reported above for BRFSS 1992. Participation in physical activity three or more times a week during leisure time was higher among males than females (60% and 49%, respectively) and tended to decrease with age. Sixty-one percent of non-Hispanic white and black males reported that they exercised three or more times a week during leisure time, compared with 45% of Mexican-American males. The percentage of non-Hispanic white females (52%) reporting regular physical activity was higher than that of non-Hispanic black (40%) and Mexican-American females (32%).

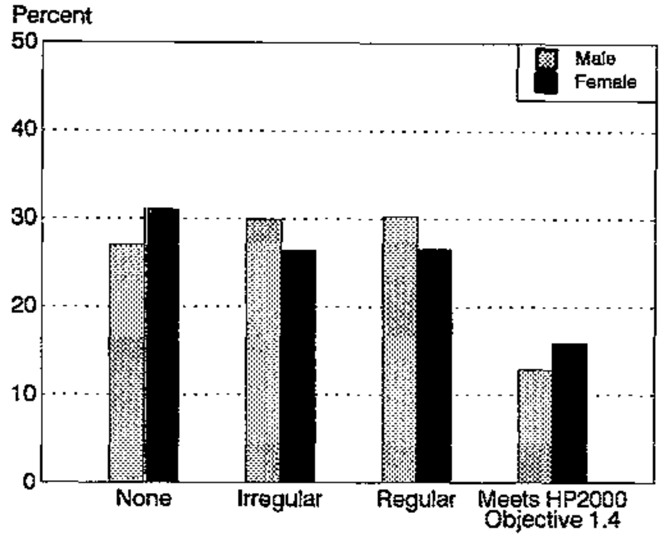

Figure 8-12. Prevalence of physical activity among people 20 years of age and older and percentage meeting the Healthy People 2000 (HP2000) objective for vigorous physical activity, by sex, 1992

NOTE: Data are from table A.F8-12 in appendix VA. "None" was defined as no physical activity in the past month. "Irregular" was defined as any physical activity or pair of activities done for <20 minutes or fewer than 3 times per week. "Regular" was defined as any physical activity or pair of activities done for ≥20 minutes 3 or more times per week at <50% of functional capacity. The HP2000 definition for "vigorous physical activity" is any rhythmic, repetitive physical activity that uses large muscle groups at ≥60% of maximum heart rate for age 3 or more days per week for ≥20 minutes per occasion. Maximum heart rate for age equals roughly 220 beats per minute minus age.

SOURCE: HHS, BRFSS, 1992.

As shown in figures 8-13 and 8-14, higher percentages of acceptable-weight than overweight non-Hispanic white and Mexican-American adult males and females in all age groups reported that they exercised three or more times a week during leisure time. In general, higher percentages of acceptable-weight than underweight non-Hispanic white males and females reported that they exercised three or more times a week during leisure time. These comparisons could not be made for non-Hispanic black and Mexican-American females because of inadequate data for the underweight groups.

Smaller percentages of non-Hispanic white males and females and Mexican-American females who exercised three or more times a week were overweight than of those who exercised less frequently (figs. 8-15 and 8-16). A higher percentage of adolescents 17-19 years of age reporting that they exercised three or more times a week during leisure time was of acceptable weight than overweight (see table A.8c in app. VA). The percentage of adolescents in this age group who exercised three or more times a week and were overweight was smaller than the percentage of adolescents who exercised less than once a week and were overweight (see table A.8d in app. VA).

The goal of Healthy People 2000 Objective 1.3 is to "increase to at least 30 percent the proportion of people aged 6 and older who engage regularly, preferably daily, in light to moderate physical activity for at least 30 minutes per day" (HHS, 1991). Because data on participation in regular physical activity by children and adolescents are not yet available, trends toward meeting this objective cannot be determined at this time.

Data from BRFSS 1992 indicated that 27% of male and 31% of female adults said that they did not participate in any physical activity in the past month (fig. 8-12). The prevalence of inactivity increased with age. Almost one-fourth of people 20-29 years of age reported that they did not engage in any physical activity in the past month, compared with 28% of people 40-49 years of age and about one-third of people aged 50-59 and 60-69 years. Healthy People 2000 Objective 1.5 is to "reduce to no more than 15 percent the proportion of people aged 6 and older who engage in no leisure time physical activity" (HHS, 1991). According to the BRFSS 1992 findings, it appears unlikely that this objective will be met by the year 2000.

The goal of Healthy People 2000 Objective 1.4 is to "increase to at least 20 percent the proportion of people aged 18 and older and to at least 75 percent the proportion of children and adolescents aged 6-17 who engage in vigorous physical activity that promotes the development and maintenance of cardiorespiratory fitness three or more days per week for 20 or more minutes per occasion." Vigorous physical activities are described in this objective as rhythmic, repetitive physical activities that use large muscle groups at 60% or more of maximum heart rate for age. An exercise heart rate of 60% of maximum heart rate for age is about 50% of maximal cardiorespiratory capacity and is sufficient for cardiorespiratory conditioning (HHS, 1991).

Figure 8-13. Percentage of males 20 years of age and older who exercised three or more times per week during leisure time, by age, race/ethnicity, and body weight status, 1988-91

NOTE: Data are from table A.F8-13,14 in appendix VA. Measured height and weight were used to calculate body mass index (BMI). Based on BMIs for males 20-29 years of age, "underweight" was defined as a BMI less than or equal to the NHANES II 15th percentile (<20.7 kg/m²), "acceptable weight" as a BMI between the NHANES II 16th and 84th percentiles (20.7-27.7 kg/m²), and "overweight" as a BMI greater than or equal to the NHANES II 85th percentile (≥27.8 kg/m²). Self-reported level of physical activity was used to determine frequency of participation in physical activity. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation; ⌶ indicates that minimum-sample-size requirements were not met.

SOURCE: HHS, NHANES III, 1988-91.

According to BRFSS 1992 data, only 13% of male and 16% of female adults reported physical activities or exercises vigorous enough to meet Healthy People 2000 Objective 1.4. Data from YRBS 1990 indicated that participation in vigorous physical activity by adolescents was also below the goals set in this objective (fig. 8-17). On average, 36% of male high school students and 15% of female high school students reported that they exercised vigorously for 20 or more minutes on 9 or more days in the past 14 days. Less than 15% of male and female high school students reported that they exercised vigorously for at least 20 minutes on 6-8 days in the past 14 days. Non-Hispanic white and Hispanic male students were more likely than male students who were non-Hispanic black or of other race/ethnicities (non-Hispanic) to report that they did not participate in any vigorous physical activity in the past 14 days. Nearly 40% of non-Hispanic black female students and of female students of other race/ethnicities (non-Hispanic), 29% of Hispanic female students, and 22% of non-Hispanic white female students reported no vigorous physical activity in the past 14 days.

Declines in vigorous activity were noted with each subsequent year of high school, especially in females. Among students aged 18 and older, 41% of males and 17% of females reported that they exercised vigorously for at least 20 minutes per occasion on 6 or more days in the past 14 days. In comparison, 50% of males and 23% of females 16-17 years of age and 53% of males and 30% of females 15 years of age and younger reported such practices. According to Heath et al. (1994), adolescents appear to spend considerably less time participating in physical activity than watching television.

A major limitation on the physical-activity estimates is that they are based on self-reported data, which can lead to over- and underestimates (CDC, 1995; Heath et al., 1994). Another limitation is that physical activity from nonleisure activities, such as occupational activities or walking or cycling to work, were not included in the BRFSS 1992 and the NHANES III 1988-91 estimates, which could have led to underestimates for some groups.

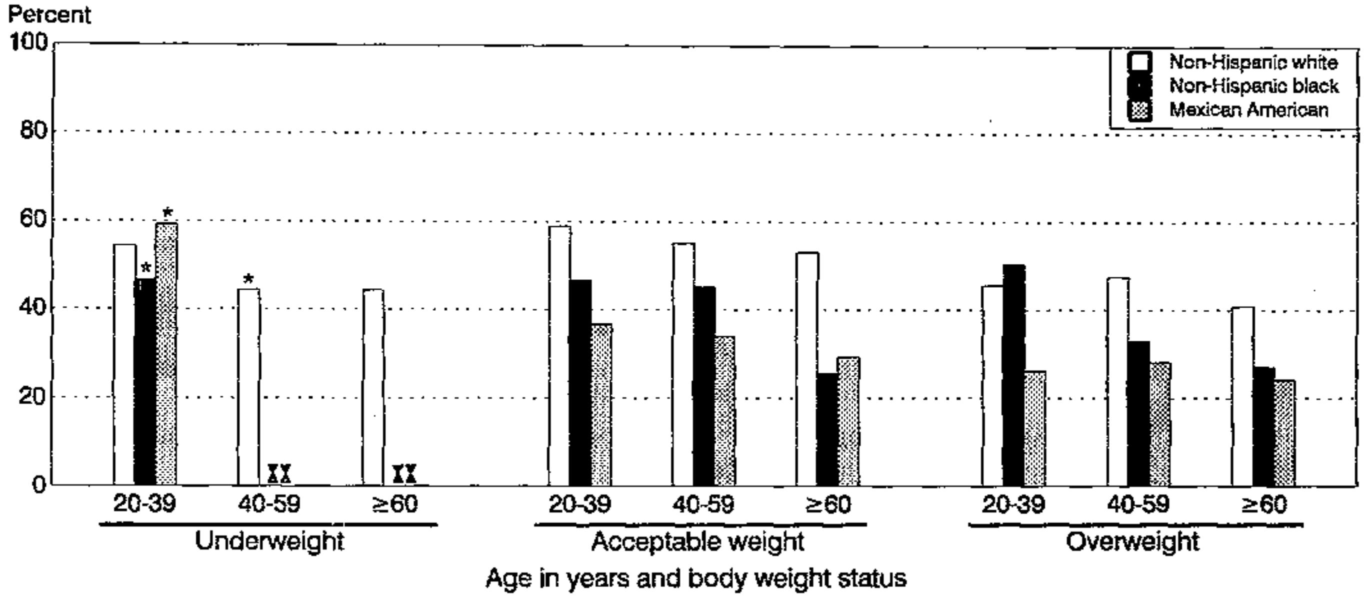

Figure 8-14. Percentage of females 20 years of age and older who exercised three or more times per week during leisure time, by age, race/ethnicity, and body weight status, 1988-91

NOTE: Data are from table A.F8-13,14 in appendix VA. Measured height and weight were used to calculate body mass index (BMI). Based on BMIs for females 20-29 years of age, "underweight" was defined as a BMI less than or equal to the NHANES II 15th percentile (<19.1 kg/m²), "acceptable weight" as a BMI between the NHANES II 16th and 84th percentiles (19.1-27.2 kg/m²), and "overweight" as a BMI greater than or equal to the NHANES II 85th percentile (≥27.3 kg/m²). Self-reported level of physical activity was used to determine frequency of participation in physical activity. An asterisk (*) indicates a statistic that is potentially unreliable because of a small sample size or large coefficient of variation; I indicates that minimum-sample-size requirements were not met. Pregnant females were excluded from analyses.

SOURCE: HHS, NHANES III, 1988-91.

Intensity of physical activity and television watching

Data from CSFII 1989-91 suggest that television watching was more prevalent among males and females 18 years of age and older who were light exercisers than among those who were heavy exercisers and heavy and moderate exercisers (fig. 8-18). Among people who considered themselves to be light exercisers, about 20% watched 5 or more hours of television per day. In contrast, among people classified as heavy exercisers and as heavy or moderate exercisers, about 10% watched 5 or more hours of television a day.

Awareness of diet and health relationships

An awareness of diet and health relationships is a prerequisite for adopting and maintaining healthier dietary behaviors. In DHKS 1989-91, the main meal planner and preparer in each household was asked whether he or she had heard about any health problems that might be related to how much fat, "saturated fat," cholesterol, fiber, sugar, iron, calcium, and salt or sodium a person eats and whether he or she had heard about any health problems that might be related to being overweight. (Quotation marks denote actual terms used in questionnaires.) If the respondents said that they had heard of any health problems related to a specific nutrient or food component or to being overweight, they were then asked to identify the health problems related to each nutrient or food component and to being overweight.

Awareness of diet and health relationships differed between female main meal planners and preparers of different races, ages, income categories, and education levels. White female main meal planners and preparers were more likely than their black counterparts to be aware of diet and health relationships. Awareness of health problems related to intakes of total fat, "saturated fat," cholesterol, fiber, sugar, iron, calcium, and salt or sodium and to being overweight was higher among female main meal planners and preparers 40-59 years of age than

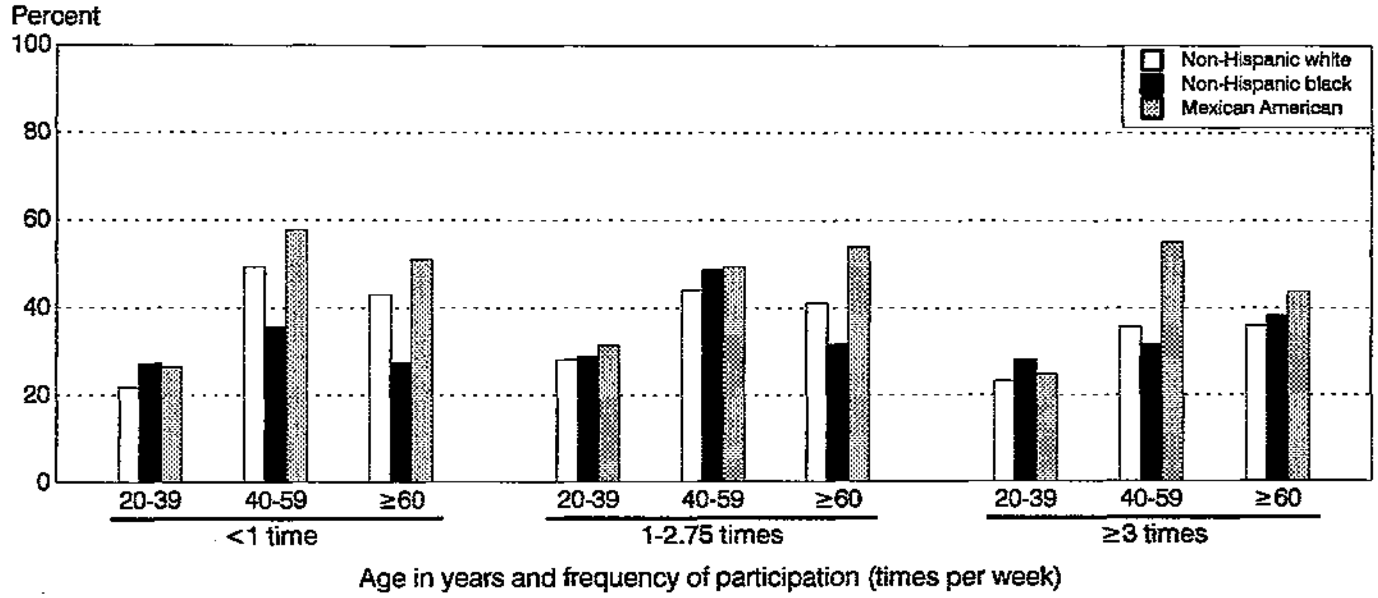

Figure 8-15. Percentage of males 20 years of age and older who are overweight (high BMI), by age, race/ethnicity, and frequency of participation in physical activity during leisure time, 1988-91

NOTE: Data are from table A.F8-15,16 in appendix VA. "Overweight" was defined as body mass index ≥27.8 kg/m^2. Self-reported level of physical activity was used to determine frequency of participation in physical activity.

SOURCE: HHS, NHANES III, 1988-91.

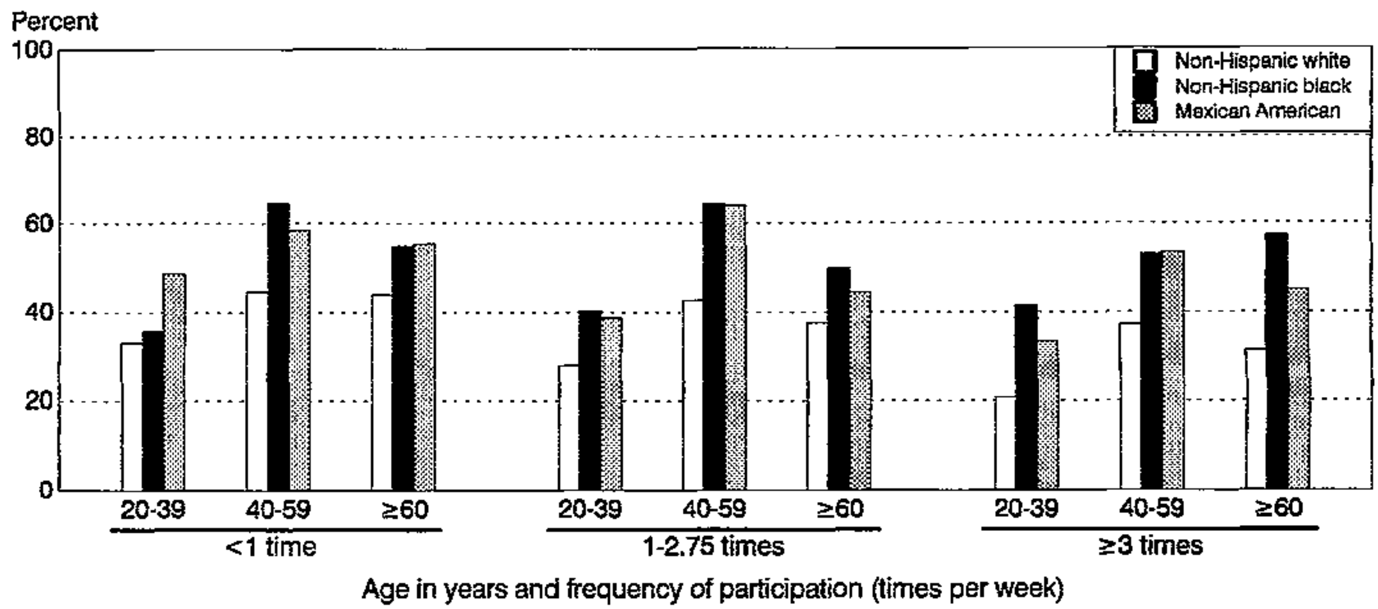

Figure 8-16. Percentage of females 20 years of age and older who are overweight (high BMI), by age, race/ethnicity, and frequency of participation in physical activity during leisure time, 1988-91

NOTE: Data are from table A.F8-15,16 in appendix VA. "Overweight" was defined as body mass index ≥27.3 kg/m^2. Self-reported level of physical activity was used to determine frequency of participation in physical activity. Pregnant females were excluded from analyses.

SOURCE: HHS, NHANES III, 1988-91.

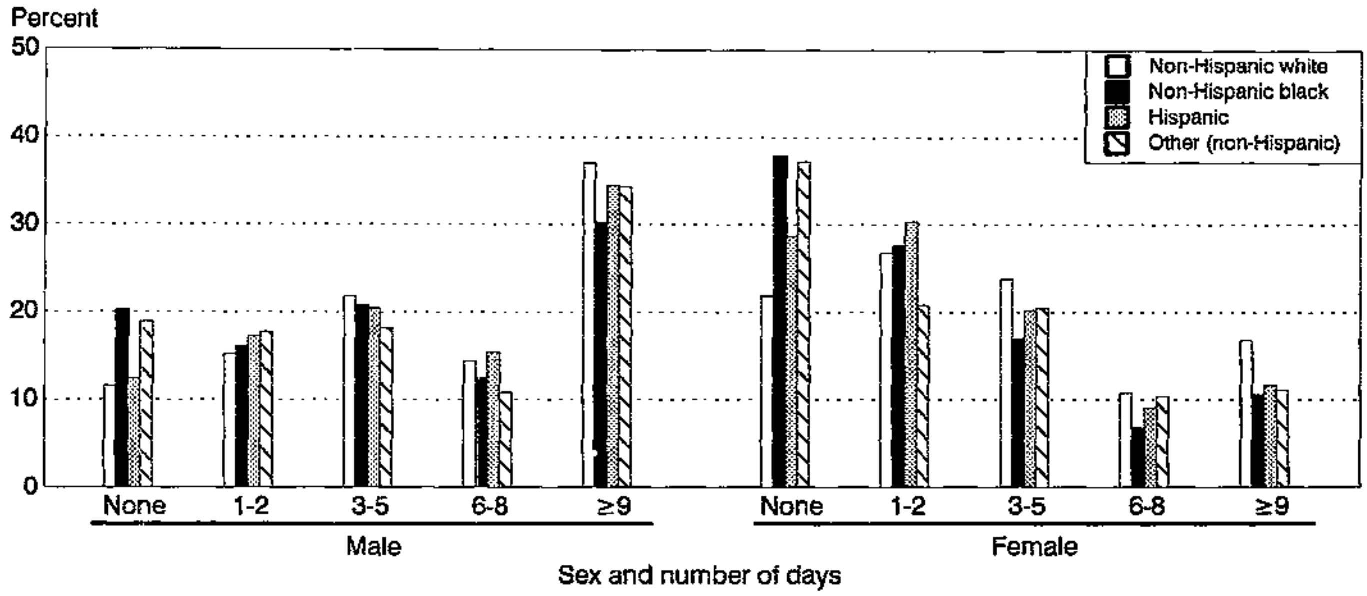

Figure 8-17. Frequency of participation in vigorous physical activity over the past 14 days among high school students, by sex and race/ethnicity, 1990

NOTE: Data are from table A.F8-17 in appendix VA. "Vigorous physical activity" was described to respondents as hard exercise done for at least 20 minutes that causes one to breathe heavily and makes the heart beat fast (e.g., playing basketball, jogging, fast dancing, and fast bicycling).

SOURCE: HHS, YRBS, 1990.

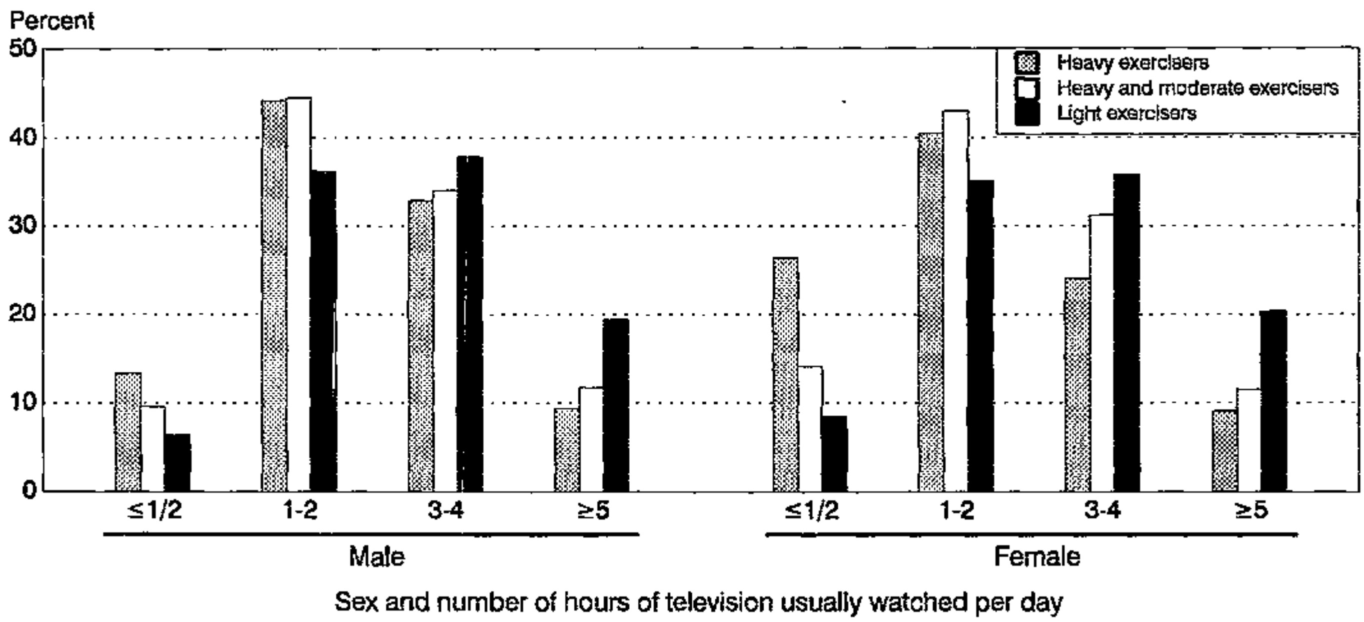

Figure 8-18. Percentage of people 18 years of age and older who are heavy exercisers, heavy and moderate exercisers, or light exercisers and who watch ≤1/2, 1-2, 3-4, or ≥5 hours of television per day, by sex, 1989-91

NOTE: Data are from tables A.F8-18a through A.F8-18f in appendix VA.

SOURCE: USDA, CSFII, 1989-91.

among those 39 years of age and younger and 60 years of age and older. Awareness of diet and health relationships increased with income level. Across all income levels, awareness of health problems related to being overweight was higher than awareness of health problems related to all other dietary components studied (table 8-4). Fairly high percentages of female main meal planners and preparers from all income levels reported that they were aware of health problems related to how much cholesterol, salt or sodium, and sugar a person eats. Regardless of income level, awareness of health problems related to cholesterol intake was higher than awareness of health problems related to intakes of total fat and "saturated fat." About 76% of female main meal planners and preparers from households with incomes >350% of poverty were aware of health problems related to calcium intake, compared with 51% of female main meal planners and preparers from households with incomes <131% of poverty. Sixty-three percent of those from households with incomes >350% of poverty were aware of health problems related to fiber and iron intake, compared with only 40% of those from households with incomes <131% of poverty. Awareness of diet and health relationships was also found to increase as education level increased. Although income level is often closely correlated with education level, education level generally has a greater influence on awareness of diet and health relationships than does income.

Almost 80% of female main meal planners and preparers from households with incomes >350% of poverty mentioned heart disease as a health problem related to being overweight. In contrast, only 56% of female main meal planners and preparers from households with incomes <131% of poverty responded in this manner. Hypertension and diabetes were mentioned as health problems related to being overweight by almost 40% and 20%, respectively, of female main meal planners and preparers from households with incomes >350% and 131-350% of poverty, compared with 30% and 11%, respectively, of those with household incomes <131% of poverty. Sixty-nine percent to 81% of female main meal planners and preparers from households with incomes >350% of poverty reported heart disease as a health problem related to intakes of total fat, "saturated fat," and cholesterol, compared with 40-55% of those from households with incomes <131% of poverty. Almost 75% of female main meal planners and preparers from households with incomes >350% of poverty mentioned hypertension as a health problem related to salt or sodium intake, whereas only 60% of those from households with incomes <131% of poverty

Table 8-4. Percentage of female main meal planners and preparers who are aware of health problems related to nutrient intakes and to being overweight, by income level, 1989-91 (%)[1]

Nutrient or condition	All	<131% poverty	131-350% poverty	>350% poverty
Total fat	79.6	63.7	79.1	87.9
Saturated fat	65.1	49.8	61.9	76.9
Cholesterol	86.7	72.0	86.0	93.4
Fiber	53.8	39.5	52.4	63.0
Sugar	82.9	77.3	83.0	85.9
Iron	53.7	43.1	52.0	60.3
Calcium	66.0	50.7	63.7	75.9
Salt or sodium	87.8	79.9	86.8	92.6
Being overweight	90.7	82.5	90.4	94.6

[1] Data are from tables A.T8-4a through A.T8-4i in appendix VA. Percentages are based on the number of respondents who provided 3 days of dietary intake data. Questions asked were as follows: Have you heard about any health problems that might be related to how much (nutrient) a person eats? Have you heard about any health problems that might be related to being overweight? If respondents answered yes to either question, they were asked, What health problems are these? (Multiple responses possible.)

SOURCE: USDA, DHKS, 1989-91; CSFII, 1989-91.

responded in this manner. About one-third of female main meal planners and preparers from households with incomes >350% of poverty and 25% of those from households with incomes <131% of poverty also mentioned heart disease as a health problem related to salt or sodium intake.

Of female main meal planners and preparers from households with incomes >350% of poverty, 64% mentioned bone problems or osteoporosis as a health problem related to calcium intake, compared with 39% of those from households with incomes <131% of poverty. Anemia was mentioned as a health problem related to iron intake by 47% of female main meal planners and preparers from households with incomes >350% of poverty and by 31% of those from households with incomes <131% of poverty. About one-third of female main meal planners and preparers from households with incomes >350% of poverty and 28% of those from households with incomes <131% of poverty associated bowel problems with fiber intake. Almost 30% of those from households with incomes >350% of poverty also mentioned cancer as a health problem related to fiber intake, whereas only 8% of those from households with incomes <131% of poverty responded in his manner. The percentages of female main meal planners and preparers from households with incomes 131-350% of poverty responding in a particular way generally fell between those of females from households with incomes in the higher and lower categories.

Perceived importance and use of dietary guidance

Food choices are influenced by many factors. In DHKS 1989-91, the main meal planner and preparer in the household was asked about factors considered important in grocery shopping. More than two-thirds of the female main meal planners and preparers rated taste, product safety, nutrition, food-storage quality, and price as highly important in grocery shopping (fig. 8-19). Ease of preparation was considered highly important by over half of the respondents.

Female main meal planners and preparers were also asked about their perceptions of the safety of certain foods (table 8-5). More than half of the respondents perceived that foods made at home with raw eggs, such as homemade ice cream or homemade mayonnaise, were safe to eat. About one-third of female main meal planners and preparers perceived that meat from animals that were given antibiotics or hormones at approved levels was safe. Fifteen

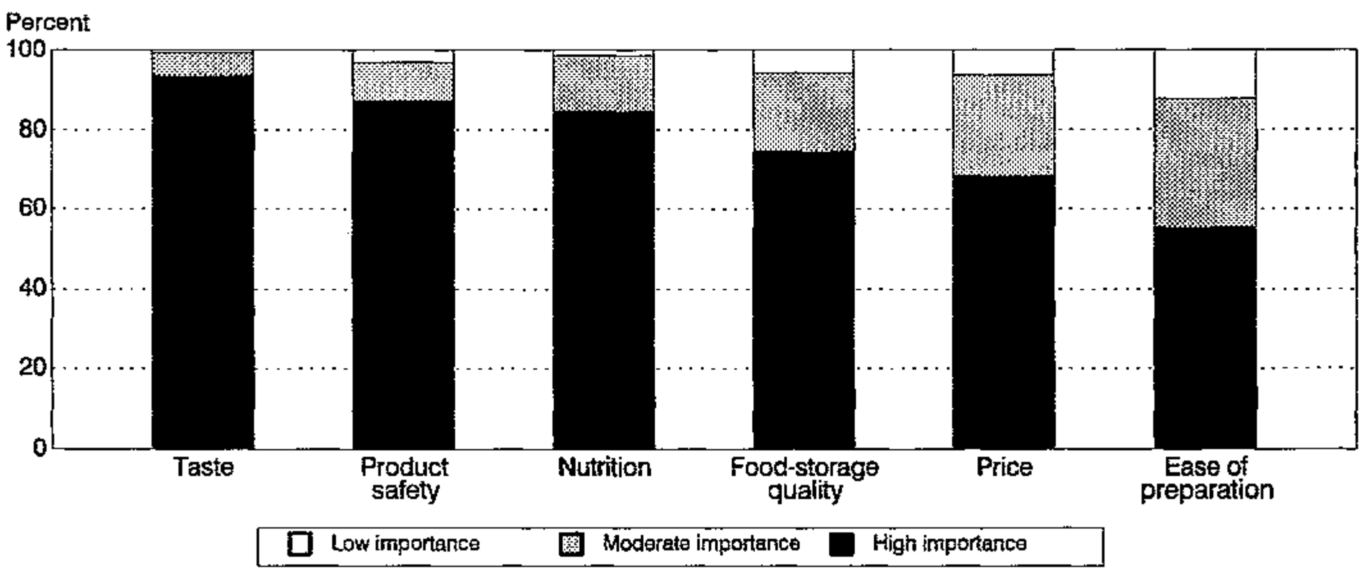

Figure 8-19. Perceived importance of selected factors in grocery shopping among female main meal planners and preparers, 1989-91

NOTE: Data are from table A.F8-19 in appendix VA. Percentages are based on respondents who provided 3 days of dietary intake data. All "don't know/no answer" values for all categories were ≤0.5%, and they are all potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, DHKS, 1989-91.

Table 8-5. Perceived safety of specified foods, as a percentage of respondents, among female main meal planners and preparers, 1989-91 (%)[1]

Food	Safe	Not safe	Don't know/no answer
Foods that have been treated with radiation	14.5	74.0	11.3
Meat from animals that have been given antibiotics at approved levels	37.9	53.1	8.9
Meat from animals that have been given hormones at approved levels	32.5	57.7	9.7
Foods made at home with raw eggs, such as homemade ice cream and homemade mayonnaise	56.3	35.8	7.8
Meat that has nitrite	14.7	65.7	19.5

[1]Data are from table A.T8-5 in appendix VA. Percentages are based on respondents who provided 3 days of dietary intake.

SOURCE: USDA, DHKS, 1989-91.

percent regarded meats containing nitrites and irradiated foods as safe.

When the DHKS 1989-91 data on awareness of specific diet and health relationships were stratified by the perceived importance of following related dietary guidance, main meal planners and preparers who were aware of diet and health relationships were found to be more likely than those who were not aware of diet and health relationships to report that following related dietary guidance was highly important to them personally (fig. 8-20). Female main meal planners and preparers were more likely than their male counterparts to report that following dietary guidance was highly important to them personally, regardless of whether they were aware of specific diet and health relationships.

One of the 1990 *Dietary Guidelines for Americans* is to maintain a healthy body weight by balancing energy intake with energy expenditure (USDA and HHS, 1990). Almost 80% of main meal planners and preparers who were aware of health problems related to being overweight and 70% of those who were not aware of such problems thought that it was highly important to them personally to maintain a healthy weight. However, despite high levels of awareness, the prevalence of overweight continues to increase in this country. This suggests that there is a strong need to educate Americans about how to translate knowledge about the health risks of being overweight into behavior appropriate for attaining or maintaining a healthy body weight.

The 1990 *Dietary Guidelines for Americans* also recommends that healthy people 2 years of age and older follow a diet that is low in fat, saturated fatty acids, and cholesterol and that includes plenty of fiber-rich foods such as fruits, vegetables, and grain products (USDA and HHS, 1990). Further recommendations are to use sugars and salt and sodium only in moderation. Among main meal planners and preparers who were aware of health problems related to how much fat a person eats, two-thirds reported that choosing a diet low in fat was highly important to them personally, whereas only about half of those who were not aware of health problems related to fat intake reported that following this dietary guidance was highly important to them personally. Seventy-two percent of main meal planners and preparers who were aware of health problems related to how much "saturated fat" a person eats reported that it was highly important to them personally to choose a diet low in "saturated fat." In contrast, 58% of those who were not aware of this diet and health relationship reported such beliefs.

Seventy-two percent of main meal planners and preparers who were aware and 61% of those who were not aware of health problems related to cholesterol intake reported that it was highly

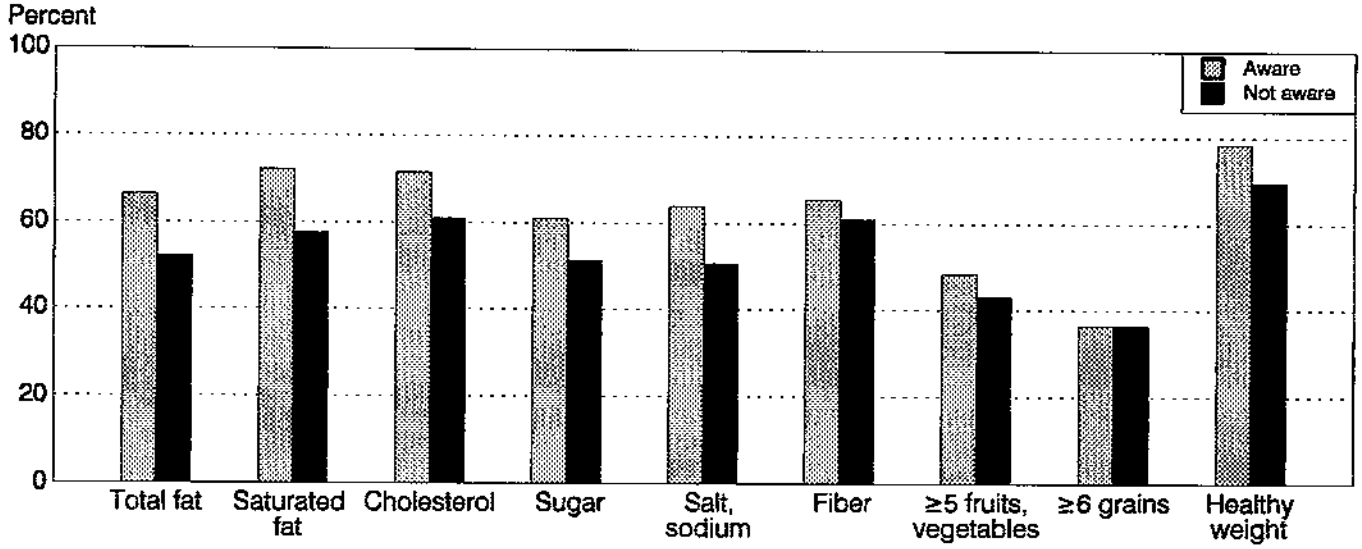

Figure 8-20. Percentage of main meal planners and preparers who said it was of high importance to them personally to follow dietary guidance on selected topics, by awareness of health problems associated with not following the guidance, 1989-91

NOTE: Data are from tables A.F8-20a through A.F8-20i in appendix VA. Percentages are based on data from respondents who provided 3 days of dietary intake.

SOURCE: USDA, DHKS, 1989-91.

important to them personally to choose a diet low in cholesterol. A slightly higher percentage (66%) of main meal planners and preparers who were aware of health problems related to how much fiber a person eats reported that it was highly important to them personally to choose a diet adequate in fiber than those who were not aware of health problems related to fiber intake (61%). Slightly more than 60% of those who were aware of health problems related to salt or sodium and sugar intake reported that it was highly important to them personally to use salt or sodium and sugar only in moderation. In comparison, 51% of those who were not aware of these diet and health relationships reported that using salt or sodium and sugar in moderation was highly important to them personally. Following dietary guidance on consuming at least 5 servings of fruits and vegetables and at least 6 servings of grain products per day was perceived as highly important by less than half of the respondents, regardless of awareness of health problems related to fiber intake.

To be aware of diet and health relationships, individuals need to have access to nutrition information. Among household food managers interviewed in NFCS 1987-88, the most frequently used sources of nutrition information were newspapers, magazines, and books and food packages or labels (fig. 8-21). About one-third of household food managers reported doctors, nurses, or other health professionals and radio or television as sources of nutrition information, whereas about one-fourth reported relatives or friends as sources of nutrition information. Fewer than 20% used nutritionists, dietitians, home economists, or extension agents; government or health organizations; or food-company publications as sources of nutrition information. The prevalence of the use of newspapers, magazines, and books; food packages or labels; radio and television; relatives and friends; and food-company publications as sources of nutrition information was higher for households with higher than lower incomes. Food managers in households with incomes >350% of poverty were almost twice as likely as those in households with incomes <131% of poverty to report that they used newspapers, magazines, and books and food packages or labels as sources of nutrition information.

Doctors, nurses, or other health professionals were the most preferred source of nutrition information among household food managers, followed by newspapers, magazines, and books (fig. 8-22).

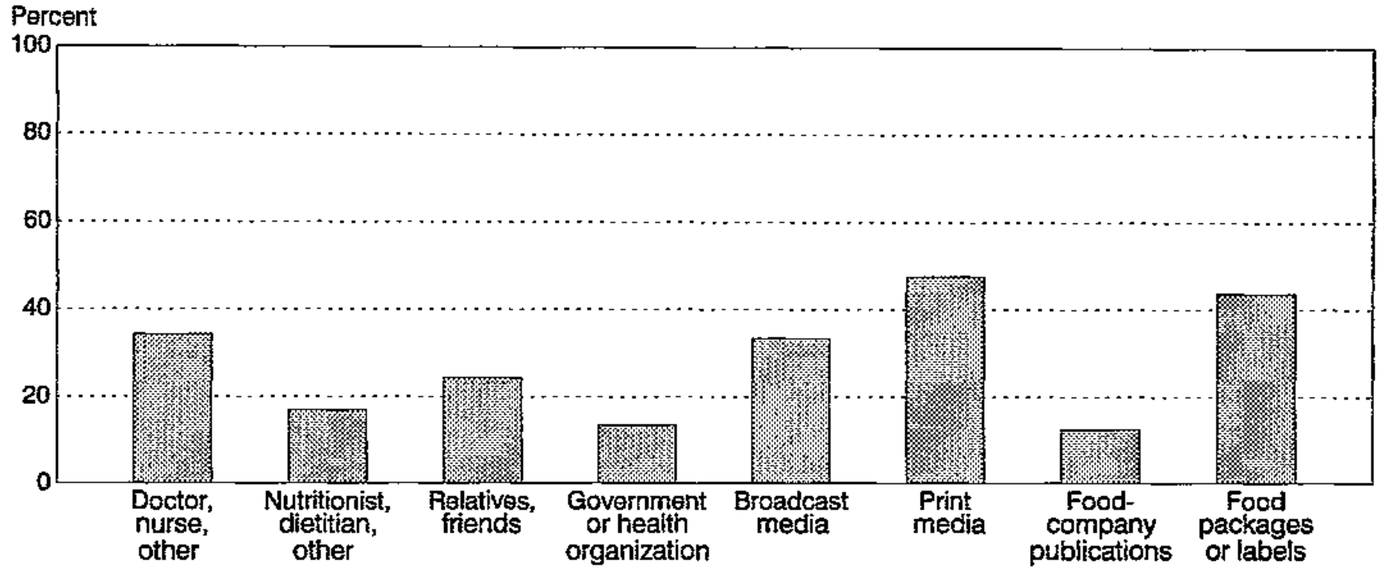

Figure 8-21. Percentage of households that reported using specific sources of nutrition information, 1987-88

NOTE: Data are from table A.F8-21 in appendix VA. "Other" in column 1 means "other health professionals"; in column 2, it means "home economist or extension agent."

SOURCE: USDA, NFCS, 1987-88.

Because health professionals and print media serve as a major source of nutrition information, it is critical that these sources provide sound information. Nutritionists, dietitians, home economists, or extension agents and food packages or labels were the preferred sources of information by about one-eighth of household food managers. Less-preferred sources of nutrition information were radio and television, relatives and friends, government or health organizations, and food-company publications. Food managers in households with incomes >350% of poverty were twice as likely as those in households with incomes <131% of poverty to report newspapers, magazines, and books as their preferred source of nutrition information.

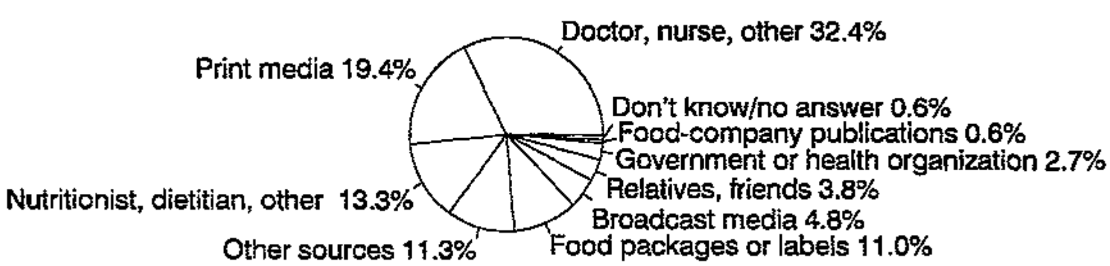

Figure 8-22. Preferred source of nutrition information among household food managers, 1987-88

NOTE: Data are from table A.F8-22 in appendix VA. "Other" after "Doctor, nurse" means "other health professionals"; after "nutritionist, dietitian," it means "home economist or extension agent."

SOURCE: USDA, NFCS, 1987-88.

The use of the nutrition panel on food labels by main meal planners and preparers was assessed in DHKS 1989. Female main meal planners and preparers were more likely than male main meal planners and preparers to report that they always or sometimes used the nutrition panel on food labels (74% and 55%, respectively). About 20% of female and male main meal planners and preparers reported that they always used the nutrition panel on food labels. More than one-half (54%) of female main meal planners and preparers said that they sometimes used the nutrition panel on food labels compared with 36% of male main meal planners and preparers. Ten percent of female main meal planners and preparers reported that they never used the nutrition panel on food labels, whereas 23% of male main meal planners and preparers reported such practices.

Female main meal planners and preparers 40-59 years of age reported a higher frequency of use of the nutrition panel on food labels than those 39 years of age or younger or 60 years of age or older, with 81% of respondents in this age range reporting that they always or sometimes used the nutrition panel on food labels (fig. 8-23). Among female main meal planners and preparers 39 years of age and younger, 75% reported that they always or sometimes used the nutrition panel on food labels, compared with 68% of those 60 years of age and older. Female main meal planners and preparers 60 years of age and older were about twice as likely to report that they never used the nutrition panel on food labels than female main meal planners and preparers who were less than 60 years of age. Female main meal planners and preparers who were white, of upper income levels, and more educated were more likely than those who were black, of lower income levels, and less educated to report that they always or sometimes used the nutrition panel on food labels. Female main meal planners and preparers who were black were almost twice as likely never to use the nutrition panel on food labels than those who were white.

Twenty percent of female main meal planners and preparers in households with incomes <131% of poverty reported that they never used the nutrition panel on food labels, compared with only 3% in households with incomes >350% of poverty. One-fourth of female main meal planners and preparers with an eighth-grade education or less reported never using the nutrition panel on food labels. In contrast, less than 10% of more-educated female main meal planners and preparers reported never doing so.

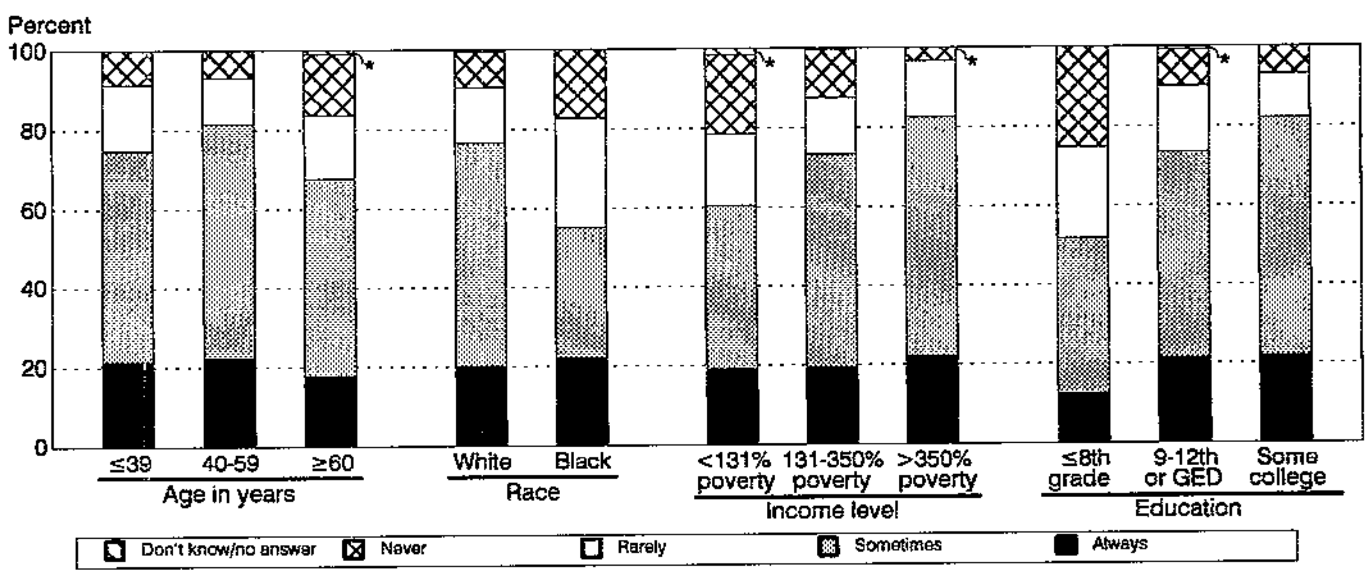

Figure 8-23. Frequency of use of the nutrient panel on food labels by female main meal planners and preparers, by age, race, income level, and education, 1989

NOTE: Data are from table A.F8-23 in appendix VA. GED, general equivalency diploma. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, DHKS, 1989.

In 1994, the "Nutrition Facts" food label was introduced. This new food label appears on virtually all food products and was designed to provide consumers with an easy-to-use tool to help them eat a more healthful diet. Continued research is needed to determine whether the new food label is easy to read and understand and whether the use of food labels has increased since 1994.

Although consumer knowledge about dietary fats and cholesterol is relatively poor, knowledge improved in some areas between 1983 and 1990 (table 8-6). According to findings from HDS 1990, 60% or more of the individuals 18 years of age and older who were interviewed were aware that "saturated fats" are usually found in animal products; that "polyunsaturated fats" are usually found in vegetables and vegetable oils; and that "saturated fats" are more likely than "polyunsaturated fats" to raise blood cholesterol levels. Only about half of the individuals who were surveyed in 1983 were knowledgeable about these issues. In 1990, 54% of the respondents knew that cholesterol is not the same thing as "saturated fat" or "polyunsaturated fat," up from 36% in 1983.

Knowledge about hydrogenation of fats and oils increased between 1983 and 1990 while knowledge about some dietary fat and cholesterol issues remained about the same. In 1990, about 1 in 4 people interviewed knew that fats and oils become more saturated when they are hydrogenated, up from 1 in 10 in 1983. In 1983 and 1990, only about one-third of respondents knew that "polyunsaturated fats" are more likely to be a liquid than a solid and that cholesterol is found only in animal products, and only about one-fifth knew that all fats are similar in their caloric value.

Self-assessment of nutrient intake

Perceived adequacy of diet

In DHKS 1989-91, the main meal planner and preparer in the household was asked to rate his or her own diet in terms of its adequacy in meeting dietary recommendations. Food components that were evaluated included many of those determined by the Expert Panel on Nutrition Monitoring (EPONM) in 1989 to be either current or potential public health

Table 8-6. Percentage of people 18 years of age and older providing correct responses to questions about fat and cholesterol knowledge, 1983 and 1990 (%)[1]

Correct response	Year of survey: 1983	Year of survey: 1990
Saturated fats usually are found in animal products such as meat and dairy products.	55	69
Polyunsaturated fats usually are found in vegetables and vegetable oils.	55	61
Polyunsaturated fats are more likely to be a liquid rather than a solid.	32	36
Saturated fats are more likely than polyunsaturated fats to raise people's blood cholesterol level.	52	60
Saturated fats and polyunsaturated fats are similar in their caloric value.	21	26
Cholesterol is not the same thing as saturated fat or polyunsaturated fat.	36	54
If a fat or oil has been hydrogenated, it has become more saturated.	10	26
Cholesterol is found in animal products such as meat and dairy products.	31	32

[1]Data are from table A.T8-6 in appendix VA.

SOURCE: HHS, HDS, 1983 and 1990.

issues: fat, saturated fatty acids, cholesterol, vitamin C, calcium, iron, salt or sodium, and fiber (LSRO, 1989). Higher percentages of white than black male main meal planners and preparers thought that their diet should be lower in "saturated fat" and cholesterol (table 8-7) and higher in vitamin C, iron, and fiber (table 8-8), whereas black male main meal planners and preparers were more likely than their white male counterparts to think that their diet should be lower in fat and salt or sodium.

Among females in DHKS 1989-91, a higher percentage of black than white main meal planners and preparers thought that their diet should be lower in fat, "saturated fat," cholesterol, and salt or sodium and higher in vitamin C, calcium, iron, and fiber. When compared with male main meal planners and preparers, a higher percentage of female main meal planners and preparers thought that their diet should be higher in calcium and iron. Compared with white female and white or black male main meal planners and preparers, a higher percentage of black female main meal planners and preparers thought that their diet should contain less "saturated fat," cholesterol, and salt or sodium and more vitamin C, calcium, iron, and fiber.

Perceived adequacy of diet compared with dietary recommendations

When perceived adequacy of diet for female main meal planners and preparers from DHKS 1989-91 is compared with their actual 3-day mean intakes from CSFII 1989-91, it is possible to get a sense of how well female main meal planners and preparers recognized the direction of change needed to meet dietary recommendations. Data in table 8-9 show the actual dietary status of the female main meal planners and preparers compared with what they think they should be doing to meet dietary recommendations for various food components.

Table 8-7. Perceived adequacy of own diet for fat, "saturated fat," and cholesterol among main meal planners and preparers, as a percentage of respondents, by sex and race, 1989-91 (%)[1]

Food component, sex, and race	Should be lower	Should be higher	About right	Don't know/ no answer
Fat				
Male				
White	49.7	5.2	42.3	2.8*
Black	60.8	2.4*	35.2	1.6*
Female				
White	53.9	2.1	43.1	0.9
Black	60.8	5.1	33.3	0.8*
"Saturated fat"				
Male				
White	44.0	2.4*	44.7	8.9
Black	31.2	1.8*	50.9	16.1*
Female				
White	43.3	1.4	50.9	4.4
Black	53.5	0.9*	37.8	7.7
Cholesterol				
Male				
White	39.8	2.5*	51.6	6.1
Black	34.1	6.4*	49.6	9.9*
Female				
White	39.9	1.3	54.9	3.9
Black	52.6	1.0*	40.8	5.5

[1]Data are from tables A.T8-7a through A.T8-7f in appendix VA. Percentages are based on data from respondents who provided 3 days of dietary intake. Percentages for each sex and race category may not add up to 100% because of rounding. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, DHKS, 1989-91.

Table 8-8. Perceived adequacy of own diet for vitamin C, calcium, iron, salt or sodium, and fiber among main meal planners and preparers, as a percentage of respondents, by sex and race, 1989-91 (%)[1]

Food component, sex, and race	Should be lower	Should be higher	About right	Don't know/ no answer
Vitamin C				
Male				
White	4.1	36.6	55.3	4.0
Black	3.0*	22.0	68.3	6.7*
Female				
White	1.9	32.0	63.9	2.1
Black	2.6*	44.4	50.2	2.8*
Calcium				
Male				
White	5.8	25.3	62.5	6.4
Black	4.9*	24.3	62.9	8.0*
Female				
White	3.0	39.7	53.9	3.4
Black	8.2	45.1	42.6	4.1
Iron				
Male				
White	2.6*	24.8	63.8	8.8
Black	5.9*	19.3	64.2	10.6*
Female				
White	1.5	35.2	58.5	4.8
Black	6.9	48.2	40.9	4.0
Salt or sodium				
Male				
White	32.7	3.2	61.8	2.3*
Black	40.3	2.4*	56.2	1.1*
Female				
White	30.3	1.7	67.3	0.7
Black	46.2	1.7*	51.6	0.5*
Fiber				
Male				
White	3.0	39.1	52.2	5.7
Black	1.0*	29.2	63.7	6.1*
Female				
White	3.4	38.3	56.5	1.8
Black	6.7	49.2	40.2	3.9

[1]Data are from tables A.T8-8a through A.T8-8j in appendix VA. Percentages are based on data from respondents who provided 3 days of dietary intake. Percentages for each sex and race category may not add up to 100% because of rounding. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation.

SOURCE: USDA, DHKS, 1989-91.

Table 8-9. Perceived adequacy of own diet for selected food components considered to be current or potential public health issues among female main meal planners and preparers, by status in meeting dietary recommendations, as a percentage of respondents, 1989-91 (%)[1]

Public health issue status, food component, and actual dietary status of respondent[2]	Should be lower	Should be higher	About right	Don't know/ no answer
Current public health issue				
Fat				
≤30% of calories (*n*=867)	48.3	1.6*	49.0	1.0*
>30% of calories (*n*=2,713)	57.1	2.6	39.4	0.9
Saturated fat				
<10% of calories (*n*=942)	40.9	1.7*	53.4	4.0
≥10% of calories (*n*=2,638)	45.9	1.3	47.3	5.4
Cholesterol				
<300 mg (*n*=2,820)	41.4	0.8	53.6	4.2
≥300 mg (*n*=760)	42.2	3.3	50.0	4.5
Vitamin C				
≥100% RDA (*n*=1,905)	1.7	29.4	66.7	2.2
<100% RDA (*n*=1,675)	2.4	39.9	55.6	2.2
Calcium				
≥100% RDA (*n*=699)	3.2	34.1	60.6	2.1*
<100% RDA (*n*=2,881)	3.7	42.5	50.0	3.8
Iron				
≥100% RDA (*n*=1,048)	2.1	29.2	64.0	4.7
<100% RDA (*n*=2,532)	2.4	39.9	52.6	5.0
Potential public health issue				
Fiber				
≥20 g (*n*=2,290)	4.5	27.2	66.9	1.5*
<20 g (*n*=3,290)	3.7	40.5	53.5	2.3

[1]Percentages are based on data from respondents who provided 3 days of dietary intake. Percentages may not add up to 100% because of rounding. An asterisk (*) indicates a statistic that is potentially unreliable because of small sample size or large coefficient of variation. RDA, Recommended Dietary Allowance.
[2]The dietary recommendation is the first item below each food component.

SOURCE: USDA, DHKS, 1989-91; CSFII, 1989-91.

According to the 1990 *Dietary Guidelines for Americans* and Healthy People 2000 Objective 2.5, healthy Americans 2 years of age and older should follow a diet that provides ≤30% of calories from fat and <10% of calories from "saturated fat" (USDA and HHS, 1990; HHS, 1991). NHLBI further suggests that cholesterol intake be reduced to less than 300 mg/d (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II), 1993; Expert Panel on Blood Cholesterol Levels in Children and Adolescents, 1991). Among female main meal planners and preparers who had a total fat intake greater than 30% of calories, 57% thought that their diet should be lower in fat and 39% thought that their diet contained about the right amount of fat. Among those whose diet met the dietary recommendation, 48% thought that their diet should be lower in fat and 49% thought that their diet contained about the right amount of fat. Among those whose diet contained recommended levels of "saturated fat," 41% thought that their diet should be lower in that nutrient. Similarly, 41% of female main meal planners and preparers who had diets containing recommended levels of cholesterol thought that their diet should be lower in cholesterol. More than one-half in both groups correctly thought that they consumed about the right amount of "saturated fat" and cholesterol.

Among female main meal planners and preparers whose diets did not meet the 1989 Recommended Dietary Allowance (RDA) for vitamin C, 40% thought that their diet should be higher in vitamin C and 56% thought that their diet contained about the right amount of vitamin C. Among female main meal planners and preparers whose diet met or exceeded the RDA for vitamin C, 29% thought that their diet should be higher in vitamin C and two-thirds thought that their diet was about right. Perceptions about dietary adequacy in relation to the RDA for calcium and iron followed patterns similar to that for vitamin C.

The National Cancer Institute recommends that adults consume 20-30 g of dietary fiber per day (NCI, 1987). Among female main meal planners and preparers whose diet contained 20 g or more of dietary fiber per day, 27% thought that their diet should be higher in fiber and 67% thought that their diet was about right. Among those whose diet contained less than 20 g of dietary fiber per day, 40% thought that their diet should be higher in fiber and 54% thought that their diet was about right.

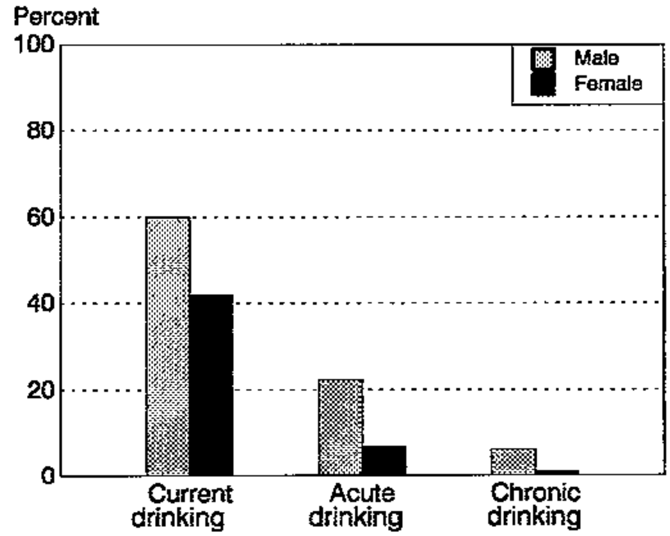

Figure 8-24. Percentage of people 20 years of age and older who reported current, acute, or chronic drinking, by sex, 1992

NOTE: Data are from tables A.F8-24a through A.F8-24c in appendix VA. "Current drinking" was defined as having any alcoholic beverages in the past month. "Acute drinking" was defined as having five or more alcoholic beverages on an occasion one or more times in the past month. "Chronic drinking" was defined as having, on average, two or more drinks a day.

SOURCE: HHS, BRFSS, 1992.

Drinking alcoholic beverages

The most recent data on consumption of alcoholic beverages among adults are from BRFSS 1992. In this survey, people 20 years of age and older were asked about their "current drinking" (having any alcoholic beverages in the past month), "acute drinking" (having five or more alcoholic beverages on an occasion one or more times in the past month), and "chronic drinking" (having, on average, two or more drinks a day) behaviors. More males than females reported current, acute, and chronic drinking (fig. 8-24). Sixty percent of males and 42% of females reported that they drank alcoholic beverages in the past month. Almost one-fourth of males and 7% of females reported having five or more alcoholic beverages on one or more occasions in the past month. Six percent of men and 1% of women reported having an average of two or more drinks a day. The prevalence of current, acute, and chronic drinking was highest among people 20-29 years of age and decreased thereafter with age. Data from NHANES III 1988-91 and CSFII 1989-91 support these findings. Those two surveys found that alcohol use was higher among males than females and among younger than older adults (see ch. 6).

The most recent data on the drinking behavior of high school students are from YRBS 1991. As in BRFSS 1992, reported consumption of alcoholic beverages was higher for males than females. A higher percentage of males than females reported that they drank at least one alcoholic beverage on 10 or more days during their lifetime, and the prevalence of this behavior increased for both sexes as students got older. Among students 15 years of age and younger, 40% of males and 36% of females reported this behavior. The prevalence of this behavior was 60% of male and 52% of female students 16-17 years of age and 67% of male and 57% of female students 18 years of age and older.

The prevalence of drinking differed among racial/ethnic groups. The percentage of students who reported that they drank at least one alcoholic beverage on 10 or more days during their lifetime was highest among non-Hispanic white and Hispanic students and lowest among non-Hispanic black students (fig. 8-25). Students of other racial/ethnic groups (non-Hispanic) reported this behavior less frequently than did non-Hispanic white and Hispanic students but more frequently than did non-Hispanic black students (see table A.F8-25a in app. VA).

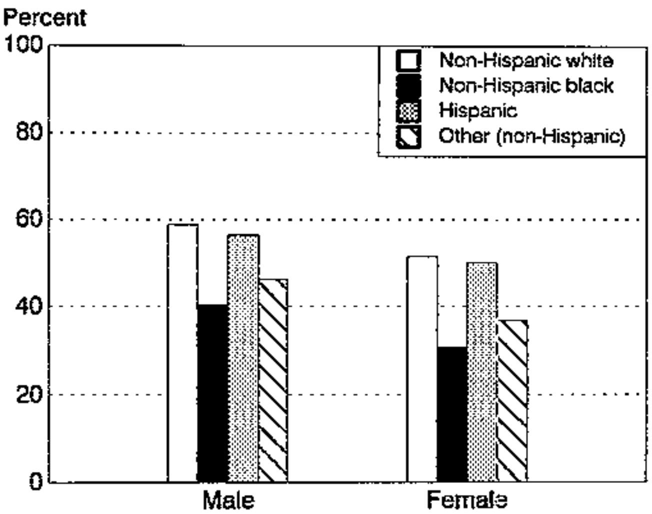

Figure 8-25. Percentage of high school students who drank at least one alcoholic beverage on 10 or more days during their lifetime, by sex and race/ethnicity, 1991

NOTE: Data are from tables A.F8-25a and A.F8-25b in appendix VA.

SOURCE: HHS, YRBS, 1991.

These drinking patterns are supported by NHANES III 1988-91 data. As discussed in chapter 6, males 16-19 years of age in NHANES III 1988-91 reported higher intakes of alcohol than did females of the same age. Non-Hispanic white adolescents of this age range reported higher intakes than non-Hispanic black and Mexican-American adolescents. Mean daily alcohol intakes of non-Hispanic white adolescent males and females were twice as high (16 and 2 g, respectively) as intakes of Mexican-American adolescent males and females (8 and 1 g, respectively). In comparison, mean intakes of non-Hispanic black male adolescents were 5 g/d and of non-Hispanic black female adolescents, 1 g/d. Data from CSFII 1989-91 indicated that about 2% of adolescents 12-19 years of age reported using alcoholic beverages.

Dietary habits

Relationship between dietary intakes and awareness of diet and health relationships

People who are aware of diet and health relationships may be more motivated to follow eating habits consistent with dietary recommendations than are people who are not aware of such relationships. In DHKS 1989-91, the main meal planner and preparer of the household was asked if he or she was aware of specific health problems related to intakes of various nutrients or food components. Awareness of diet and health relationships was then cross-tabulated against their 3-day dietary intakes from CSFII 1989-91 to determine whether the dietary intakes of those who were aware of diet and health relationships were more consistent with dietary recommendations than intakes of those who were not aware of diet and health relationships.

Small differences were found between the dietary intakes of main meal planners and preparers who were aware and not aware of diet and health relationships (see tables A.8e through A.8i in app. VA). Regardless of whether respondents were aware of a relationship between heart disease and total fat intake, mean total fat intake as a percentage of calories averaged 34-36% across sex, racial, and income groups. Mean saturated fatty acid intake as a percentage of calories averaged 11-13% across sex, racial, and income groups, regardless of whether respondents were aware of a relationship between heart disease and "saturated fat" intake.

Regardless of awareness of a relationship between heart disease and cholesterol intake, mean daily intakes of cholesterol were lower for white than for black main meal planners and preparers. Mean intakes of cholesterol averaged 232 mg/d among white main meal planners and preparers who reported that they were aware of a relationship between heart disease and cholesterol intake and, surprisingly, 220 mg/d among those who reported that they were not aware of this diet and health relationship. In contrast, mean cholesterol intakes of black main meal planners and preparers were higher, averaging 265 mg/d among those who were aware and 279 mg/d among those who were not aware of a relationship between heart disease and cholesterol intake.

White and black main meal planners and preparers who reported that they were aware that hypertension is a health problem related to how much sodium a person eats and white main meal planners and preparers who reported that they were not aware of this diet-health relationship had average sodium intakes of 2,435-2,476 mg/d. Among black main meal planners and preparers who were not aware of a hypertension and sodium relationship, the mean sodium intake was 2,110 mg/d, which is puzzling. (Sodium intakes did not include sodium from salt added at the table, medications, or other nonfood sources.) Respondents who were aware of a relationship between cancer and fiber intake had slightly higher fiber intakes than those who were not aware of that relationship.

Mean daily intakes of cholesterol, sodium, and fiber were higher among male main meal planners and preparers than among female main meal planners and preparers. This pattern occurred regardless of whether respondents were aware of a relationship between heart disease and cholesterol intake, between hypertension and sodium intake, or between cancer and fiber intake; this difference is attributed largely to the generally higher food intakes for males than females.

Serum cholesterol and hypertension awareness and action

NHANES III 1988-91 collected data on the serum cholesterol awareness of adults 20 years of age and older and on the types of actions that were being followed to control cholesterol levels. About one-half of the respondents reported ever having their cholesterol level checked (fig. 8-26). Of the respondents who ever had their cholesterol level checked, one-third said that they were told that their cholesterol level was high. Most respondents who were told that their cholesterol level was high reported that a physician or other health professional told them to change their diet to lower their high cholesterol level. About one-half were told by a physician or other health professional to exercise and to lose weight, and one-fifth were given a prescription for medication. Of those who were told to change their diet, almost 90% reported that they were currently following this medical advice. Of those who were told to lose weight, to exercise, and to take medications, more than 70% reported that they were currently following this advice.

Data were also collected on the types of cholesterol-lowering interventions, if any, that were being followed by those who were told that they had high cholesterol levels but were not told by a physician or health professional to make specific changes to control their high cholesterol levels, by those who did not have high cholesterol levels, and by those who never had their cholesterol level checked. Almost one-half said that they were changing their diet on their own to control their cholesterol level, whereas about one-third said they were losing weight on their own and about one-fourth said they were exercising on their own to control their cholesterol level.

The percentages of adults who reported ever having their cholesterol level tested in NHANES III 1988-91 differed markedly from those in the FDA Health and Diet Surveys. According to data from HDS 1990, 65% of adults reported that they had their cholesterol level tested, up from 46% in 1986 and 35% in 1983 (Schucker et al., 1991).

Figure 8-27 shows similar information for adults 20 years of age and older who were told in 1988-91 that they had hypertension on at least one occasion and the percentage of these individuals who reported that they were complying with medical advice to control their blood pressure. Of those who were told that they had hypertension, a majority (79%) were told on two or more occasions. Most people with diagnosed hypertension were told by a physician or other health professional to take medications and/or to change their diet. Almost 90% reported that they were complying with advice to change their diet, and 76% reported that they were complying with advice to take medications. About half of those with diagnosed hypertension were told to lose weight to control their blood pressure, and about three out of four of these individuals reported that they were following this advice. About 30% were told to increase exercise, stop smoking, restrict alcohol consumption, reduce stress, and/or change some other aspect of their life-style to control their blood pressure, and almost two-thirds said that they were following this advice.

Summary of findings

Although the overall prevalence of breastfeeding increased from 46% to 55% between 1978-80 and 1984-86, the percentages of mothers who ever breastfed and the duration of breastfeeding remained below the Healthy People 2000 objective for breastfeeding. Mothers were less likely to breastfeed if they were black, younger, and from low-income households.

According to data from CSFII 1989-91 and NHANES III 1988-91, females are more likely than males to perceive their body weight status incorrectly.

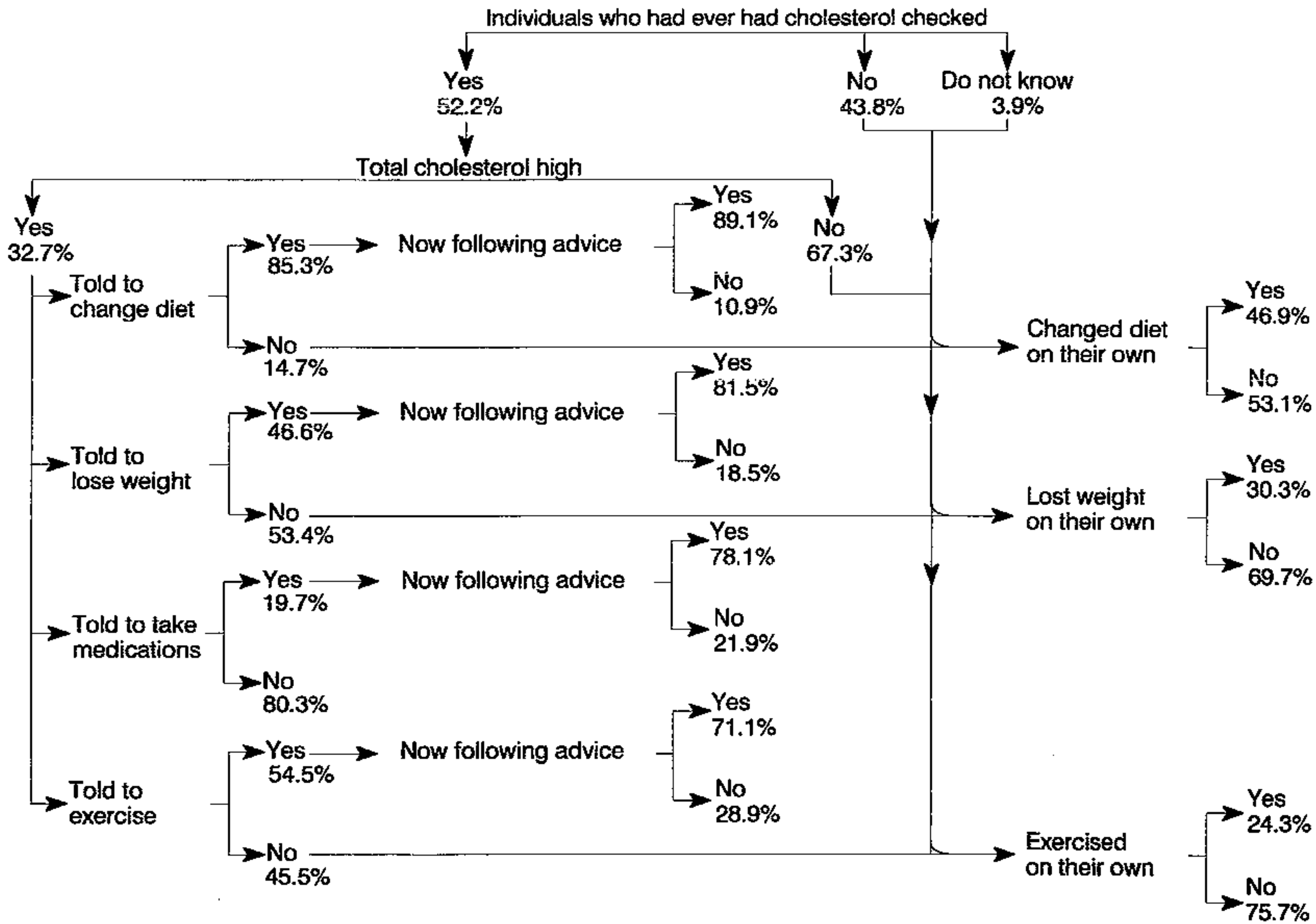

Figure 8-26. Serum cholesterol reduction intervention reported by adults 20 years of age and older: actions taken with and without advice from a doctor or other health professional, 1988-91

NOTE: Data are from figure A.F8-26 in appendix VA. Unknown values were excluded from computations.

SOURCE: HHS, NHANES III, 1988-91.

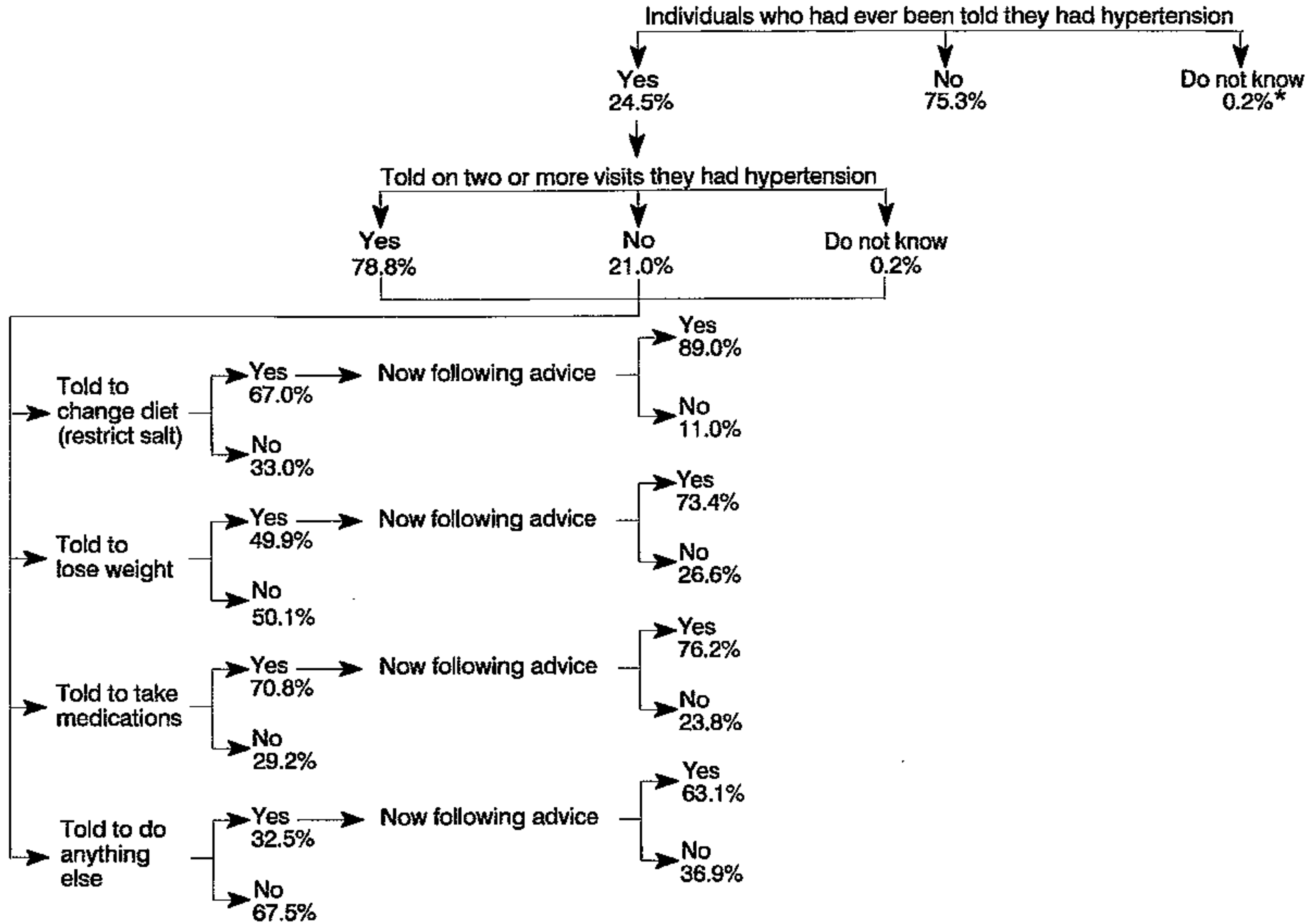

Figure 8-27. Percentage of individuals 20 years of age and older who were told they had hypertension and who reported following advice from a doctor or other health professional, 1988-91

NOTE: Data are from figure A.F8-27 in appendix VA. Unknown values were excluded from computations. An asterisk (*) indicates a statistic that is potentially unreliable because of a small sample size or large coefficient of variation. "Told to do anything else" included exercise more, restrict alcohol, stop smoking, relax, and make other diet changes.

SOURCE: HHS, NHANES III, 1988-91.

Non-Hispanic white females 20 years of age and older were more likely than non-Hispanic black and Mexican-American females of the same age to think of themselves as overweight, regardless of whether they were overweight. Non-Hispanic white females 20 years of age and older in NHANES III 1988-91 also were more likely than non-Hispanic black and Mexican-American females in that age group to report that they tried to lose weight in the past 12 months.

Data from the Weight Loss Practices Survey 1991 showed that most people 18 years of age and older dieted and/or exercised to lose weight. Females were more likely than males to report that they used over-the-counter products, meal replacements, and vitamins for weight loss and to participate in organized weight-loss programs.

In BRFSS 1992, more than one-half of American adults reported leading sedentary life-styles, and less than one-third participated in regular physical activity. Participation in regular physical activity was higher among males than females and tended to decrease with age. About one-third of male and less than 20% of female students in grades 9-12 in YRBS 1990 reported that they participated in vigorous exercise on a regular basis. Twenty-nine percent of Hispanic females, 22% of non-Hispanic white females, and nearly 40% of non-Hispanic black females and females of other race/ethnicities (non-Hispanic) reported no vigorous physical activity in the past 14 days. Participation in vigorous physical activity decreased with each subsequent year of high school, particularly for females.

Newspapers, magazines, and books and food packages and labels were the most frequently reported source of nutrition information among household food managers interviewed in NFCS 1987-88. At higher income levels, the use of newspapers, magazines, and books; food packages and labels; radio and television; relatives and friends; and food-company publications as sources of nutrition information increased. Doctors, nurses, and other health professionals were the most preferred source of nutrition information, followed by newspapers, magazines, and books. Higher-income households were twice as likely as lower-income households to report newspapers, magazines, and books as their preferred source of nutrition information.

In DHKS 1989, female main meal planners and preparers were more likely than their male counterparts to report that they always or sometimes used the nutrition panel on the food label. Female main meal planners and preparers who were white, middle-aged, more educated, and from higher-income households reported the highest frequency of use of the nutrition panel on the food label.

FDA's HDS found that many consumers in 1990 did not have the knowledge needed to implement dietary recommendations on total fat, "saturated fat," and cholesterol. Although almost 70% of respondents were aware that "saturated fats" are usually found in animal products such as meat and dairy foods, only about one-third knew that cholesterol is found only in animal products and that cholesterol is not the same thing as "saturated fat" or "polyunsaturated fat."

Knowledge about dietary fats and cholesterol did improve in some areas between 1983 and 1990. For example, the percentage of respondents who knew that "saturated fats" are usually found in animal products increased from 55% in 1983 to 69% in 1990. In 1990, about 60% of respondents knew that "polyunsaturated fats" are usually found in vegetables and vegetable oils and that "saturated fats" are more likely to raise blood cholesterol levels than "polyunsaturated fats," up from about 50% of respondents in 1983. The percentage of respondents who knew that fats and oils become more saturated when they are hydrogenated increased from 10% to 26% of respondents between 1983 and 1990. In some areas, knowledge remained relatively unchanged between 1983 and 1990. These areas included knowledge that "polyunsaturated fats" are more likely to be a liquid than a solid, that "saturated fats" and "polyunsaturated fats" are similar in their caloric value, and that cholesterol is found only in animal products.

Certain segments of the population, including people 60 years of age and older, some minority groups, and people from lower-income households, appeared to have less awareness of diet and health relationships, to use the nutrient panel on the food label less frequently, and to follow more sedentary life-styles than the general population. For example, female main meal planners and preparers who were black, from lower-income households, and less educated were less likely to be aware of diet and health relationships and to report using the nutrient panel on the food label. Those who were 60 years of age and older tended to be less aware of diet and health relationships and to report using the nutrient panel on the food label less than those who were younger. People who were older were less likely to exercise regularly than those who were younger. Non-Hispanic black and Mexican-American adult females were less likely to exercise regularly than non-Hispanic white females. Black mothers were found to be less likely to breastfeed their infants than white mothers.

According to data from DHKS 1989-91, awareness of diet and health relationships was higher among female main meal planners and preparers who were white, middle-aged, more educated, and from higher-income households than among those who were black, 39 years of age and younger and 60 years of age and older, less educated, and from lower-income households.

Main meal planners and preparers who were aware of diet and health relationships were more likely than those who were not aware of these relationships to report that following related dietary guidance was highly important to them personally. Females were more likely than males to report that following dietary guidance was highly important to them personally, regardless of whether they were aware of specific diet and health relationships. The 3-day dietary intakes of main meal planners and preparers who reported that they were aware of specific diet and health relationships were not more consistent with dietary recommendations than were intakes of main meal planners and preparers who reported that they were not aware of these diet and health relationships.

Gaps in knowledge

Data from NNMRRP knowledge and attitude surveys suggest that the public is aware of the relationships between diet and health. However, food consumption data suggest that people are not applying all their knowledge. Little is known about the barriers to comprehending nutrition and health-related information and to effectively translating knowledge into healthier food choices and life-styles in the general population and in population subgroups. For example, are dietary concepts too complex and difficult to understand, thus precluding compliance with dietary recommendations? Are health messages not relevant or appropriate to the target audience? Is language barrier an issue? What are the perceived "external" obstacles—such as lack of time and money, lack of social support, or inconvenience—to adopting and sustaining healthier food choices and life-style behaviors in the general population and in population subgroups?

The impact on respondents of the way questions are asked in surveys and the context in which they are asked is not well understood. Are respondents interpreting questions correctly so that the desired information is being obtained?

It is possible that there are factors other than socioeconomic and demographic ones that predict certain behaviors well. The proximal factors (decisions leading up to behaviors) involved in the adoption and maintenance of undesirable behaviors, such as overeating, choosing high-fat diets, and sedentary life-styles, and, conversely, in desirable behaviors, such as choosing lower-fat diets and getting regular physical activity, are poorly understood. Certain combinations of socioeconomic and demographic characteristics other than age, sex, race/ethnicity, and income level may influence food- and health-related behaviors.

Specific gaps in knowledge related to discussions in this chapter include the following:

- knowledge, attitudes, and beliefs about the risks and benefits of exercise and the effect that knowledge, attitudes, and beliefs have on physical-activity behaviors in various racial/ethnic groups;

- effective strategies for promoting the initiation and maintenance of regular physical activity;

- knowledge and attitudes related to breastfeeding among mothers in various racial/ethnic groups and effective strategies for promoting initiation and maintenance of breastfeeding;

- use and understanding of information on the new food label (the nutrient panel on the food label, ingredient list, nutrient-content claims, and health claims), and how the information on the new food label influences food purchases at the store and food consumption at home;

- attitudes about drinking alcohol and drinking behavior among different subgroups; and
- prevalence of eating disorders such as binge eating and purging in the general population and in population subgroups, and, in particular, an understanding of socioeconomic, demographic, and attitudinal influences involved in the development of eating disorders.

Recommendations

- Continue research to identify the relationships of diet, nutrition, and health knowledge and attitudes to food- and health-related behaviors, food and nutrient intake, health status, and self-care health practices (i.e., compliance with physicians' or other health professionals' recommendations), which are essential to assess alternative strategies for improving the nation's health.
- Where appropriate, continue efforts to promote greater comparability of results across surveys by standardizing questions and methods used to assess the diet, nutrition, and health-related knowledge, attitudes, and behavior of the general population and of population subgroups.
- Continue efforts to determine the reliability and validity of the questions asked in surveys that measure knowledge, attitudes, and behaviors for the general population and for population subgroups.
- Develop procedures for measuring 1) the importance of food, nutrition, and health to individuals in the general population and in population subgroups and 2) how making food choices and other health-related behaviors are influenced by the value people place on food, nutrition, and health.
- Explore the development of effective models for translating knowledge into behavior for the general population and for population subgroups.
- Collect data on factors that influence behavior in the desired direction of change.
- Establish better ways to evaluate physical activity levels in children, adolescents, and adults.
- Identify and monitor factors contributing to the low levels of physical activity in the general population and in population subgroups and factors influencing people to become more active and to maintain more active life-styles.
- Continue to collect data on people's perceptions of dietary and nutrition issues and of health-related behaviors in order to improve approaches to translating knowledge into action. Identify perceived internal barriers and external obstacles that discourage adopting and maintaining healthier food and life-style choices.
- Collect in-depth information on the use and understanding of information on the new food label (the nutrient panel on the food label, the ingredient list, nutrient-content claims, and health claims) by the general population and by population subgroups. Focus on the impact of the food-label information on food purchases and consumption, what specific information on the food label is used and found to be valuable, and where food-label information is used (in the home and/or in the supermarket).
- Identify factors influencing consumers to buy food products that are lower in fat and sodium and higher in fiber. For example, do people who are aware of health problems related to fat intake buy more low-fat and/or fat-free foods than people who are not aware of health problems related to fat intake?
- Continue to collect information on the sources of nutrition information used by the general population and by population subgroups and what sources of information are preferred and are perceived to be credible.
- Include questions about knowledge and attitudes related to breastfeeding and about factors that influence infant feeding practices.
- Incorporate questions about eating disorders, such as binge eating and purging, into survey measures, and collect and use socioeconomic, demographic, and attitudinal data that could influence the development of such behaviors.

- Collect information on the personal beliefs and values related to diet, nutrition, and health-related behaviors of the general population and of population subgroups.

- Continue the coordination among Federal agencies to enhance the collection and use of survey data on diet, nutrition, and health-related knowledge, attitudes, and behavior. Such efforts help to reduce gaps and duplication of efforts, to identify and prioritize monitoring needs, and to strengthen linkages between national surveys and programs that use these data for program planning and evaluation.

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Chapter 9

Assessment of Food Components that Represent Public Health Issues in National Nutrition Monitoring

Introduction

The Expert Consultants and LSRO used the EPONM's categories for monitoring priority status of food components to classify the intake of food components for the TRONM (table 9-1). The three EPONM categories emphasize the evaluation of food components with respect to whether they are 1) current public health issues, 2) potential public health issues for which further study is required, or 3) not current public health issues.

Food components that were considered current public health issues should have high-priority monitoring status. Monitoring efforts for food components in this category should include biochemical, clinical, and anthropometric assessments as appropriate, with high priority assigned to the development of any needed assessment tools. Food components considered to be potential public health issues should have moderate monitoring priority status. Assessment should be continued in subgroups suspected to be at risk, with moderate priority given to development of improved assessment techniques. Lower monitoring priority status is recommended for food components not considered to be public health issues, although this does not necessarily mean that there are no known health problems associated with these components. The prevalence of such problems on a national scale is known or expected to be so low, however, that components in this category require a lower level of monitoring effort than do those in the other categories. Assessment of these components should continue and include, at a minimum, estimation of dietary intake.

The following food components are included in the USDA Nutrient Data Base for Individual Food Intake Surveys (Survey Nutrient Data Base) and were assessed for the TRONM:

- food energy,
- protein,
- total fat,
- saturated fatty acids,
- monounsaturated fatty acids,
- polyunsaturated fatty acids,
- cholesterol,
- carbohydrates,
- dietary fiber,
- alcohol,
- vitamin A, vitamin C, vitamin E, carotenes, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and folate, and
- iron, calcium, phosphorus, magnesium, sodium, potassium, copper, and zinc.

In addition, several other food components were considered with respect to their public health significance:

- *trans* fatty acids,
- fat substitutes,
- sugars, and
- selenium, fluoride, and iodine.

Data from the NNMRRP food consumption surveys were not available for the evaluation of these other food components, so their assessments were based on data from the Food and Drug Administration's (FDA's) Total Diet Study or on published information.

Table 9-1. JNMEC and EPONM classifications for monitoring priority status of food components[1]

JNMEC classification	EPONM classification
• **Food components warranting public health monitoring priority status**	• **Food components were considered to be current public health issues**
— if evidence from health and nutrition surveys indicated related health problems in the population, and a substantial proportion of the population had 3-day dietary intakes considerably higher or lower than recommended levels, or	— if dietary intakes were low or high for a substantial proportion of the population, and if evidence from NNMS surveys of health and nutritional status indicated related health problems in the population or in subgroups of the population, or
— if evidence from epidemiological and controlled clinical studies indicated related health problems in the population, and a substantial proportion of the population had 3-day dietary intakes considerably higher or lower than recommended levels.	— if dietary intakes were low or high for a substantial proportion of the population, and if evidence from epidemiological or clinical studies in the literature indicated related health problems in the population or in subgroups of the population.
	Food components in this category are recommended for high-priority monitoring status; that is, multiple assessments, when possible, should continue to be employed. A high priority should be given to development of assessment tools when these are lacking.
• **Food components requiring further investigation**	• **Food components were considered to be potential public health issues, for which further study is required,**
— if information from dietary and health surveys was insufficient to permit judgment about public health significance, or	— if dietary intakes were low or high for a substantial proportion of the population, and if limited evidence from either NNMS nutrition and health surveys or studies in the literature suggested related health problems in at least some subgroups in the population, or
— if intakes deviated from recommended levels for many in the population, but related health problems could not be found or methods for identifying health problems were not available, or	— if dietary intakes were adequate for the majority of the population, but limited evidence from either NNMS nutrition and health surveys or studies in the literature suggested related health problems in at least some subgroups in the population, or
— if, despite theoretical reasons for believing that the food component might have public health significance, intakes were in an acceptable range and related health problems could not be identified.	— if dietary intakes were low or high for a substantial proportion of the population, and if evidence was not available from either NNMS nutrition and health surveys or studies in the literature that permitted evaluation of the public health significance of observed dietary intakes.
	Food components in this category are recommended for moderate monitoring priority status, with continued assessment at the least in subgroups suspected to be at risk, and moderate priority for the development of improved assessment techniques.

Table 9-1. JNMEC and EPONM classifications for monitoring priority status of food components—continued

JNMEC classification	EPONM classification
• **Food components warranting continued public health monitoring consideration** — if no currently available evidence from health and nutrition examination surveys indicated related health problems in the population, and most of the population had 3-day dietary intakes that met recommended levels, or — if potential health problems related to inadequate intakes were ruled out at the time. The JNMEC assigned some components to more monitoring consideration and some to less monitoring consideration.	• **Food components were not considered to be current public health issues** — if dietary intakes were adequate for the majority of the population, and evidence from either NNMS nutrition and health surveys or studies in the literature did not suggest related health problems in the population, or — if dietary intakes were low or high for a substantial proportion of the population, but evidence from either NNMS nutrition and health surveys or studies in the literature did not suggest related health problems in the population. Food components in this category are recommended for lower monitoring priority status; continued assessment should include, at a minimum, estimation of dietary intake.

[1]JNMEC, Joint Nutrition Monitoring Evaluation Committee; EPONM, Expert Panel on Nutrition Monitoring; NNMS, National Nutrition Monitoring System.

SOURCE: LSRO (1989).

Approach used to classify food components by nutrition monitoring priority

Process

The Expert Consultants and LSRO used the decision-making process developed for the second nutrition monitoring report to assess monitoring priority status for food components (fig. 9-1). Nutrient intake data collected in NHANES III 1988-91 and CSFII 1989-91 were used in combination with food composition data and with contemporaneous information on nutritional status and nutrition-related health status from the NNMRRP and, in some instances, the general biomedical literature to update the assessment of public health monitoring priority for each nutrient. Nutrient intakes were not available from surveys for iodine and selenium. Data from the Total Diet Study provided estimates for those intakes. Each food component was considered independently. The sources of NNMRRP data on nutrient intakes that were available for assessing monitoring priority status of each food component are listed in table 9-2. Although per capita intakes of most nutrients were available from food supply data, the data were not used to assess public health monitoring priority because intake estimates are not specific for age-sex groups.

Evidence for health consequences was provided mainly by the anthropometric, biochemical, and clinical data from the NNMRRP. Criteria for assessing specific diseases and health conditions established by authoritative groups were used to evaluate these data. As noted by the Joint Nutrition Monitoring Evaluation Committee in the first nutrition monitoring report, "Much can be inferred about the nutritional status of the population, even with imperfect data judged by imperfect criteria, especially when a wider knowledge of nutrition is brought to bear" (HHS and USDA, 1986). In this regard, the Expert Consultants and LSRO have used their experience and judgment in categorizing food components.

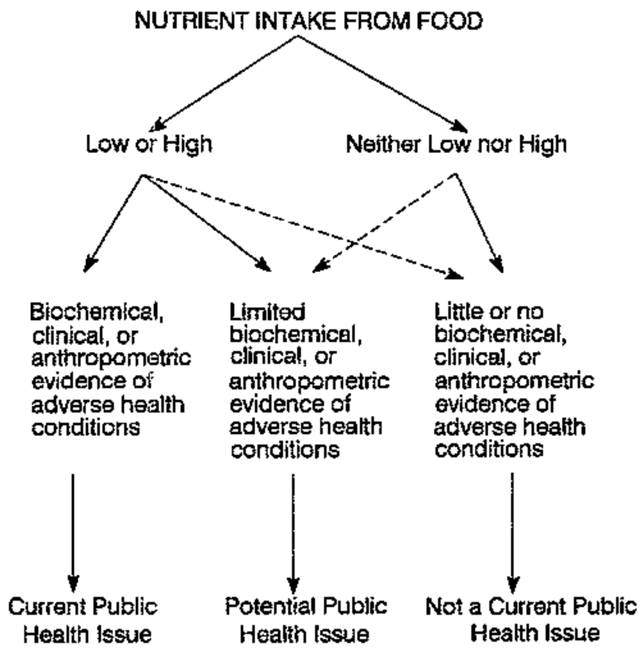

Figure 9-1. Decision-making process used to categorize food components by monitoring priority status

NOTE: Whenever nutrient intake data were available from surveys, they were used and evaluated by established criteria. When survey data were not available, Total Diet Study data were used and evaluated by established criteria. Dashed lines indicate less likely outcomes.

SOURCE: Modified from LSRO (1989).

Guidance documents

The following materials were used for guidance in the interpretation and assessment of nutrition monitoring data in the report:

- *Nutrition Monitoring in the United States: A Progress Report from the Joint Nutrition Monitoring Committee* (HHS and USDA, 1986),
- *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring* (LSRO, 1989),
- *Recommended Dietary Allowances* (NRC, 1989a),
- Healthy People 2000 Objectives 1.3-1.5 and 2.3-2.11 (HHS, 1991),
- *Nutrition and Your Health: Dietary Guidelines for Americans* (USDA and HHS, 1990),
- *Second Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II)* (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II), 1993),
- *Report of the Expert Panel on Blood Cholesterol Levels in Children and Adolescents* (Expert Panel on Blood Cholesterol Levels in Children and Adolescents, 1991),
- *The Fifth Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure* (Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure, 1993), and
- additional evaluation criteria judged appropriate by the Expert Consultants and LSRO.

Criteria

NNMRRP data on food composition, nutrient intakes, nutritional status, and nutrition-related health status were used to assign monitoring priority status to individual food components. The adequacy of food composition data for nutrient intake estimates is evaluated in chapter 5, nutrient intakes are evaluated in chapter 6, and nutritional status and nutrition-related health status are evaluated in chapter 7. Criteria for evaluation are specified in each chapter. Because food consumption is often underreported, nutrient intakes are likely to be underestimated. It is not known whether intakes of all nutrients are underestimated or whether all nutrients are underestimated to a similar extent. The following criteria were used to assign monitoring priority status when low intakes were of concern:

- If the median intake of a specified food component exceeded its recommended value (usually the 1989 Recommended Dietary Allowance, or RDA) for a population subgroup, then, in most cases, few individuals would likely be at risk of deficiency in that subgroup.
  - If the biochemical and clinical evidence available from the NNMRRP or other sources did not suggest the presence of a nutritional-deficiency problem, the specified component was ***not considered to be a current public health issue*** with respect to deficiency in the population surveyed.
  - On the other hand, if additional evidence from the NNMRRP or other sources indicated the potential of deficiency in at least some groups in the population, the food component was ***considered to be a potential public health issue for which further study is required*** to determine the nature and extent of the potential problem.

Table 9-2. Data available as of June 1994 for assignment of nutrition monitoring priority status for food components evaluated in the National Nutrition Monitoring and Related Research Program (NNMRRP)

Food component	Quality of food composition data[1]	NNMRRP data on nutrient intake		NNMRRP data on nutritional status and nutrition-related heath status[4]
		Source[2]	Criteria for evaluation[3]	
Food energy	Variable	Food supply	—	—
		Individual intake	REI	Body weight; exercise level; sedentary life-style
Water	Acceptable	Food supply	—	—
		Individual intake	RDA	—
Protein	Acceptable	Food supply	—	—
		Individual intake	RDA	NA
Total fat	Variable	Food supply	—	—
		Individual intake	≤30% kcal	Total serum cholesterol level; LDL-cholesterol level
Saturated fatty acids	Variable	Food supply	—	—
		Individual intake	≤10% kcal	Total serum cholesterol level; LDL-cholesterol level
Monounsaturated fatty acids	Variable	Food supply	—	—
		Individual intake	≤15% kcal	Total serum cholesterol level; LDL-cholesterol level
Polyunsaturated fatty acids	Variable	Food supply	—	—
		Individual intake	≤10% kcal	Total serum cholesterol level; LDL-cholesterol level
Trans fatty acids	Unacceptable	Food supply	—	Total serum cholesterol level; LDL-cholesterol level
Cholesterol	Variable	Food supply	—	—
		Individual intake	<300 mg/d	Total serum cholesterol level; LDL-cholesterol level
Carbohydrate	Variable	Food supply	—	—
		Individual intake	≥55% kcal	—
Sugars	Unacceptable	Food supply	—	—
Dietary fiber	Variable	Individual intake	20-30 g/d (adults)	—
Alcohol	Acceptable[5]	Sales data[6]	—	—
		Individual intake	—	Blood pressure; HDL-cholesterol level
Vitamin A	Variable	Food supply	—	—
		Individual intake	RDA	Serum retinol

Table 9-2. Data available as of June 1994 for assignment of nutrition monitoring priority status for food components evaluated in the National Nutrition Monitoring and Related Research Program (NNMRRP)—continued

Food component	Quality of food composition data[1]	NNMRRP data on nutrient intake		NNMRRP data on nutritional status and nutrition-related heath status[4]
		Source[2]	Criteria for evaluation[3]	
Carotenes	Variable	Food supply	—	—
		Individual intake	—	NA
Vitamin E	Moot	Food supply	—	—
		Individual intake	RDA	NA
Vitamin C	Variable	Food supply	—	—
		Individual intake	RDA	NA
Thiamin	Acceptable	Food supply	—	—
		Individual intake	RDA	NC
Riboflavin	Acceptable	Food supply	—	—
		Individual intake	RDA	NC
Niacin	Acceptable	Food supply	—	—
		Individual intake	RDA	NC
Vitamin B_6	Acceptable	Food supply	—	—
		Individual intake	RDA	NA
Vitamin B_{12}	Moot	Food supply	—	—
		Individual intake	RDA	NA
Folate	Variable	Food supply	—	—
		Individual intake	RDA	NA
Iron	Acceptable	Food supply	—	—
		Individual intake	RDA	Hemoglobin level
		Dietary analysis	RDA	—
Calcium	Acceptable	Food supply	—	—
		Individual intake	RDA	Total femur bone mineral density; blood pressure
		Dietary analysis	RDA	—
Phosphorus	Acceptable	Food supply	—	—
		Individual intake	RDA	—
		Dietary analysis	RDA	—
Magnesium	Acceptable	Food supply	—	—
		Individual intake	RDA	Blood pressure
		Dietary analysis	RDA	—

Table 9-2. Data available as of June 1994 for assignment of nutrition monitoring priority status for food components evaluated in the National Nutrition Monitoring and Related Research Program (NNMRRP)—continued

Food component	Quality of food composition data[1]	NNMRRP data on nutrient intake		NNMRRP data on nutritional status and nutrition-related heath status[4]
		Source[2]	Criteria for evaluation[3]	
Sodium	Variable	Food supply	—	—
		Individual intake	≤2,400 mg/d	Blood pressure
		Dietary analysis	≤2,400 mg/d	—
Potassium	Acceptable	Food supply	—	—
		Individual intake	3,500 mg/d	Blood pressure
		Dietary analysis	3,500 mg/d	—
Copper	Variable	Food supply	—	—
		Individual intake	ESADDI	—
		Dietary analysis	ESADDI	—
Zinc	Acceptable	Food supply	—	—
		Individual intake	RDA	Childhood growth
		Dietary analysis	RDA	—
Selenium	Acceptable	Dietary analysis	RDA	NA
Iodine	Unacceptable	Dietary analysis	RDA	—
Fluoride	Moot	—	ESADDI	—
Fat substitutes	Nonexistent	—	—	—

[1]Quality of data was rated acceptable, variable, or unacceptable in relation to their use for assessment of nutrition-related health status for nutrition monitoring. Quality of data was rated moot if the Expert Consultants and LSRO considered it unlikely that improved data for that food component would make a difference in the assessment of nutrition-related health status and the assignment of nutrition monitoring priority status. Food composition data for components rated moot may be important for other purposes.

[2]—, data were lacking.

[3]For food energy, the Recommended Energy Intake (REI) was used to evaluate intake (NRC, 1989a). For nutrients with RDA (Recommended Dietary Allowance) or ESADDI (Estimated Safe and Adequate Daily Dietary Intake) values, those values were used to evaluate intake (NRC, 1989a). The Food and Nutrition Board's recommended maximum intake of 2,400 mg/d was used for sodium (NRC, 1989a). The value for potassium (3,500 mg/d) is the approximate amount of potassium in the recommended daily intake of 5 or more servings of fruits and vegetables (NRC, 1989a,b). For carbohydrate, total fat, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, and cholesterol, recommendations of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel II) (1993) and Expert Panel on Blood Cholesterol Levels in Children and Adolescents (1991) were used for individuals 2 years of age and older. For dietary fiber, NCI recommendations were used for adults (NCI, 1987). For carbohydrates, the recommendation to increase consumption of foods containing complex carbohydrates was used as a guideline (HHS, 1991; NRC, 1989a,b; USDA and HHS, 1990). —, specific criteria for evaluating intakes were lacking.

[4]NA, data were collected but are not yet available; NC, data were not collected in NNMRRP surveys; —, specific criteria for evaluating nutritional status or nutrition-related health status were lacking. LDL, low-density lipoprotein; HDL, high-density lipoprotein.

[5]Alcohol data are acceptable for alcoholic beverages.

[6]Because intakes of alcohol are often underreported, data on sales of ethanol are useful as a check on intake data.

SOURCE: LSRO, 1995.

- Alternatively, if the median intake of a component fell below the recommended value, a possible problem of undernutrition was considered.
  - Additional evidence of a nutritional problem based on clinical or biochemical data from the NNMRRP was needed to determine that the component should be ***considered a current public health issue.*** Such clinical and biochemical data were accorded more weight than were the dietary intake data.
  - If such data were not available from the NNMRRP, information in the general medical literature was used to assess the possibility that the specified component be ***considered a current public health issue.***
  - If intakes were low by the criteria described above but data from the NNMRRP or elsewhere did not indicate that there was a problem, the food component was ***not considered to be a current public health issue.***
  - If intakes were low by the criteria described above and data on health or nutritional status were not available from the NNMRRP or any other source to assess the potential for deficiency, then the component was ***considered to be a potential public health issue for which further study is required.***

Assessment of high intakes of food components was treated in a similar manner, although the RDA was less useful in identifying potential public health problems related to excessive intake. If the median intake was near or above the RDA and the distribution of intakes was skewed to the side of high intakes, the possibility of deleterious health effects was evaluated. Consumption from supplements should also be considered when effects of high intakes are considered. However, estimates of total nutrient intakes from foods and dietary supplements were not available for preparation of the TRONM, so estimates of nutrient intakes were based only on nutrients provided by food. Standards established by other expert groups and specified in the assessments below were applied to components such as total fat, saturated fatty acids, cholesterol, and sodium, for which excessive intake is presumed to be harmful. Confirmatory anthropometric, clinical, or biochemical evidence from the NNMRRP data or from other sources about adverse effects resulting from high intakes is required for the categorization of high intakes as current or potential public health issues.

Assessments

The Expert Consultants' and LSRO's classification of food components as public health issues is shown in table 9-3. The assignments should be regarded as provisional. It is likely that as new data from the NNMRRP and other sources become available, future assessments of public health significance and of the levels of monitoring needed will result in changes in the categorization of some food components.

Current public health issues

Food energy

Although median food energy intakes reported by adolescents and adults in 1988-91 were below recommended levels, approximately one-fifth of the adolescents and one-third of the adults were overweight. Only small changes in reported food energy intakes have been observed since 1977-78. Food energy intake in excess of energy expenditure is responsible for the high prevalence of overweight. Thus, the tracking of this public health issue must include monitoring energy expenditure (i.e., physical activity) as well as food energy intake. More than one-half of adults have a sedentary life-style, and fewer than one-third participate in regular physical activity. More complete and accurate information on both energy intake and energy expenditure is needed to assess the contributions of these factors to overweight.

Total fat, saturated fatty acids, and dietary cholesterol

In 1988-91, median intakes of total fat and saturated fatty acids for most adults, adolescents, and children older than 2 years of age were above the recommended levels (≤30% of calories from total fat and ≤10% of calories from saturated fatty acids) and above the target set in Healthy People 2000 Objective 2.5 (HHS, 1991). Although median intakes of dietary cholesterol were generally within the recommended range (<300 mg/d), intakes of cholesterol were still above 300 mg/d for many people. High intakes of total fat, saturated fatty

Table 9-3. Classification of food components as public health issues in the TRONM[1]

Current public health issues	Potential public health issues for which further study is required	Not current public health issues
Food energy	⇒ Total carbohydrate	Thiamin
Total fat	Dietary fiber	Riboflavin
Saturated fatty acids	Sugars‡	Niacin
Cholesterol	Polyunsaturated and monounsaturated fatty acids‡	Iodine‡
Alcohol	*Trans* fatty acids‡	
Iron	Fat substitutes‡	
Calcium	⇒ Protein	
Sodium	Vitamin A	
	Antioxidant vitamins	
	Vitamin C	
	⇒ Vitamin E	
	Carotenes	
	Folate	
	Vitamin B_6	
	⇒ Vitamin B_{12}	
	⇒ Magnesium	
	Potassium	
	Zinc	
	⇒ Copper	
	Selenium‡	
	⇒ Phosphorus	
	Fluoride	

[1]Arrows (⇒) point to components whose monitoring priority status has changed since the second report on nutrition monitoring was published (LSRO, 1989). Double daggers (‡) indicate components that are being evaluated for the first time for the NNMRRP.

SOURCE: LSRO, 1995.

acids, and dietary cholesterol are associated with elevated levels of serum total cholesterol and of low-density-lipoprotein (LDL) cholesterol, which are major risk factors for coronary heart disease. Although serum total cholesterol levels and intakes of total fat, saturated fatty acids, and cholesterol appear to be decreasing, substantial proportions of the U.S. population still have high serum total cholesterol levels and high intakes of total fat, saturated fatty acids, and cholesterol. Levels of serum LDL cholesterol associated with increased risk of coronary heart disease were observed in substantial proportions of the adult population. Monitoring Americans' progress toward achieving recommended intakes of total fat, saturated fatty acids, and cholesterol, which includes assessing the levels of serum total cholesterol, high-density-lipoprotein (HDL) cholesterol, and LDL cholesterol, is a continuing priority.

Alcohol

The public health and social consequences of excessive alcohol intake are serious concerns. Furthermore, alcoholic beverages are a source of food energy and may displace other sources of nutrients. In 1989-91, average reported alcohol intakes of adult males 20-59 years of age, including drinkers and nondrinkers, ranged from 17 to 20 g/d, equivalent to 16.0-18.8 fl oz of beer, 6.2-7.3 fl oz of wine, or 1.6-1.9 fl oz of whiskey per day. Estimates of per capita ethanol consumption for the U.S. population 14 years of age and older based on annual sales of alcohol are higher than the reported values. However, both self-reported and sales-based estimates are low because both include drinkers and nondrinkers. Alcohol consumption among adolescents appears to be widespread. Continued monitoring of alcohol consumption and improving the methods for doing so are recommended.

Iron

Low iron intake may affect biochemical indicators of iron status and may lead to anemia. Some research suggests that high levels of iron stores may also be a public health concern (Salonen et al., 1992). In 1988-91, median intakes of iron from food were below RDA values for children 1-2 years of age and for adolescent and adult females, and prevalences of low hemoglobin levels indicative of anemia were generally higher in these groups than in other age and sex groups. However, low hemoglobin levels in the absence of other data on iron status do not necessarily indicate iron deficiency. To assess iron status adequately, multiple indicators must be evaluated. Continued monitoring of iron status should include total intake from food and dietary supplements and assessment of biochemical and hematological indicators.

Calcium

Some data suggest that low calcium intakes may be associated with hypertension (Hamet, 1995). More important from a public health perspective, however, is that current calcium intakes may be insufficient to attain optimal peak adult bone mass and to prevent age-related loss of bone mass (NIH Consensus Development Panel on Optimal Calcium Intake, 1994). In 1988-91, median calcium intakes from food were consistently below RDA values for adolescent and adult females and for males of most age and racial/ethnic groups. Data from NHANES III 1988-91 are now available for evaluating bone mineral density and for estimating the prevalence of osteopenia and osteoporosis in the U.S. population and in population subgroups. Continued monitoring of total calcium intake (dietary plus supplements) and bone density is recommended.

Sodium

High sodium intakes are associated with high prevalences of hypertension, which remains a major public health problem in the United States. In 1988-91, median sodium intakes from food alone (excluding salt added at the table, medications, and other nonfood sources) for children 6-11 years of age, adolescents, and adults were consistently above the recommended level of 2,400 mg/d or less. Prevalence of hypertension was lower in 1988-91 than it was a decade before; however, it is not possible to determine how much of this decrease is due to methodologic changes and how much is due to primary prevention. Continued monitoring is warranted because of the serious and largely preventable adverse effects of hypertension. Blood pressure should continue to be measured in future surveys, and efforts should be made to improve and validate the assessment of total sodium intake.

Potential public health issues for which further study is required

Total carbohydrate

Median intakes of total carbohydrate are somewhat lower than recommended values (≥ 55% of calories). The carbohydrate components associated with health effects are sucrose and dietary fiber. Sucrose consumption has been associated with dental caries, and high intakes of certain types of dietary fiber have been associated with lower serum cholesterol levels and a lower risk of colon cancer. Because Healthy People 2000 Objective 2.6 targets increasing consumption of food containing complex carbohydrates and fiber (fruits, vegetables, and grain products), the monitoring of the consumption of carbohydrate-containing foods should continue. If total fat intakes (as a percentage of energy) decrease as recommended, then increases in carbohydrate consumption should also occur. It is preferable that increases in carbohydrate consumption come from complex carbohydrates, such as fruits, vegetables, and grain products, rather than from sugars.

Dietary fiber

Median intakes of dietary fiber from food were lower than recommended intakes (20-30 g/d for healthy adults); however, the health effects of these levels of intake cannot be judged on the basis of available NNMRRP data. More information is required about the health effects of dietary fiber and about the food content of dietary fiber and various fiber components that differ in their physiological effects. For example, higher intakes of soluble fiber may lower serum cholesterol levels, whereas higher intakes of insoluble fiber are thought to be associated with lower risk of colon cancer. Continued monitoring of dietary fiber intakes is warranted.

Sugars

The development of dental caries has been associated with sucrose consumption (Glinsmann et al., 1986). Sugars, which are simple carbohydrates, provide food energy, may contribute to energy intakes in excess of energy expenditures, and may displace other sources of nutrients. When the fat content of food is reduced, the sugar content may increase and may result in higher intakes of sugars by people who consume fat-free, low-fat, or reduced-fat foods. Data are not available in the Survey Nutrient Data Base to evaluate intakes of sucrose, high-fructose corn syrup, or other substances used to sweeten foods. However, estimated intakes of individual sugars are available in the 1986 FDA Sugars Task Force report, which used data from a variety of sources on food content of sugars (Glinsmann et al., 1986). Monitoring the intake of sugars is needed to track the sources of carbohydrate in the U.S. diet.

Polyunsaturated and monounsaturated fatty acids

Results of metabolic studies in humans indicate that intake of polyunsaturated fatty acids is inversely associated with serum total cholesterol. When substituted for saturated fatty acids in the diet, polyunsaturated and monounsaturated fatty acids have been shown to lower serum LDL cholesterol. The effects of increasing monounsaturated fatty acids without lowering other fatty acids (i.e., of displacing carbohydrates) are less certain. Median intakes of polyunsaturated and monounsaturated fatty acids were within recommended ranges (≤10% of calories and ≤15% of calories, respectively) in 1988-91. Monitoring the dietary intakes of polyunsaturated and monounsaturated fatty acids should be continued in conjunction with the monitoring of intakes of total fat, saturated fatty acids, and cholesterol and with the assessment of serum total cholesterol and HDL- and LDL-cholesterol levels.

Trans *fatty acids*

Monitoring priority status for *trans* fatty acids is being considered for the first time in the TRONM. *Trans* unsaturated fatty acids are found naturally in meat and dairy products and are produced from naturally occurring *cis* unsaturated fatty acids when vegetable oils are hydrogenated to produce margarine, shortening, or other hardened fat products.

Limited epidemiological evidence suggests that higher dietary consumption of *trans* fatty acids may be associated with increased prevalence of coronary heart disease in women in the United States (Willett et al., 1993). However, a nine-country study of concentrations of one *trans* fatty acid in adipose tissue in men found considerable differences among countries but no overall association within countries between a high concentration of that *trans* fatty acid in adipose tissue and myocardial infarction, a manifestation of coronary heart disease (Aro et al., 1995). These findings suggest that caution is needed in interpreting epidemiological data on associations of *trans* fatty acids with risk of coronary heart disease (McKeigue, 1995).

Clinical studies have suggested that consumption of *trans* fatty acids may increase serum LDL-cholesterol levels and decrease HDL-cholesterol levels. For example, consumption of a diet with about 11% of calories as *trans* fatty acids raised serum LDL-cholesterol levels and lowered serum HDL-cholesterol levels in healthy subjects (Mensink and Katan, 1990). The proportion of calories as *trans* fatty acids available for consumption in the U.S. diet, based on disappearance data, was estimated in two different studies to be 6% and 3.7% of calories (Enig et al., 1990; Hunter and Applewhite, 1991). In a controlled study of healthy men and women who were consuming diets containing 3.8% and 6.6% of calories as *trans* fatty acids, Judd et al. (1994) reported that *trans* fatty acid consumption increased serum LDL-cholesterol levels more than did a diet containing oleic acid (a *cis* unsaturated fatty acid) and less than did a diet containing saturated fatty acids. Serum HDL cholesterol was unchanged with the lower level of *trans* fatty acids but decreased slightly with the higher level of *trans* fatty acids (Judd et al., 1994). Questions remain about whether those studies have shown that *trans* fatty acids can raise serum total and LDL-cholesterol levels (Nicolosi and Dietschy, 1994).

Trans fatty acids are not included in the Survey Nutrient Data Base and, therefore, the distribution of intakes has not been described in the NNMRRP. Because the proportion of the population with high intakes of *trans* fatty acids is not known and because of their potential effects on serum LDL cholesterol and HDL cholesterol, monitoring is warranted.

Fat substitutes

With the many new developments in fat substitutes and higher consumer demand for low-fat and fat-free foods, fat substitutes are being incorporated into many foods. This may result in significant changes in the U.S. diet, including lower fat intakes, lower intakes of fat-soluble vitamins, and higher intakes of carbohydrates. Consumption of these substances is expected to increase as people try to lower dietary total fat intake. Substances used as fat substitutes include modified fats, proteins, gums, and dietary fiber. Evidence of the absence of adverse effects must be demonstrated before fat substitutes are used in foods (Vanderveen and Glinsmann, 1992). Methods for analyzing these substances in foods will need to be developed, and the food composition data should be incorporated into the Survey Nutrient Data Base so that intakes of these substances may be monitored.

Protein

Median intakes of protein from food were well above RDA values for most demographic groups in 1988-91. Diets high in protein can increase urinary calcium losses and interfere with calcium conservation when dietary calcium intakes are low (Heaney, 1991). Epidemiological evidence from 16 countries also suggests that higher estimated per capita dietary intakes of animal protein are associated with higher prevalences of hip fracture in women over 50 years of age (Abelow et al., 1992). Because calcium intakes are low for many adolescents and adults in the U.S. population and because evidence from clinical and epidemiological studies suggests that high protein intakes may adversely affect calcium excretion and bone health, the higher-than-adequate intakes of protein by much of the U.S. population may be of concern.

The adverse effects of inadequate intakes of protein have been described extensively (NRC, 1989a,b). Median protein intakes of adults 60 years of age and older were somewhat lower than they were for other age groups in 1988-91, although they were still at or above the RDA levels. Protein requirements of older people may be about the same as for younger people when food energy intakes are adequate (Hunt et al., in press), but they may be higher when energy intakes are low (Campbell et al., 1994). Because of high protein intakes by most age-sex groups, including those with low calcium intakes, and the potential for low protein and low food energy intakes by elderly people, the monitoring of dietary protein intakes should continue.

Vitamin A

High and low intakes of vitamin A are considered to be a potential public health issue. Adverse effects of inadequate vitamin A intake include ocular changes such as night blindness; excessive intakes of preformed vitamin A may result in toxicity, including headaches, bone abnormalities, and liver damage (NRC, 1989a).

Median intakes of vitamin A from food were below RDA values for adults and some subgroups of older children, but the prevalence of low serum levels of vitamin A was very low in these groups. This finding was not unexpected because concurrent dietary intakes do not usually correlate with serum vitamin A distribution curves (Joint WHO/UNICEF Consultation, 1994). Median vitamin A intakes of younger children were above RDA values, but the prevalence of low serum vitamin A levels in younger children was relatively high when current cutoff values were used. This pattern was previously observed in children in national surveys done in 1971-74, 1976-80, and 1982-84 (Pilch, 1985). These repeated findings suggest that different interpretive criteria should be developed to evaluate serum vitamin A levels in children. In all age groups, high intakes of vitamin A may result from misuse of high doses of preformed vitamin A in dietary supplements. Further study is needed to make quantitative estimates of total vitamin A intake from dietary supplements as well as from food and to develop interpretive criteria for assessing vitamin A status when serum levels of retinyl esters, a form of vitamin A found in serum, are high.

Antioxidant vitamins

As a group, the antioxidant vitamins (vitamin C, vitamin E, and carotenes) are classified as a potential public health issue. Epidemiological and clinical studies suggest that antioxidants in food can lower the risk of heart disease (Gey et al., 1991), some forms of cancer (Block, 1991; Byers and Perry, 1992), cataracts (Hankinson et al., 1992; Jacques and Chylack, 1991), and macular degeneration, one of the leading causes of visual loss among people aged 65 years and older (Eye Disease Case-Control Study Group, 1993; West et al., 1994). Additional research is needed on the biochemical and health effects of diets containing specified levels and combinations of antioxidant nutrients.

Vitamin C.—Although median intakes of vitamin C from food were above RDA values for population subgroups, interpreting these data is difficult because the range of intakes necessary for optimal antioxidant activity of vitamin C remains unknown. In addition, preliminary inspection of serum vitamin C data from NHANES III 1988-91 raised questions about using cutoff values derived for other methods of vitamin C analysis (used in other surveys) to interpret serum vitamin C values obtained with the more sensitive and specific methods used in NHANES III 1988-91. Continued monitoring is warranted, but research is needed to resolve uncertainty about the interpretation of vitamin C intake data and serum levels.

Vitamin E.—Median intakes of vitamin E from food were below RDA values for all population subgroups of people 1 year of age and older. These data are difficult to interpret because the content of vitamin E, which is added as an antioxidant to food as α-tocopherol, decreases over time, whereas the vitamin E esters added as a dietary source of vitamin E are relatively stable in food but do not provide antioxidant activity until the digestive enzymes in the intestine remove the ester linkage. Thus, the vitamin E content of a food is likely to be different when the food is analyzed and when it is consumed, and the food composition data on vitamin E have little meaning in the evaluation of vitamin E intakes. Interpretation of serum vitamin E levels is confounded by factors such as serum lipid concentrations. Improved interpretive guidelines based on the linkage of serum vitamin E levels to serum lipid concentrations or to functional indices, such as immune function and protection of LDL cholesterol from oxidation, are needed to evaluate vitamin E status in populations. Data from NHANES III 1988-91 provide the first measurement of serum vitamin E in a nationally representative sample. Continued monitoring is warranted, but the priority given to that effort may be determined more appropriately after guidelines for interpreting serum vitamin E concentrations are developed.

Carotenes.—Carotenes may have a protective effect on macular degeneration (Eye Disease Case-Control Study Group, 1993; West et al., 1994), and some epidemiological studies have suggested that β-carotene intake may be protective against lung cancer (Shekelle et al., 1981; Willett, 1990). However, these results have not been observed in all epidemiological studies (Alpha-Tocopherol Beta Carotene Cancer Prevention Study Group, 1994), nor have they been confirmed in clinical trials. Data on intake of carotenes from food are available in the NNMRRP, but interpretive criteria are lacking for assessing dietary intake of carotenes and the biochemical indicators of carotenoid status. These criteria are needed before the status of carotenes can be evaluated.

Folate

Folate, vitamin B_6, and vitamin B_{12} play a role in homocysteine metabolism. Epidemiological studies have suggested that elevated serum levels of homocysteine may be a risk factor for atherosclerosis. High serum homocysteine levels in the presence of low serum levels of folate and vitamin B_6 have been associated with an increased risk of a narrowing of extracranial carotid arteries in elderly people (Selhub et al., 1995). The use of dietary supplements containing folate by females before they become pregnant and during early pregnancy has been associated with a decreased incidence of some types of neural-tube defects in some populations (MRC Vitamin Research Study Group, 1991; Werler et al., 1993). Fortification of the U.S. food supply with folate and the use of folate supplements by women of child-bearing age have been proposed as alternative ways to prevent some types of neural-tube defects. However, the prevalence of neural-tube defects in the U.S. population is sufficiently low that national surveys and surveillance systems would not be able to detect changes in prevalence in response to changes in folate intakes.

Median intakes of folate from food were higher than 1989 RDA values for all age, sex, and racial/ethnic groups except non-Hispanic black females 16 years of age and older and Mexican-American females 60 years of age and older. The mean intake of folate from food by pregnant females in NHANES III 1988-91 was below the 1989 RDA value for pregnant women. The monitoring of folate status should include intakes from dietary supplements as well as from food.

Serum and red blood cell levels of folate were measured in NHANES III 1988-94, but there were analytical problems related to the kit used in NHANES III 1988-91 (Levine et al., 1993). Because of these problems, the biochemical indices of folate status were not evaluated in time for consideration in this report. Issues related to these problems, proposed adjustment factors, and interpretation of the data were evaluated by an LSRO Expert Panel (Raiten and Fisher, 1994). Improved methodology for analyzing folate in food and blood samples is the most critical need for further study of folate.

Vitamin B_6

Adverse effects of inadequate vitamin B_6 intake include neurologic abnormalities (including convulsions in infants), dermatitis, impaired immune function, and anemia (NRC, 1989a). In addition, elevated levels of serum homocysteine in the presence of low serum levels of vitamin B_6 and folate have been associated with increased prevalence of atherosclerosis (Selhub et al., 1995). Chronic high intakes of vitamin B_6 as dietary supplements or as therapies have caused ataxia (the inability to coordinate voluntary muscular movements) and neuropathy (degeneration of nerves) (NRC, 1989a).

Median intakes of vitamin B_6 from food were below RDA values for adults and adolescents, more so for females than males, and for females 6-11 years of age. Further research is needed on vitamin B_6 requirements and on biochemical and other techniques for assessing vitamin B_6 nutritional status so that the public health importance of these intakes can be interpreted effectively. An appropriate level of monitoring activity may be assigned when more information is available on these issues.

Vitamin B_{12}

Compromised absorption of vitamin B_{12} may lead to pernicious anemia. Median intakes of vitamin B_{12} from food were above RDA values for all age, sex, and racial/ethnic groups in the U.S. population. However, intakes from food and dietary supplements may not provide sufficient vitamin B_{12} if absorption is impaired, as it appears to be in some elderly people. Serum concentrations of vitamin B_{12}, which will be available for NHANES III 1991-94, may prove to be more useful than dietary data for evaluating vitamin B_{12} status. Further investigations and monitoring activities should focus on elderly people.

Magnesium

Limited evidence suggests that low serum levels of magnesium may be associated with an increased risk of hypertension (Ascherio et al., 1992; Witteman et al., 1989). Median magnesium intakes from food were below RDA values for adolescents and adults but not for children in 1988-91. There are no good biochemical or clinical indicators for measuring magnesium status. Dietary and serum magnesium are not correlated. Magnesium deficiency has not been reported in people with low dietary intakes alone (NRC, 1989a). Research into a possible association of magnesium intake with hypertension or other health outcome is needed, and further monitoring of magnesium intake is warranted.

Potassium

Adequate dietary potassium intake appears to have a beneficial effect on hypertension. In 1988-91, the median intakes of potassium from food in adults were consistently below 3,500 mg/d, which is approximately the amount of potassium in the recommended daily intake of 5 or more servings of fruits and vegetables (NRC, 1989a,b). Biochemical and clinical indicators are not currently available for evaluating potassium nutritional status. Further research on the role of potassium intake in the regulation of blood pressure and on the assessment of potassium status is needed to examine the public health significance of current intakes. Further monitoring is warranted.

Zinc

Zinc deficiency can lead to poor appetite, impaired sense of taste, and growth retardation. Some findings from the clinical literature suggest that zinc deficiency, as manifested by growth retardation, has occurred in some otherwise apparently healthy children in the United States (Hambidge et al., 1972). In 1988-91, median zinc intakes from food were below RDA values for all age and sex groups except infants. The significance of the observed low dietary intakes of zinc cannot be evaluated until adequate biochemical and/or clinical indicators of zinc status are available. Further monitoring is warranted.

Copper

Abnormal electrocardiographs (i.e., ventricular arrhythmias) have been found consistently in people who consumed low-copper diets (about 0.65-1.0 mg copper daily) in metabolic studies (Klevay et al,. 1984; Lukaski et al., 1988; Sandstead, 1995). Median copper intakes from food were below the lower limit of the Estimated Safe and Adequate Daily Dietary Intake (ESADDI) (1.5 mg/d) for adolescents and adults and for children 3-5 years of age and females 6-11 years of age. Because median daily copper intakes of adults in the United States were not substantially above 1.0 mg, future monitoring of copper status is warranted.

Selenium

Several epidemiological studies have suggested an association of selenium status with risk of cancer or heart disease (Levander, 1987). A broad base of animal research also provides evidence that selenium may have an anticarcinogenic effect. Additional research is needed to demonstrate conclusively that selenium (and in what chemical form) protects against cancer and heart disease in humans (Levander and Burk, 1990; NRC, 1989b). Selenium toxicity has also been reported in the United States; however, biochemical indicators of dietary selenium overexposure are not available (International Programme on Chemical Safety, 1987; Levander and Burk, 1990).

Data from the Total Diet Study (1982-89) indicated that mean selenium intakes from food were above RDA values for all age and sex groups assessed. Although selenium is not yet included in the Survey Nutrient Data Base, analyses of the selenium content of foods have provided data that may be incorporated into that data base and, thereby, used for nutrition monitoring. Analysis of serum selenium levels measured in NHANES III 1988-91 was not available in time for the preparation of the TRONM; interpretive criteria will be needed to evaluate the serum selenium data. Monitoring of selenium is warranted.

Fluoride

Fluoride occurs naturally in water or is added to municipal water supplies. In 1986, the JNMEC was concerned that fluoride intakes might be too low for many people (HHS and USDA, 1986). In 1989, the EPONM was likewise concerned that intakes might be too low to provide maximal benefits to some groups, but it noted that the availability of fluoride has increased and may be approaching levels that induce mild dental fluorosis (mottled teeth) (HHS, 1988; LSRO, 1989). It may be possible to estimate the prevalence of mottled teeth and, thus, of high fluoride intakes, from the NHANES III 1988-94 dental-examination data. Data are not currently available in the NNMRRP surveys to evaluate fluoride intakes. Because the availability of fluoride has increased and food contributes only small amounts of fluoride, monitoring the diet for fluoride intake is not very useful for current public health concerns.

Phosphorus

Consumption of diets high in phosphorus and protein can adversely affect calcium metabolism and increase urinary calcium excretion (NRC, 1989a,b). Adverse effects of high phosphorus intakes have not been observed in humans when calcium intakes are adequate; however, the effects of high phosphorus (as phosphate) intakes on calcium losses may be of concern when calcium intakes are low (Calvo, 1993). Median phosphorus intakes from food were at or above RDA values in 1988-91; however, calcium intakes from food were consistently below RDA values for adolescent and adult females and for males of most age and racial/ethnic groups. Because calcium intakes are low for many adolescents and adults in the U.S. population and because interactions between phosphorus and calcium may result in adverse effects on calcium metabolism, monitoring of phosphorus intakes should continue. (See "Protein," above.)

Not current public health issues

Thiamin, riboflavin, and niacin

Adverse effects of inadequate intakes of thiamin, riboflavin, and niacin are well-characterized. There is little evidence that high intakes of thiamin and riboflavin have adverse effects. Consumption of large amounts of niacin, however, can cause skin flushing and certain metabolic effects (NRC, 1989a). Median intakes generally appear to be adequate, and no other evidence suggests that these vitamins pose a public health problem. However, because intakes may be low in some groups of Hispanic females, monitoring of intakes of these vitamins should continue with a focus on these subpopulations.

Iodine

Low iodine intakes cause goiter, which was a public health problem in the United States in the past. High intakes of iodine can also induce goiter (Park et al., 1981). Until recently, iodine intakes were estimated in the Total Diet Study. Data from that study indicated that mean iodine intakes from food were above RDA values for all age-sex groups assessed. Iodine intakes are not assessed in NNMRRP surveys, and the high cost of accurate analyses of iodine content of foods precludes addition of data on iodine composition of food to the Survey Nutrient Data Base. No epidemiological or clinical evidence suggests that low or high iodine intakes are currently of public health concern in the United States. Monitoring the diet for iodine intake is not very useful for current public health concerns.

Comparison with EPONM and JNMEC classifications

Most of the evaluations of individual nutrients in the TRONM, listed in table 9-3, are consistent with those in the first and second nutrition monitoring reports (HHS and USDA, 1986; LSRO, 1989). Food energy, total fat, saturated fatty acids, cholesterol, alcohol, iron, calcium, and sodium were again classified as current public health issues. Changes from previous evaluations in this report included classifiying total carbohydrate, vitamin E, vitamin B_{12}, magnesium, copper, phosphorus, and protein as potential public health issues rather than as not current public health issues. The change in the classification of total carbohydrate was made on the basis of Healthy People 2000 Objective 2.6, which encourages people to consume more foods that are rich sources of complex carbohydrates and dietary fiber (i.e., fruits, vegetables, and grains). This objective reflects the recommendations shown in the 1990 *Dietary Guidelines for Americans* and the Food Guide Pyramid to eat a minimum of 2 servings of fruit, 3 servings of vegetables, and 6 servings of grain products every day.

The changes in the classification of the other nutrients were made on the basis of evidence from the general biomedical literature rather than on the basis of evidence of changes in intakes of these nutrients or of changes in the nutritional and nutrition-related health status of the U.S. population. This is the first assessment for the NNMRRP of monitoring priority status for polyunsaturated and monounsaturated fatty acids, *trans* fatty acids, fat substitutes, sugars, selenium, and iodine.

Recommendations for future nutrition monitoring and research activities

Monitoring needs

The NNMRRP should monitor intakes from food and dietary supplements for all of the food components evaluated in the TRONM with the exception of fluoride and, possibly, vitamin E. For food components that are current public health issues, the program should monitor appropriate anthropometric, biochemical, and clinical indices of nutritional status and nutrition-related health status for food energy, total fat, saturated fatty acids, cholesterol, iron, calcium, and sodium. For food components that are potential public health concerns, the program should monitor appropriate biochemical and clinical indices of nutritional status and nutrition-related health status. The monitoring of biochemical and clinical indices is not recommended for food components that are not current public health issues; however, monitoring of dietary intakes should continue.

Research needs

During the course of interpreting and evaluating NNMRRP data for the TRONM, the Expert Consultants and LSRO identified information needed to improve future monitoring efforts. Additional research is required to obtain this information. The most immediate research needs are 1) to develop interpretive criteria to link monitoring data to functional or health outcomes; 2) to improve biochemical assays; and 3) to improve food composition data. Table 9-4 presents recommendations for future research for use in

Table 9-4. Recommendations for further research for national nutrition monitoring in the United States

Classification and food component[1]	Recommended research action[2]
Current public health issue	
Food energy	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Total fat	• Improve food composition data.
Saturated fatty acids	• Improve food composition data.
Cholesterol	• Improve food composition data.
Iron	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Calcium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Sodium	• Improve food composition data.
Potential public health issue for which further study is required	
Total carbohydrate	• Improve food composition data.
Dietary fiber	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Sugars	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., metabolic effects of sugars such as high-fructose corn syrup). • Improve food composition data.
Monounsaturated fatty acids	• Improve food composition data.
Polyunsaturated fatty acids	• Improve food composition data.
Trans fatty acids	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Protein	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., effects of high phosphorus and high protein intakes on bone density when calcium intakes are low).
Fat substitutes	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., cutoff values for serum retinol in children). • Improve food composition data.
Vitamin A	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.

Table 9-4. Recommendations for further research for national nutrition monitoring in the United States—continued

Classification and food component[1]	Recommended research action[2]
Carotenes	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Vitamin C	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays. • Improve food composition data.
Vitamin E	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Folate	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays. • Improve food composition data.
Vitamin B_6	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays.
Magnesium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Potassium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Zinc	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve biochemical assays.
Copper	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes. • Improve food composition data.
Selenium	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes.
Phosphorus	• Develop interpretive criteria to link monitoring data to functional outcomes or health outcomes (e.g., effects of high phosphorus and high protein intakes on bone density when calcium intakes are low).

[1]Further research actions are not recommended at this time for nutrition monitoring purposes for food components not listed here (alcohol, fluoride, iodine, vitamin B_{12}, thiamin, riboflavin, and niacin), although further monitoring is recommended for all of them.
[2]Recommended research actions are listed in descending order from the most immediate need for interpreting existing data and for comparisons with data collected in future surveys; however, all research actions listed for each nutrient should be considered high priority. The Expert Consultants and LSRO regarded recommended monitoring activities as separate from recommended research actions. Further monitoring was recommended for all food components (see text).

SOURCE: LSRO, 1995.

interpreting existing data and in comparisons with data collected in future surveys. If more than one research need is indicated for a given food component, the need considered of highest priority is listed first. However, all research actions listed for each nutrient should be considered of high priority.

Gaps in knowledge

The gaps in knowledge about food composition, food consumption and nutrient intake, and nutritional status and nutrition-related health status identified in previous chapters were evident as the Expert Consultants and LSRO assigned monitoring priorities for food components. A lack of knowledge about mean requirements and distributions of requirements for most nutrients for most age-sex groups limited the interpretation of data on dietary intakes, particularly when biochemical data on nutritional status for many nutrients were not yet available for consideration. In some cases, questions about the methodology used in NHANES III 1988-91 and appropriateness of cutoff values established on the basis of other methodologies will have to be resolved before the data can be interpreted.

Recommendations

- Continue monitoring of foods consumed by individuals to examine differences in food consumption patterns among population subgroups and to track progress toward meeting Healthy People 2000 objectives and adopting dietary recommendations in the Food Guide Pyramid.

- Monitor nutrient intakes from foods and from dietary supplements.

- Continue monitoring appropriate anthropometric, biochemical, clinical, and hematologic indicators of nutritional status.

- Develop interpretive criteria to link nutrition monitoring data to functional outcomes or health outcomes.

- Continue monitoring nutrition-related health conditions, including low birth weight, growth status in children, overweight in adults, serum lipids, hypertension, osteoporosis, and anemia. Monitoring efforts should not be limited to these conditions and should continue to include other diseases with a nutritional component, such as diabetes mellitus, dental conditions, and gallbladder disease.

- In future nutrition monitoring reports, nutrition monitoring assessments should be based on health conditions and nutrient intakes of public health concern.

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Chapter 10

Recommendations for the National Nutrition Monitoring and Related Research Program

Introduction

The United States' national nutrition monitoring system takes a broad, multidisciplinary approach to monitoring the nutritional and nutrition-related health status of the U.S. population, with particular emphasis on high-risk subgroups, such as low-income and certain minority groups.

The cornerstone surveys of the NNMRRP (CSFII and NHANES) provide a unique opportunity for the comprehensive and coordinated evaluation of the dietary, behavioral, anthropometric, clinical, and biochemical status of the U.S. population and certain subgroups considered to be at high risk for nutrition-related problems. The need to continue these two cornerstone surveys and adjunct activities at a national level is critical for several reasons. First, within each survey cycle, data on many factors related to diet and health are collected from a single, large, nationally representative sample of people. Meaningful comparisons of health effects can be made within and among many age, sex, racial/ethnic, and income-level groups. Such comparisons cannot be made with as much confidence with data from surveys that do not use nationally representative samples. Second, continuing to use the complex survey designs of the cornerstone surveys, which require large sample sizes, will minimize such potentially confounding effects as population mobility and variabilities in the distribution of domestic and imported foods throughout the country. Third, centralized laboratory analyses with well-defined protocols and quality-control procedures, although difficult, can be carried out in large surveys such as NHANES, but achieving this uniformity of procedures and quality control across several surveys is much more difficult. Finally, collecting data in future nutrition surveys at the national level should permit comparisons with information from other cycles of these surveys. Trends in the dietary, nutritional, and nutrition-related health status of the U.S. population can then be identified and monitored, and the information can be used to recommend appropriate interventions to improve Americans' health.

Comparability among the surveys has been improved since the publication of the second nutrition monitoring report (LSRO, 1989). To allow more direct comparisons among surveys, a common set of population descriptors and guidelines for statistical and reporting categories for those descriptors were recommended by the Interagency Board for Nutrition Monitoring and Related Research Survey Comparability Working Group in 1992. A joint policy on variance estimation and statistical reporting standards for NHANES III 1988-91 and CSFII 1989-91 reports was developed by an HNIS/NCHS Analytic Working Group in 1993 (HNIS/NCHS Analytic Working Group, 1993; see also app. III). That group also developed a set of statistical guidelines for reporting data for the TRONM. As the Expert Consultants and LSRO reviewed data provided for the TRONM, they found the use of the common descriptors and reporting categories vital for comparing results across surveys. Use of these common entities should continue, and further consideration should be given to developing more common descriptors that could be recommended for across-survey comparisons.

The NNMRRP is still evolving. At various points during its evolution, expert committees and other groups have made recommendations for its improvement. Key publications that include these recommendations are

- *National Survey Data on Food Consumption: Uses and Recommendations* (NRC, 1984),
- *Nutrition Monitoring in the United States: A Progress Report from the Joint Nutrition Monitoring Evaluation Committee* (HHS and USDA, 1986),
- *Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring* (LSRO, 1989),
- *Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program: Notice* (HHS and USDA, 1993),
- *Nutrition Monitoring: Progress in Developing a Coordinated Program* (GAO, 1994),
- *Nutrition Monitoring: Data Serve Many Purposes; Users Recommend Improvements* (GAO, 1995a), and
- *Nutrition Monitoring: Establishing a Model Program* (GAO, 1995b).

To strengthen the program and overcome some limitations of the present system, specific gaps in knowledge and recommendations for enhancing the usefulness of the survey data are identified in chapters 3 through 9 of this report. Recommendations that apply broadly to the NNMRRP are listed below.

General

- Support basic research and epidemiological studies by Federal agencies and academia or assume the responsibility to do so in order to maximize the NNMRRP's usefulness in nutrition and health monitoring. Conducting basic research or epidemiological studies to establish or evaluate the scientific validity of various interpretive criteria of biochemical and behavioral parameters of nutrition and health is not a primary mission of the NNMRRP. However, the interpretation and use of NNMRRP data for public policy decisions rely upon the validity of the interpretive criteria. Part of the mission of the NNMRRP should be the development of interpretive criteria. The program should provide for research to improve methodology for all aspects of nutritional assessment, including food composition, food consumption, biochemical evaluations, and behavioral indices so that interpretive criteria can be based on the best and most current methodology.

- Develop statistical models to examine relationships and interactions among the many types of data collected for NNMRRP surveys.

- Encourage and support efforts of agencies that participate in the NNMRRP to publish survey and surveillance system data in agency reports and peer-reviewed scientific journals. Although resources for these activities are limited, making data available in a timely fashion to the public, the scientific community, and for public policy consideration is an essential component of the NNMRRP. The agencies should also release the primary data (i.e., government reports and data tapes) to the research community as quickly as possible.

- Conduct special studies of high-risk population subgroups (e.g., American Indians, pregnant females, and migrant populations) concurrently with national surveys using comparable data-collection methodologies.

- Develop, standardize, and disseminate nutrition methodologies for comparable use at national, State, local, and community levels to allow for appropriate data comparisons.

- Improve the system for the electronic transfer of nutrition survey data to data base users. This capability enhances the States' abilities to use NNMRRP data. Consideration should be given to implementing a system in which States can obtain NNMRRP data that pertain to their specific needs. Any system for electronic data transfer must require strict adherence to quality-control criteria for inclusion of data and would have to include protection against change by unauthorized individuals or organizations.

- Support the development of a comprehensive catalog of the types of data and analyses available from all surveys and surveillance systems of the NNMRRP. Such a catalog should be patterned after the *Catalog of Electronic Data Products* (NCHS, 1994). The currently available *Nutrition Monitoring in the United States: The Directory of Federal and State Nutrition Monitoring Activities* (IBNMRR, 1992) could be expanded or supplemented by a more comprehensive listing of data that are available on tape, diskette, or CD-ROM or as published reports. Such a comprehensive source document on the entire NNMRRP would be quite valuable to research investigators, State agencies, and others.

- Start planning for the fourth report on nutrition monitoring immediately. The quantity of data generated by the NNMRRP is substantial and the data are complex, requiring careful planning of analyses. Early initiation of planning, including a sharper focus on topics to be included in the next comprehensive 5-year report, is critical.

National food-supply determinations and household-based food expenditures

- Continue to collect reliable food-supply data from a variety of government and private sources and to calculate estimates of the total available food supply, per capita consumption, and nutrient availability annually.

- Continue to collect and analyze data on household food use and expenditures for food at home, including preprepared foods (foods purchased in a ready-to-eat form and taken home for consumption).

- Continue to gather information on the amount of money spent for food away from home. Expand efforts to capture information for food away from home by type of food item and by facility where food is eaten (e.g., school cafeteria, restaurant with counter service, restaurant with waiter-waitress service, vending machine, etc.).

Food composition and nutrient data bases

- Develop acceptable assay methods that are faster and less expensive than current methods. Efforts should involve coordination with the food industry and other groups to increase the accuracy of methods, improve data quality, and make food composition data more accessible.

- Enhance communication between government and the food industry so that the development of food composition methodologies used for food-safety and food-labeling (i.e., regulatory) purposes and those used to generate food composition data for food composition data bases can be coordinated. Such coordination should allow for greater use of brand-specific information in the USDA Nutrient Data Base for Individual Food Intake Surveys (Survey Nutrient Data Base).

- Improve and expand food composition data for total fat, fatty acids including *trans* fatty acids, fat substitutes, dietary fiber, vitamin A, carotenes, vitamin C, folate, sodium, copper, cholesterol, total carbohydrate, and sugars. Incorporate food composition data for selenium into the Survey Nutrient Data Base.

- Continue to collect and compile food composition data for analytical research purposes and to use, develop, and maintain nutrient data bases for estimating nutrient intakes from food consumption surveys. Maintain the USDA Nutrient Data Base for Standard Reference and the Survey Nutrient Data Base as two separate entities because their data are used in very different ways.

- Continue to develop a survey nutrient data base for trend analysis that will permit food composition data added in the future to be used to analyze food consumption data collected earlier.

- Create and maintain a product-specific data base for the nutrient composition of dietary supplements so that nutrient intakes from supplements—as well as from foods—can be analyzed.

Food consumption and nutrient intakes

- Continue monitoring foods consumed by individuals to examine differences in food consumption patterns among population subgroups and to track progress toward meeting Healthy People 2000 objectives and adopting dietary recommendations in the Food Guide Pyramid and the *Dietary Guidelines for Americans*.

- Monitor nutrient intakes from foods and from dietary supplements.

- Support research to determine the mean and variance of requirements for each nutrient. This information is needed to adequately assess the risk of dietary inadequacies and excesses in the U.S. population.

- Support research to determine whether nutrient requirements of population subgroups differ. Give higher priority to groups at nutritional risk and whose numbers are increasing in the population, such as elderly people.

- Support research to determine the extent of underreporting of food consumption that occurs in nutrition surveys, improve food consumption survey methodology and instruments that minimize underreporting, and develop analytic approaches to adjust for underreporting.

- Continue monitoring the magnitude and severity of food insufficiency in future nutrition monitoring surveys. Identify groups within low-income and other populations at risk for food insufficiency and examine factors that influence the development of food insufficiency.

Nutritional status and nutrition-related health status

- Continue monitoring indicators of nutritional status, including anthropometric, biochemical, hematologic, and clinical measures, and of nutrition-related health conditions, including low birth weight, growth status in children, overweight in adults, serum lipids, hypertension, osteoporosis, and anemia. Monitoring efforts should not be restricted to these conditions and should continue to include other diseases that have a nutritional component, such as diabetes mellitus, dental conditions, and gallbladder disease.

- Develop interpretive criteria to link nutrition monitoring data to functional or health outcomes.

- Conduct studies to improve the validity of biochemical and other methodologies used to assess nutritional status and nutrition-related health status.

- Explore links between nutritional status, particularly anthropometric indicators, and food insufficiency.

- In future nutrition monitoring reports, nutrition monitoring assessments should be based on health conditions and intakes of nutrients of public health concern.

Knowledge, attitudes, and behavior assessments

- Continue coordination among Federal agencies to enhance the collection and use of survey data on diet, nutrition, and health-related knowledge, attitudes, and behavior. Such efforts help reduce information gaps and duplication of effort, identify and prioritize monitoring needs, and strengthen the links between national surveys and programs that use these data for program planning and evaluation.

- Collect information on people's perceptions of dietary and nutrition issues and of health-related behaviors to improve approaches to translating knowledge into action. Determine the perceived internal and external barriers that keep people from adopting and maintaining healthier food and life-style choices.

- Establish better measures to evaluate physical-activity levels in children, adolescents, and adults.

- Identify and monitor factors that contribute to the low levels of physical activity in the general population and in population subgroups and factors that influence people to become more active and to maintain more active life-styles.

- Collect in-depth information from consumers on their use and understanding of information on the food label, and analyze the data for the general population and for population subgroups. For nutrition monitoring purposes, focus on the impact of the food label's nutrition panel on food purchases and consumption, on what specific information on the nutrition panel is used and found to be valuable, on where food-label information is used (at home and/or in the supermarket), and on the effect of food-label use on subsequent food purchases.

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Appendix I

Glossary

A. Terms

Alcohol: Ethanol; source of food energy (approximately 7 kcal/g); depressant. Found in beer, wine, other alcoholic beverages.

Anemia: Refers to a hemoglobin level below the normal reference range for individuals of the same sex and age. Hemoglobin references are sometimes, but not always, adjusted for smoking and altitude. This assessment corresponds roughly, but not exactly, to the third stage of iron deficiency because anemia may result from causes other than iron deficiency, including infection, chronic disease, and deficiencies of folate or vitamin B_{12}.

Atherosclerosis: A progressive process that begins in childhood with the appearance of lesions in the form of fatty streaks in the lining of the coronary arteries or aorta. The fatty streaks may eventually progress to fatty and fibrous plaques or even larger, more complicated lesions. As the lesions develop, the progressive narrowing of the vessels reduces blood flow to the tissues supplied by the affected vessels, resulting in angina pectoris (chest pain), myocardial infarction (heart attack), or sudden death. These are the most common manifestations of coronary heart disease.

Body mass index: A ratio relating body weight to height, calculated by dividing weight in kilograms by the square of height in meters. Also referred to as the Quetelet Index.

Calcium: An essential mineral needed for formation and maintenance of bones and teeth; transmission of nerve impulses; muscle contraction; blood clotting; integrity of cell membranes. Found in milk, cheese, broccoli, spinach, turnip greens, canned fish.

Carbohydrates: Source of energy in the diet; contributes approximately 4 kcal/g; stored as glycogen or converted to body fat. Simple carbohydrates (sugars) are found mainly in fruits, milk, sucrose, other caloric sweeteners. Complex carbohydrates include starches and dietary fiber; starches are found primarily in grain products, legumes, potatoes, and other vegetables. (*See also* "dietary fiber.")

Carotenes: Beta-carotene and other provitamin A carotenoids. Found in dark-green leafy vegetables, yellow and orange vegetables, some fruits.

Carotenoids: A group of about 600 naturally occurring compounds; about 50 have provitamin A activity. Most serve as antioxidants under certain conditions.

Cholesterol: Fat-like substance required for the synthesis of steroid hormones, bile acids, and vitamin D; found in animal foods and synthesized in the body; carried by lipoproteins in the blood.

Coefficient of variation: Most often calculated as (standard deviation divided by the mean) × 100; however, for purposes of this report, it is calculated as (standard error of the mean divided by the mean) × 100 or as (standard error of prevalence (or proportion) divided by prevalence (or proportion)). The latter statistic is also referred to as the relative standard error.

Comparability: Having sufficient measurement parameters in common among selected NNMRRP activities to afford comparison.

Consumer unit: The basic reporting unit for the Consumer Expenditure Survey consisting of 1) all members of a particular household who are related by blood, marriage, adoption, or other legal arrangements, 2) a financially independent person living alone or sharing a household with others, living as a roomer in a private home or lodging house, or living in permanent quarters in a hotel or motel, or 3) two or more people living together who use their incomes to make joint expenditure decisions. Financial independence is determined by three major expense categories: housing, food, and other living expenses. To be considered financially independent, at least two of the three major expense categories have to be provided entirely or in part by the respondent.

Continuous data collection: An approach to data collection in which data collection is repeated regularly and frequently. Survey or surveillance systems with continuous data collection include PedNSS, PNSS, BRFSS, and YRBS.

Copper: Essential mineral that functions as a component of several proteins and enzymes and in iron utilization. Found in liver, kidney, shellfish, nuts, whole-grain cereals, seeds, legumes.

Coronary heart disease: Includes a variety of pathological processes pertaining to the heart and blood vessels. (*See also* "atherosclerosis.")

Cutoff values: Points that divide a population into groups, such as "adequately nourished," "at risk of impaired nutrition status," and "deficient." Cutoff values may be based on the relationship between nutritional assessment indices and functional impairment and/or clinical signs of deficiency or on reference limits.

Data users: Includes policymakers, public health and nutrition researchers, food industry, academia, Federal agencies, State and local groups.

Dietary fiber: Heterogeneous group of plant components that are resistant to digestion by the enzymes of the human gastrointestinal tract. Soluble fiber includes gums, mucilages, some pectins and hemicelluloses; insoluble fiber includes cellulose, lignin, and other pectins and hemicelluloses. Found in fruits, vegetables, grains, legumes.

Dietary status: The condition of a population's or an individual's intake of foods and food components, especially nutrients.

Dietary supplements: Vitamin and mineral supplements; nonvitamin and nonmineral nutrient supplements (e.g., amino acids, protein powders, fatty acids, fish oils, and lecithin) and other supplemental compounds (e.g., herbs and plants, fiber, hormones, enzymes, bee pollen, brewer's yeast, and formula diets).

Discretionary salt: Salt added by an individual at the table.

Fat (total): Concentrated energy source in the diet; provides approximately 9 kcal/g. Carrier for the fat-soluble vitamins; structural and functional components of cell membranes; precursors of compounds involved in many aspects of metabolism. Found in salad and cooking oils, margarine, shortening, meat, poultry, fish, milk, cheese, other milk products.

Fat substitutes: Substances that replace traditional fats in foods but do not provide as much food energy as fat. Substances used as fat substitutes include modified fats, proteins, gums, and dietary fiber.

Fluoride: Essential mineral that is a component of bones and tooth enamel. Found in fluoridated water, certain fish, tea (also in fluoridated toothpastes and rinses).

Folate: Water-soluble vitamin required for formation of red blood cells and genetic material. Found in liver, dark-green leafy vegetables, dry beans, wheat germ, yeast, some fruits.

Food components: As discussed in this report, they include nutrients (macronutrients, vitamins, and minerals) and nonnutrients that may affect health (such as dietary fiber).

Food disappearance: The amount of food that remains after subtracting the nonfood uses (including exports, industrial uses, farm inputs (seed and feed), and ending inventories) from the total available food supply. This represents food that "disappears" into the marketing system and is available for human consumption. Food disappearance includes all food used by households, restaurants, fast-food chains, and other eating establishments.

Food energy: Chemical energy, obtained from foods, that supports body functions. Food energy is measured in kilocalories or kilojoules.

Food insufficiency: Inadequate food intake due to a lack of money or resources.

Growth retardation: Impairment in growth parameters (such as height, body weight, and head circumference).

HDL cholesterol: High-density-lipoprotein cholesterol. Substantial evidence suggests that a low HDL cholesterol (<35 mg/dL) imparts increased risk for coronary heart disease.

Health status: As used in this report, refers to a population's or an individual's status with respect to physical state or disease condition.

Hemoglobin: Protein in red blood cells that carries oxygen. Low hemoglobin concentration is used to assess the third stage of iron depletion. (*See also* "iron deficiency.")

Household: As defined in NFCS 1977-78 and 1987-88, all people who regularly share a house, an apartment, a room, or group of rooms used as separate living quarters; includes people temporarily absent, such as those in the hospital or traveling. Excludes individuals living away in group quarters such as dormitories, rooming houses, military barracks, and institutions. Residences with nine or more people unrelated to each other were considered group quarters and were not eligible to participate in the survey.

Household food consumption: Food and beverages from the household food supplies used within a given period of time, whether purchased, provided in the home, or received without direct expense. This includes food and beverages eaten at home, carried from home in packed meals, thrown away, or fed to pets.

Household size: Actual number of people in the household, including roomers, boarders, and employees.

Household size in 21-meal-at-home-equivalent people: Total adjusted meals eaten from household food supplies in the past 7 days, including meals and meal equivalent of refreshments for guests, divided by 21. The 21-MEP is an adjustment for variation among households in the number of meals eaten from home food supplies. Household size in terms of 21-MEP is determined as follows: the total number of meals is calculated by adding together 1) meals reported as eaten at home by members (adjusted proportionately with meals eaten away from home to total 21 meals in a week—three meals for each of 7 days—to account for skipped meals and for snacks that might substitute for or supplement meals), 2) meals eaten from household supplies by guests, boarders, roomers, and employees, and 3) meal equivalents of refreshments served to guests (one or two foods equals one-fourth meal; over two foods equals one-half meal). Then, the total number of meals is divided by 21 to obtain the household size in 21-MEP.

Hypertension: Mean systolic blood pressure greater than or equal to 140 mm Hg, mean diastolic blood pressure greater than or equal to 90 mm Hg, or under current treatment for hypertension with a prescription medication.

Import share: The proportion of the total food supply that is imported, equivalent to the quantity of food imported divided by the quantity available in the total food supply.

Incidence: Refers generally to the number of new events (e.g., new cases of disease) in a defined population, within a specified time period.

Iodine: Essential mineral that is an integral part of thyroid hormones. Found in seafoods, iodized table salt, iodates used as dough conditioners, iodine-containing disinfectants used in the dairy industry.

Iron: Essential mineral needed for oxygen transport in body; component of hemoglobin in red blood cells. Found in liver, beef, dry beans, spinach.

Iron deficiency: Refers to the presence of two or more abnormal values for iron-metabolism indicators and corresponds to the second stage of iron depletion (biochemical changes that reflect a lack of iron sufficient for normal production of hemoglobin and other essential iron compounds) and third stage of iron depletion (frank iron-deficiency anemia).

Kilocalorie: A unit used to express the energy value of food.

LDL cholesterol: Low-density-lipoprotein cholesterol. Most cholesterol in serum (60-70%) is found in this form. Elevated LDL-cholesterol level is a risk factor for coronary heart disease; ≥160 mg/dL is considered indicative of high risk and 130-159 mg/dL is considered borderline-high-risk for coronary heart disease.

Low birth weight: Birth weight less than 2,500 g for human infants.

Magnesium: Essential mineral that is a component of bone. Needed for protein synthesis, energy metabolism, muscle activity, and nerve function. Found in nuts, whole-grain products, dry beans, dark-green vegetables.

Marginal nutritional status: A condition in which nutrient stores may be low, the activity of some enzymes may be lower or higher than normal, and/or growth may be slightly impaired, but impairment of performance, health, and/or survival may not be evident. People with marginal nutritional status are considered *at risk of nutritional deficiency*, especially when subjected to stress.

Mean: Measure of central tendency, calculated by adding all individual values and dividing by the number of values.

Median (or 50th percentile): Value that divides a distribution of values into two equal parts, with 50% of the values above and 50% of the values below this point.

Money value of food used at home: Money value, as defined in NFCS 1977-78 and 1987-88, was based on expenditures for bought food used at home and on assigned values for home-produced food and food received free of cost. Expenditures for bought food were based on prices reported as paid, regardless of the time of purchase. Sales tax was excluded. To make the money values comparable across years, the data were adjusted to 1988 prices using the percentage increase in the consumer price index (CPI) for the respective food group.

Monounsaturated fatty acids: Fatty acids with one double bond. Found in olive oil and canola oil.

National Nutrition Monitoring and Related Research Program (NNMRRP): As defined by Public Law 101-445, the set of activities necessary to provide timely information about factors related to nutrition's contribution to the health of the U.S. population. The program includes the five measurement component areas described below, related research activities, and exchange and dissemination of information among Federal agencies, State and local agencies, food industry, the health community, consumer industry groups, academia, and professional organizations. Measurement component areas in the NNMRRP, formerly known as the National Nutrition Monitoring System, are categorized by 1) nutrition and related health measurements, 2) food and nutrient consumption, 3) knowledge, attitudes, and behavior assessments, 4) food composition and nutrient data bases, and 5) food-supply determinations.

National survey: National probability sample surveys such as the NHANES (NHANES I 1971-74, NHANES II 1976-80, and NHANES III 1988-91) and CSFII (CSFII 1985, CSFII 1986, and CSFII 1989-91).

Niacin: Water-soluble vitamin; obtained from food preformed, or may be synthesized from tryptophan. Involved in energy metabolism and synthesis of protein and fat. Found in whole and enriched grain products, liver, peanuts, poultry, red meat, fish (also dairy products and eggs as sources of tryptophan).

Nutrient assessment: The measurement of indicators of dietary status and nutrition-related health status to identify the possible occurrence, nature, and extent of impaired nutritional status (ranging from deficiency to toxicity). Examples of indicators include dietary intake, nutrient intake, and biochemical and clinical assessments.

Nutrient availability: The amount of nutrients and food components available in the food supply for consumption.

Nutrient deficiency: A condition associated with adverse health consequences arising from inadequate intake or utilization of a nutrient.

Nutrient excess and/or toxicity: A condition associated with adverse health consequences arising from excessive intake or utilization of a nutrient.

Nutrition intervention: A process of planned change to improve the nutritional status of the population, subgroups of the population, or individuals. The implementation of clinical trials, food assistance, and educational programs to promote positive dietary changes and improve nutritional status are examples of such intervention. Strategies for nutrition intervention depend on the problem, the needs of the population, the population subgroup or individual involved, and available resources.

Nutrition monitoring: Assessment of dietary or nutritional status at intermittent times for the purpose of detecting changes in the dietary or nutritional status of a population.

Nutrition surveillance: Continuous assessment of nutritional status for the purpose of detecting changes in trends or distributions in order to initiate corrective measures. PNSS, PedNSS, BRFSS, and YRBS are surveillance systems that provide data for the nutrition monitoring program.

Nutritional imbalance: A condition associated with adverse health consequences arising from insufficient or excessive intake of one nutrient or food component relative to another.

Nutritional risk: An increased probability of an existing nutritional imbalance arising from insufficient or excessive intake of one or more nutrients or food components that could lead to adverse health consequences, or from an existing health condition.

Nutritional status: The condition of a population's or an individual's health as influenced by the intake and utilization of nutrients and nonnutrients. It reflects, directly or inferentially, the processes of food ingestion and digestion; absorption, transport, and metabolism of food components; and excretion of food components and their metabolic products. Indicators of nutritional status include 1) levels of specific food components in diets; 2) clinical anthropometric, hematological, and biochemical measurements related to specific food components; and 3) health conditions or diseases that may be associated with diet.

Obesity: Excessive accumulation of body fat.

Osteopenia: A low bone mass characterized as bone mineral density between 1 and 2.5 standard deviations below the mean value for young adults.

Osteoporosis: Reduced bone mass resulting in increased skeletal fragility and increased tendency for low-trauma fractures. Osteoporosis is characterized by bone mineral density more than 2.5 standard deviations below the mean value for young adults.

Overnutrition: The condition resulting from the excessive intake of foods in general or of particular food components.

Overweight: Body weight above a standard usually defined in relation to height (*see* chs. 7 and 8 for standards for overweight used in this report).

Per capita consumption: Mean quantity of food consumed per person in a year, usually calculated by dividing total food available for consumption by the total U.S. population on July 1 of that year.

Percentiles: Divisions of a distribution into 100 equal, ordered subgroups.

Phosphorus: Essential mineral that is a structural element of bones and teeth; participates in a variety of chemical reactions. Found in dairy products, meat, poultry, fish, carbonated soft drinks.

Polyunsaturated fatty acids: Fatty acids with two or more double bonds. There are two types of polyunsaturated fatty acids: ω-6 and ω-3. Omega-6 fatty acids are found in plant oils such as corn, soybean, and canola oils; ω-3 fatty acids are found in fish oils and some plant oils.

Potassium: Essential mineral required, with sodium, for regulation of body-fluid volume and acid-base balance; principal intracellular cation. Found in red meat, milk, many fruits and vegetables, seafood.

Poverty guidelines: A set of cash-income cutoffs that varies by the number of individuals in a family or household. Various cutoffs for the definition of poverty (e.g., <131% of poverty) have been used for a variety of analytical and policy applications.

Poverty-income ratio: Income divided by the appropriate Federal Poverty Income guideline.

Prevalence: The number of cases of a given disease or other condition in a given population at a designated time.

Protein: Formed from various combinations of amino acids; energy source in the diet; provides approximately 4 kcal/g; involved in most metabolic processes; essential for growth, development, and maintenance of body tissues; amino acids are structural elements of muscle, connective tissue, bone, enzymes, hormones, and antibodies. Found in meat, poultry, fish, eggs, milk, cheese, legumes.

Reference distribution: The distribution of values from a predefined sample, generally of healthy people.

Reference limits: Values derived by statistical means from a reference distribution. Reference intervals are often set to 90% of the distribution, with 5% of the population at each tail of the distribution described as having unusually low or high values. For situations where only high or only low values are of interest, one-sided reference intervals may be developed.

Region: Those areas of the 50 States and the District of Columbia as defined by the U.S. Department of Commerce. The four Census regions and their States are:

Northeast—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.

Midwest (formerly North Central)—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.

South—Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia.

West—Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

Related research: Investigation of issues and topics pertinent to monitoring the nutritional and health status of the population and selected subgroups, such as designing samples for difficult-to-sample population subgroups; statistical modeling for State-based estimates; developing applied methodological studies of dietary intake and nutritional-status assessment; developing methods for measuring nutrients in food and biological fluids; and developing computer technology for compiling nutrition monitoring data.

Relative standard error: *See* "coefficient of variation."

Response rate: In this report, the value obtained by multiplying the participation rates for each survey component.

Riboflavin: Water-soluble vitamin that is a component of enzymes involved in protein, fatty acid, and energy metabolism. Found in enriched and whole-grain products, milk, some cheeses, meat, liver, green vegetables.

Sample size: As used in this report, the number of people who provided a response (actual sample size).

Saturated fatty acids: Fatty acids with no double bonds. Found in butter, lard, meat, dairy products, tropical oils.

Secular trends: Changes in a population with the passage of time.

Selenium: Essential mineral that functions as a component of antioxidant enzymes. Found in seafoods, organ meats, muscle meats. Content in grains and seeds depends on soil composition.

Sodium: Essential mineral needed with potassium for regulation of body-fluid volume and acid-base balance of blood; transmission of nerve impulses; principal extracellular cation. Found in table salt (sodium chloride), sodium-containing food additives, salt-cured foods, many processed foods.

Standard deviation: Measure of dispersion or variation; the square root of the sum of the squares of the deviations from the mean, divided by $n-1$.

Standard error: The standard deviation (measure of dispersion or variation) of a statistic (mean or percent).

Sugars: Simple carbohydrates (monosaccharides and disaccharides) used as sweeteners, including sucrose, glucose, fructose, high-fructose corn syrup.

Surveillance: *See* "continuous data collection." Surveillance systems in the NNMRRP include PNSS, PedNSS, BRFSS, and YRBS.

Survey: *See* "national survey."

Thiamin: Water-soluble vitamin that is a component of enzymes involved in energy metabolism; required for cell reproduction, fatty acid metabolism, and nervous system functions. Found in pork, beef and pork liver, whole-grain and enriched grain products.

Total available food supply: The quantity of food available in the U.S. food supply, calculated as the sum of the foods produced, beginning inventories, and imports.

***Trans* fatty acids**: Unsaturated fatty acids that contain a *trans* double bond. The carbon moieties on the two sides of a double bond point in opposite directions, in contrast to *cis* double bonds, in which the carbon moieties on the two sides of a double bond point in the same direction. Found in partially hydrogenated fats and oils (margarines and shortenings), milk, butter, tallow.

Undernutrition: The condition resulting from the inadequate intake of foods in general or of particular food components.

Vitamin A: Fat-soluble vitamin; activity is derived from both preformed vitamin A (retinol) and provitamin A carotenoids. Needed for formation and maintenance of skin, hair, and mucous membranes; essential for vision, bone growth, tooth development, and reproduction. Preformed retinol is found in eggs, milk, butter, liver, and vitamin A-fortified foods. Provitamin A carotenoids are found in yellow and orange fruits and vegetables and in dark-green vegetables.

Vitamin B_6: Water-soluble vitamin; functions in metabolism of protein; nervous system function. Found in poultry, fish, bananas, red meat, eggs, nuts.

Vitamin B_{12}: Water-soluble vitamin required for formation of red blood cells, building genetic material, function of nervous system, and metabolism of protein and fat. Found in liver, red meat, fish, eggs, milk.

Vitamin C: Water-soluble vitamin needed for formation of collagen; maintenance of capillaries, bones, and teeth; iron absorption; antioxidant. Found in citrus fruits, other fruits, tomatoes, potatoes, dark-green vegetables.

Vitamin E: Fat-soluble vitamin with antioxidant functions. Found in vegetable fats and oils, some whole-grain cereal products, nuts, some seafood.

Zinc: Essential mineral needed for formation of protein; component of many enzymes; wound healing, blood formation, general growth and maintenance of all tissues. Found in shellfish, red meat, poultry, ricotta cheese, whole-grain cereals, dry beans.

B. Acronyms and Abbreviations

AEDS: Alcohol Epidemiologic Data System
ARS: Agricultural Research Service, USDA
BLS: Bureau of Labor Statistics, DOL
BMI: body mass index
BRFSS: Behavioral Risk Factor Surveillance System
CDC: Centers for Disease Control and Prevention, HHS
CES: Consumer Expenditure Survey
CNPP: Center for Nutrition Policy and Promotion, USDA
CSFII: Continuing Survey of Food Intakes by Individuals
CV: coefficient of variation
DHKS: Diet and Health Knowledge Survey
dL: deciliter
DOC: U.S. Department of Commerce
DOD: U.S. Department of Defense
DOL: U.S. Department of Labor
EPONM: Expert Panel on Nutrition Monitoring
ERS: Economic Research Service, USDA
ESADDI: Estimated Safe and Adequate Daily Dietary Intake
FAFH: food away from home
FASEB: Federation of American Societies for Experimental Biology
FCL: Food Composition Laboratory, ARS, USDA
FCS: Food and Consumer Service, USDA
FDA: Food and Drug Administration, HHS
FLAPS: Food Label and Package Survey
GLC: gas-liquid chromatography
g: gram
HANES: Health and Nutrition Examination Survey
HCFA: Health Care Financing Administration, HHS
HDL: high-density lipoprotein
HDS: Health and Diet Survey
HEW: Department of Health, Education and Welfare
Hg: mercury
HHANES: Hispanic Health and Nutrition Examination Survey 1982-84
HHS: U.S. Department of Health and Human Services
HNIS: Human Nutrition Information Service, USDA (now part of ARS, USDA)
HPLC: High-performance liquid chromatography
IBNMRR: Interagency Board for Nutrition Monitoring and Related Research
IHS: Indian Health Service, HHS
IOM: Institute of Medicine, NAS
JNMEC: Joint Nutrition Monitoring Evaluation Committee
kcal: kilocalories
kg: kilogram
L: liter
LDL: low-density lipoprotein
LSRO: Life Sciences Research Office, FASEB
m: meter
MEC: mobile examination center
mg: milligram
mm: millimeter

mmol: millimole
μ: micro (for example, μg=microgram, μmol=micromole)
NAS: National Academy of Sciences
NASS: National Agricultural Statistical Service, USDA
NCCDPHP: National Center for Chronic Disease Prevention and Health Promotion, CDC, HHS
NCEH: National Center for Environmental Health, CDC, HHS
NCEP: National Cholesterol Education Program
NCHS: National Center for Health Statistics, CDC, HHS
NCI: National Cancer Institute, NIH, HHS
NDL: Nutrient Data Laboratory, ARS, USDA
NFCS: Nationwide Food Consumption Survey
NHANES I: first National Health and Nutrition Examination Survey (1971-74)
NHANES II: second National Health and Nutrition Examination Survey (1976-80)
NHANES III: third National Health and Nutrition Examination Survey (1988-94)
NHEFS: NHANES I Epidemiologic Follow-up Study
NHES: National Health Examination Survey
NHIS: National Health Interview Survey
NHLBI: National Heart, Lung, and Blood Institute, NIH, HHS
NIA: National Institute on Aging, NIH, HHS
NIAAA: National Institute on Alcohol Abuse and Alcoholism, NIH, HHS
NIAID: National Institute of Allergy and Infectious Diseases, NIH, HHS
NIAMS: National Institute of Arthritis and Musculoskeletal and Skin Diseases, NIH, HHS
NICHD: National Institute of Child Health and Human Development, NIH, HHS
NIDA: National Institute on Drug Abuse, NIH, HHS
NIDDK: National Institute of Diabetes and Digestive and Kidney Disease, NIH, HHS
NIDR: National Institute of Dental Research, NIH, HHS
NIH: National Institutes of Health, HHS
NIST: National Institute of Standards and Technology, DOC
NLEA: Nutrition Labeling and Education Act of 1990
NNDB: National Nutrient Data Bank
NNMAC: National Nutrition Monitoring Advisory Council
NNMRRP: National Nutrition Monitoring and Related Research Program
NNMS: National Nutrition Monitoring System (now NNMRRP)
NRC: National Research Council, NAS
NSFG: National Survey of Family Growth
NSLP: National School Lunch Program
PDS: Primary Data Set
PedNSS: Pediatric Nutrition Surveillance System
PHS: Public Health Service, HHS
PNSS: Pregnancy Nutrition Surveillance System
RDA: Recommended Dietary Allowance
SE: standard error
SEM: standard error of the mean
SNDA: School Nutrition Dietary Assessment Study
TDS: Total Diet Study
TRONM: *Third Report on Nutrition Monitoring in the United States*
USARIEM: U.S. Army Research Institute of Environmental Medicine, DOD
USDA: U.S. Department of Agriculture
WHO: World Health Organization
WIC: Special Supplemental Nutrition Program for Women, Infants, and Children
WLPS: Weight Loss Practices Survey
YRBS: Youth Risk Behavior Survey

Appendix II

1989 Recommended Dietary Allowance Values

Appendix IIA. Food and Nutrition Board, National Academy of Sciences—National Research Council Recommended Dietary Allowances for vitamins, revised 1989: designed for the maintenance of good nutrition of practically all healthy people in the United States[1]

Category and age in years	Fat-soluble vitamins				Water-soluble vitamins						
	A (µg RE)[2]	D (µg)[3]	E (mg α-TE)[4]	K (µg)	C (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg NE)[5]	B_6 (mg)	Folate (µg)	B_{12} (µg)
Infants											
0.0-0.5	375	7.5	3	5	30	0.3	0.4	5	0.3	25	0.3
0.5-1.0	375	10	4	10	35	0.4	0.5	6	0.6	35	0.5
Children											
1-3	400	10	6	15	40	0.7	0.8	9	1.0	50	0.7
4-6	500	10	7	20	45	0.9	1.1	12	1.1	75	1.0
7-10	700	10	7	30	45	1.0	1.2	13	1.4	100	1.4
Males											
11-14	1,000	10	10	45	50	1.3	1.5	17	1.7	150	2.0
15-18	1,000	10	10	65	60	1.5	1.8	20	2.0	200	2.0
19-24	1,000	10	10	70	60	1.5	1.7	19	2.0	200	2.0
25-50	1,000	5	10	80	60	1.5	1.7	19	2.0	200	2.0
51+	1,000	5	10	80	60	1.2	1.4	15	2.0	200	2.0
Females											
11-14	800	10	8	45	50	1.1	1.3	15	1.4	150	2.0
15-18	800	10	8	55	60	1.1	1.3	15	1.5	180	2.0
19-24	800	10	8	60	60	1.1	1.3	15	1.6	180	2.0
25-50	800	5	8	65	60	1.1	1.3	15	1.6	180	2.0
51+	800	5	8	65	60	1.0	1.2	13	1.6	180	2.0
Pregnant	800	10	10	65	70	1.5	1.6	17	2.2	400	2.2
Lactating											
1st 6 months	1,300	10	12	65	95	1.6	1.8	20	2.1	280	2.6
2nd 6 months	1,200	10	11	65	90	1.6	1.7	20	2.1	260	2.6

[1]The allowances, expressed as average daily intakes over time, are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well defined.
[2]Retinol equivalents. 1 RE = 1 µg retinol or 6µg β-carotene.
[3]As cholecalciferol. 10 µg cholecalciferol = 400 IU vitamin D.
[4]α-Tocopherol equivalents. 1 mg d-α tocopherol = 1 α-TE.
[5]Niacin equivalent. 1 NE = 1 mg niacin or 60 mg dietary tryptophan.

SOURCE: National Research Council (NRC). 1989. Recommended Dietary Allowances. 10th rev. ed. National Academy Press, Washington, DC.

Appendix IIB. Food and Nutrition Board, National Academy of Sciences—National Research Council Recommended Dietary Allowances for protein and minerals, revised 1989: designed for the maintenance of good nutrition of practically all healthy people in the United States[1]

Category and age in years	Protein (g)	Calcium (mg)	Phosphorus (mg)	Magnesium (mg)	Iron (mg)	Zinc (mg)	Iodine (μg)	Selenium (μg)
Infants								
0.0-0.5	13	400	300	40	6	5	40	10
0.5-1.0	14	600	500	60	10	5	50	15
Children								
1-3	16	800	800	80	10	10	70	20
4-6	24	800	800	120	10	10	90	20
7-10	28	800	800	170	10	10	120	30
Males								
11-14	45	1,200	1,200	270	12	15	150	40
15-18	59	1,200	1,200	400	12	15	150	50
19-24	58	1,200	1,200	350	10	15	150	70
25-50	63	800	800	350	10	15	150	70
51+	63	800	800	350	10	15	150	70
Females								
11-14	46	1,200	1,200	280	15	12	150	45
15-18	44	1,200	1,200	300	15	12	150	50
19-24	46	1,200	1,200	280	15	12	150	55
25-50	50	800	800	280	15	12	150	55
51+	50	800	800	280	10	12	150	55
Pregnant	60	1,200	1,200	320	30	15	175	65
Lactating								
1st 6 months	65	1,200	1,200	355	15	19	200	75
2nd 6 months	62	1,200	1,200	340	15	16	200	75

[1]The allowances, expressed as average daily intakes over time, are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well defined.

SOURCE: National Research Council (NRC). 1989. Recommended Dietary Allowances. 10th rev. ed. National Academy Press, Washington, DC.

Appendix IIC. Estimated Safe and Adequate Daily Dietary Intakes of selected vitamins and minerals[1]

	Vitamins		Trace elements[2]				
Category and age in years	Biotin (μg)	Pantothenic acid (mg)	Copper (mg)	Manganese (mg)	Fluoride (mg)	Chromium (μg)	Molybdenum (μg)
Infants							
0-0.5	10	2	0.4-0.6	0.3-0.6	0.1-0.5	10-40	15-30
0.5-1	15	3	0.6-0.7	0.6-1.0	0.2-1.0	20-60	20-40
Children and adolescents							
1-3	20	3	0.7-1.0	1.0-1.5	0.5-1.5	20-80	25-50
4-6	25	3-4	1.0-1.5	1.5-2.0	1.0-2.5	30-120	30-75
7-10	30	4-5	1.0-2.0	2.0-3.0	1.5-2.5	50-200	50-150
11+	30-100	4-7	1.5-2.5	2.0-5.0	1.5-2.5	50-200	75-250
Adults	30-100	4-7	1.5-3.0	2.0-5.0	1.5-4.0	50-200	75-250

[1]Because there is less information on which to base allowances, these figures are not given in the main table of RDA and are provided here in the form of ranges of recommended intakes.
[2]Since the toxic levels for many trace elements may be only several times usual intakes, the upper levels for the trace elements given in this table should not be habitually exceeded.

SOURCE: National Research Council (NRC). 1989. Recommended Dietary Allowances. 10th rev. ed. National Academy Press, Washington, DC.

Appendix III

Statistical and Reporting Guidelines for the TRONM and the HNIS/NCHS Joint Policy on Variance Estimation and Statistical Reporting Standards on NHANES III and CSFII Reports

A. Statistical and reporting guidelines for the *Third Report on Nutrition Monitoring*

Reporting category guidelines for key variables used in producing tables for the TRONM are listed in the attached tables. These population descriptor variables (Table A.1) and nutrition-related health variables (Table A.2) have been defined by the IBNMRR Survey Comparability Working Group in its report on Population Descriptors, or by the HNIS/NCHS Analytic Working Group. These guidelines are to be used by all Board agencies for tables submitted for the TRONM[1]. Any exceptions must receive approval from the co-project officers for the report.

In addition, a set of statistical guidelines for reporting data has been developed by the HNIS/NCHS Analytic Working Group. Table A.3 is a nomogram presenting minimum sample size requirements and is the primary guideline proposed for reporting of findings for the TRONM. It is part of a larger document on Statistical Reporting Guidelines developed by a group of survey mathematical statisticians from NCHS/CDC/HHS and HNIS/USDA for the HNIS/NCHS Analytic Working Group. The larger document follows.

Sample size requirements shown in Table A.3 for prevalence estimation should be used for all surveys and surveillance systems. The first column of the table represents a simple random sample design and the other columns reflect the increased sample size requirements for more complex survey designs. A minimum sample size of 30 is recommended for reporting any mean, proportion, percentile, and variance under the simple random sample assumption. As indicated in the table, proportions (or prevalences) that are small (or large) require a much larger sample size to achieve the same degree of reliability as the mean or median. The analytic guidelines should be reviewed for sample size requirements for estimation of means from highly skewed distributions and for a discussion of the special problem of variance estimation from complex survey designs. In addition, estimates with large coefficients of variation should be marked as potentially unreliable (in a statistical sense).

It is important to remember that these guidelines are not absolute. They represent conditions that yield the most sound statistical conclusions. Violating these sample size guidelines (or other criteria included in the larger report) introduces a greater degree of uncertainty about the soundness of the analytic conclusions, but does not necessarily mean that a particular analysis is invalid. Subject matter knowledge, as well as the survey design and the analytic approach, are required to judge the merit of each use and interpretation of data for a particular survey or surveillance system.

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[1]These Guidelines were adopted by the Agricultural Research Service when the functions and staff of HNIS were transferred to that agency on Feb. 20, 1994.

Table A.1. Suggested Reporting Categories for Population Descriptors
Third Report on Nutrition Monitoring

Suggested Reporting Categories	Alternative Category #1	Alternative Category #2
Gender[1]		
Male Female Combined for both sexes		
Age[1] (years)		
<1 1-2 3-5 6-11 12-15 16-19 20-29 30-39 40-49 50-59 60-69 70-79 80+	≤5 6-11 12-19 20-29 30-39 40-49 50-59 60-69 70+	≤5 6-11 12-19 20-39 40-59 60+
Race/Ethnicity[2]		
<u>Race-Ethnicity</u> White Hispanic Non-Hispanic Black Hispanic Non-Hispanic Asian/Pacific Islander Hispanic Non-Hispanic American Indian/Alaska Native Hispanic Non-Hispanic Combined for all race-ethnicities	<u>Race only</u> White Black Other Combined for all races (Use this category if your sample size is inadequate to report ethnicity) ("Other" races not shown separately if sample size is inadequate.)	<u>Race-Ethnicity</u> Non-Hispanic White Non-Hispanic Black Hispanic All others Combined for all race-ethnicities

Table A.1. Suggested Reporting Categories for Population Descriptors
Third Report on Nutrition Monitoring—continued

Suggested Reporting Categories	Alternative Category #1	Alternative Category #2
Education[1] (years)		
Never attended school 1-8 9-11 12/GED 13+	≤8 9-11 12/GED 13+	≤8 9-12/GED 13+
Income[2] (dollars)		
<10,000 10,000-14,999 15,000-19,999 20,000-24,999 25,000-29,999 30,000-34,999 35,000-50,000 Over 50,000 Don't know/Not sure Refused	<10,000 10,000-19,999 20,000-29,999 30,000-50,000 Over 50,000 Don't know/Not sure Refused	<10,000 10,000-29,999 30,000-50,000 Over 50,000 Don't know/Not sure Refused
PIR[2] **(Poverty Income Ratio)**		
0.001-0.999 (Below Poverty) 1.000+ (At or above poverty)	0.001-1.300 1.31-3.50 3.51+	All five of the categories separating the two groupings. (A category of 0.001-1.850 is used for some food program analyses and is an acceptable option)

Table A.1. Suggested Reporting Categories for Population Descriptors
Third Report on Nutrition Monitoring—continued

Suggested Reporting Categories	Alternative Category #1	Alternative Category #2
Regions[1]		
Northeast	Northeast	
New England	Midwest	
Middle Atlantic	South	
Midwest	West	
East North Central		
West North Central		
South		
South Atlantic		
East South Central		
West South Central		
West		
Mountain		
Pacific		

[1]Survey Comparability Working Group, Improving Comparability in the National Nutrition Monitoring and Related Research Program: Population Descriptors.

[2]HNIS/NCHS Analytic Working Group.

Table A.2. Suggested Reporting Categories for Nutrition Related and Health Variables
Third Report on Nutrition Monitoring

Body Mass Index for Adults Ages 20+ Years[1]

Overweight

Men:	≥27.8
Women:	≥27.3

Severe Overweight

Men:	≥31.1
Women:	≥32.3

No definition for underweight.

Food Stamp Participation[1]

Yes - At least one member of household/family participates in the Food Stamp Program.

No - No members of household/family participate in the Food Stamp Program.

Serum Cholesterol for Adults Ages 20+ Years[2]

Total Cholesterol

<200 mg/dL	Desirable Blood Cholesterol
200-239 mg/dL	Borderline High Blood Cholesterol
≥240 mg/dL	High Blood Cholesterol

HDL-Cholesterol

<35 mg/dL	Low HDL-Cholesterol

[1]HNIS/NCHS Analytic Working Group.

[2]National Cholesterol Education Program, Second Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, June 15, 1993.

Table A.2. Suggested Reporting Categories for Nutrition Related and Health Variables
Third Report on Nutrition Monitoring—continued

Blood Pressure for Adults Ages 18+ Years[3]

Category	Systolic	Diastolic
Normal	<130 mmHg	<85 mmHg
High Normal	130-139 mmHg	85-89 mmHg
Hypertension*		
Stage 1 (Mild)	140-159 mmHg	90-99 mmHg
Stage 2 (Moderate)	160-179 mmHg	100-109 mmHg
Stage 3 (Severe)	180-209 mmHg	110-119 mmHg
Stage 4 (Very Severe)	≥210 mmHg	≥120 mmHg

* Hypertension is defined as taking anti-hypertensive drugs or meeting these criteria based on the average of 2 or more readings taken at each of 2 or more visits, following an initial screening.

[3]National High Blood Pressure Education Program, The Fifth Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. January, 1993.

Table A.3. Minimum sample sizes recommended for estimating a statistic reliably in specified proportions of a distribution given specified design effects

	Design effect													
Proportion (p)	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.5	3.0	3.5
0.99	800	880	960	1040	1120	1200	1280	1360	1440	1520	1600	2000	2400	2800
0.95	160	176	192	208	224	240	256	272	288	304	320	400	480	560
0.90	80	88	96	104	112	120	128	136	144	152	160	200	240	280
0.85	53	59	64	69	75	80	85	91	96	101	107	133	160	187
0.80	40	44	48	52	56	60	64	68	72	76	80	100	120	140
0.75	32	35	38	42	45	48	51	54	58	61	64	80	96	112
—	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.55	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.50	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.45	30	33	36	39	42	45	48	51	54	57	60	75	90	105
—	30	33	36	39	42	45	48	51	54	57	60	75	90	105
0.25	32	35	38	42	45	48	51	54	58	61	64	80	96	112
0.20	40	44	48	52	56	60	64	68	72	76	80	100	120	140
0.15	53	59	64	69	75	80	85	91	96	101	107	133	160	187
0.10	80	88	96	104	112	120	128	136	144	152	160	200	240	280
0.05	160	176	192	208	224	240	256	272	288	304	320	400	480	560
0.01	800	880	960	1040	1120	1200	1280	1360	1440	1520	1600	2000	2400	2800

NOTE: For a simple random sample (SRS), sample size is determined based on the general rule for normal approximation: for mid-range proportions ($0.25 < p < 0.75$), the minimum sample size is 30. For extreme proportions ($p \leq 0.25$ or $p \geq 0.75$), the SRS sample size (n) satisfies the rule: $np \geq 8$ and $n(1-p) \geq 8$. For a complex sample, minimum-sample-size requirements are adjusted for the relative inefficiency in the sample design by a factor equal to the design effect, where design effect equals complex-sample variance divided by SRS variance.

SOURCE: HNIS/NCHS Analytic Working Group (1993).

B. Joint policy on variance estimation and statistical reporting standards on NHANES III and CSFII reports: HNIS/NCHS analytic working group recommendations

Below is a summary of the recommendations reached by the Methodological Subcommittee of the HNIS/NCHS Analytic Working Group on the issues of variance estimation and statistical reporting standards. Specific recommendations are underlined, whereas suggested practices are italicized. The implementation of these recommendations and suggestions will vary from survey to survey and, perhaps, from estimate to estimate. Nevertheless, official agency publications should contain a "statistical notes" section describing the variance estimation and statistical reporting standards used therein.

The design-based approach to the estimation and analysis of survey data is assumed here. Unlike model-dependent alternatives, the design-based approach makes few assumptions about the nature of the data being summarized and/or analyzed. Two aspects of the sampling design must be taken into account when using this approach: the sample weights and the complex sample design (stratified, multi-stage sampling). Weights are used in this approach when estimating mean, medians, and other descriptive statistics as well as analytical statistics like regression coefficients. Both weights and indicators of stratum and primary sampling unit (PSU) membership are used when estimating variances and testing for statistical significance. In general, using statistical weights that reflect the probability of selection and propensity of response for sampled individuals will affect parameter estimates, while incorporating the attributes of the complex sample design (i.e., clustering and stratification) will affect estimated standard errors and thereby test statistics and confidence intervals.

The recommendations for presentation of statistical data that follow arise from the issue of sampling variability, and reflect the random way (in the rigorous statistical sense) in which the sample was selected. Although beyond the scope of this report, a consideration of nonsampling issues such as measurement error, nonresponse bias, and other methodologic biases are necessary for any thorough interpretation and evaluation of the validity of survey findings.

Variance estimation

Average design effect methods are often used to stabilize variance estimates (see section below on unstable standard errors). Moreover, these methods offer a parsimonious way of providing information from which users can calculate standard errors themselves. By a "standard error" we mean the estimated standard deviation of an estimated mean or proportion (prevalence). The decision to use average design effect methods in an agency publication should be made on a survey by survey basis depending on the inherent need for variance stabilization. Such a method may also be used when estimating proportions and means even when there is no compelling need to stabilize variance estimates (in particular, when the method allows for the parsimonious display of information).

No particular average design effect method is recommended over any other. NCHS's approach of averaging design effects across age groups in a particular demographic group for a particular survey item is reasonable.

Statistical reporting standards

GENERAL GUIDELINES - An estimate with a very large coefficient of variation (CV) may be combined with other estimates to create an aggregate with a reasonable small CV (by a "coefficient of variation" we mean the ratio of the standard error of estimate divided by the estimate, expressed as a percent). For that reason, no estimate should be suppressed simply because it is deemed statistically unreliable. Nevertheless, the presence of such an estimate in a published table should be noted. In particular, an estimated mean or proportion in a table of an agency publication should be marked with an asterisk denoting it as potentially unreliable (in a statistical sense) if either the sample size on which it is based is less than a fixed number of individuals or if its CV is greater than some designated value.

ADEQUATE SAMPLE SIZE FOR NORMAL APPROXIMATION - The sample size minimum in the above recommendation should be determined, where practical, to assure the near normality of the estimate. *For means of fairly symmetric populations and proportions based on commonly occurring events (where 0.25 < P < 0.75), a good rule of thumb is the sample size should be no smaller than a broadly calculated average design effect times 30; otherwise, the estimate should be marked with an asterisk.* By "broadly calculated average design effect," we mean the average of estimated design effects across a broad number of cells. The decision on how broad this collection of cells should be is up to the agency.

A second rule of thumb is needed for asymmetric populations. Let G denote the skewness coefficient for a population ($G = m_3/\sigma^3$, where m_3 is the population's third moment around the mean, and σ^2 the second mean moment) and g be an broadly defined estimate of G. *For means of asymmetric populations, a good rule of thumb is the sample size should exceed $25g^2$ times a broadly calculated average design effect; otherwise, the estimate should be marked with an asterisk.*

Many continuous variables, like food intakes, are by their nature very skewed. For these, *the rule of thumb given above may be dropped, but it should be made clear in accompanying text that some estimated means may not be normally distributed* (and, as a result, there may not be a nearly 95% probability that the difference between an estimated mean and the population mean it is estimating is less than 2 times the standard error of the mean).

THE COEFFICIENT OF VARIATION - *The designated CV value in the above recommendation can be set at the agency's discretion for means and proportions based on commonly occurring events.* One goal here is to inform the user that most estimates in a publication have a CV below that level. CV's of 25 and 30 percent have commonly been used in HNIS and NCHS publications.

UNCOMMON OR VERY COMMON EVENTS - It is unlikely that estimated proportions based on uncommon ($P \leq 0.25$) or very common ($P \geq .75$) events will be normally distributed unless the sample size is very large. Moreover, a CV rule is not very informative for such estimates. A rule for estimated proportions that are based on uncommon or very common events that is consistent with the literature and the rules given above for commonly occurring events is that n be sufficiently large that *the minimum of nP and n(1-P) be greater or equal than 8 times a broadly calculated average design effect.* The accompanying nomogram spells out the required sample sizes for many proportions given a number of different design effects.

STANDARD ERRORS - A standard error is often used to form a confidence interval around an estimated mean or proportion. Consequently, it would be helpful to provide information on the reliability of an agency's standard error estimates. Rather than forming a solid recommendation, the subcommittee offers the following suggestion: *A directly estimated standard error may be marked with an asterisk in a published table if the sample size on which it is based has less than 30 individuals or if the sampled individual comes from less than 12 variance strata with observations in both primary sampling units. Moreover, the estimate to which that standard error applies should also be marked with an asterisk.*

UNSTABLE STANDARD ERRORS - Generally, standard error estimates based on small numbers of paired PSU's (i.e. degrees of freedom) are prone to instability. *The decision as to whether an average design effect method is needed to stabilize standard error estimates should be made on a variable by variable basis.* Practical concerns may mitigate against using an average design effect approach for some variables - "variance smoothing" may have little real effect on the relative size of confidence intervals when the standard error is small relative to the estimated mean or proportion (say, when the CV is less than 5 percent).

ESTIMATING THE POPULATION DISTRIBUTION - There are many continuous biomedical variables for which the population distribution is of interest to users. The population standard deviation is often used as a measure of the dispersion of the observations in a population when the distribution is approximately symmetric. [Note that an estimated population standard deviation, a sample size, and an average design effect are sometimes displayed together in an agency publication. This allows users to calculate the standard error of the corresponding estimated mean by themselves.] Percentiles are often used to describe asymmetric distributions like those associated with dietary intake.

The suggestion for the presentation of population standard deviations is the same as for standard errors - *unless there is a minimum of 30 individuals and at least 12 variance strata with observations in both primary sampling units, an estimated population standard deviation should be marked with an asterisk.*

The suggestions for the presentation of percentiles parallels those for proportions: *Medians and other percentiles in middle range (i.e., .25 < P < .75) should be marked with an asterisk when the sample size is less than 30 times a broadly calculated design effect. The quantity values at a tail percentiles, P, (i.e., P ≤ .25 or P ≥ .75) should be marked with an asterisk when the minimum of nP and n(1-P) is less than 8 times a broadly calculated design effect* (see accompanying nomogram). Unlike means, an agency may choose to suppress the publication of percentile values that are based on small numbers of observations or have a high estimated CV.

Substantive as well as statistical considerations play a part in the way in which a population distribution is displayed and interpreted. For example, estimated percentiles for one-day (or many-day) dietary intakes can be misleading, since it is the distribution of long-run or usual dietary intakes that most interests users. Thus, *the distinction between long-run and one-day (or many-day) distributions of dietary intakes must be made clear in the text accompanying any table displaying the estimated percentiles of one-day (or many-day) intakes.* The same distinction should also be made clear for certain biomedical variables like blood pressure and cholesterol level.

Appendix IV

Response Rates for Population Surveys and Surveillance Systems in the NNMRRP

Survey or study	Sponsoring agency (department)[1]	Date	Actual sample size[2]	Response rate	Comments
Continuing Survey of Food Intakes by Individuals (CSFII)	HNIS[3] (USDA)	1989-91	6,718	67%	Households—overall.
			15,192	58%	Individuals—1 day.
			11,912	45%	Individuals—3 days.
Diet and Health Knowledge Survey (DHKS)	HNIS[3] (USDA)	1989-91	5,750	57%	Households with DHKS respondent.
			4,346	45%	Individuals with 3 day dietary intakes.
Continuing Survey of Food Intakes by Individuals (CSFII)	HNIS[3] (USDA)	1985-86	3,224	63%	Households—overall.
			4,463	60%	Individuals—1 day.
Nationwide Food Consumption Survey (NFCS)	HNIS[3] (USDA)	1987-88	4,495	37%	Households—overall.
			10,172	31%	Individuals—1 day.
			8,421	25%	Individuals—3 days.
Nationwide Food Consumption Survey (NFCS)	ARS (USDA)	1977-78	14,930	61%	Households—overall.
			30,467	42%	Individuals—1 day.
			27,920	38%	Individuals—3 days.
School Nutrition Dietary Assessment Study (SNDA)	FCS (USDA)	1992	3,350	75%	Students—1 day.
Consumer Expenditure Survey (CES)	BLS (DOL)	1980-92	5,000 per quarter	85% (avg.)	Quarterly interview survey of consumer units.
			6,000 per year	87% (avg.)	Diary survey of consumer units kept for two consecutive 1-week periods.
Third National Health and Nutrition Examination Survey (NHANES III)	NCHS, CDC (HHS)	1988-91	17,464	86%	Interviewed.
			15,630	77%	Examined in MEC.
			15,884	78%	Examined in MEC or home.
Hispanic Health and Nutrition Examination Survey (HHANES)	NCHS (HHS)	1982-84	8,554	87%	Mexican Americans— interviewed.
					Mexican Americans— examined.
			7,462	75%	Cuban Americans— interviewed.
					Cuban Americans—examined.
			1,766	79%	Puerto Ricans—interviewed.
					Puerto Ricans—examined.
			1,357	61%	
			3,369	89%	
			2,834	75%	

Response rates for population surveys and surveillance systems in the NNMRRP—continued

Survey or study	Sponsoring agency (department)[1]	Date	Actual sample size[2]	Response rate	Comments
Second National Health and Nutrition Examination Survey (NHANES II)	NCHS (HHS)	1976-80	25,286 20,322	91% 73%	Interviewed. Examined.
First National Health and Nutrition Examination Survey (NHANES I)	NCHS (HHS)	1971-74	27,753 20,749	99% 74%	Interviewed. Examined.
First National Health Examination Survey (NHES I)	NCHS (HHS)	1960-62	6,672	87%	Interviewed/examined.
5 A Day for Better Health Baseline Survey	NCI (HHS)	1991	2,059	43%	Estimated response rate for random digit dial sample; includes refusals, break-offs, those unreachable.
			778	52%	Estimated response rate for black and Hispanic oversample.
Longitudinal Followup to the 1988 National Maternal and Infant Health Survey (NMIHS)	NCHS, CDC (HHS)	1991	8,285	89%	Interviewed.
National Ambulatory Medical Care Survey (NAMCS)	NCHS, CDC (HHS)	1989-91	4,459 physicians 115,648 patient visits	73%	Eligible participating physicians.
National Vital Registration System —Natality Statistics	NCHS, CDC (HHS)	1991	4,110,907	100%	Overall entries on birth certificates.
National Survey of Family Growth (NSFG)	NCHS, CDC (HHS)	1982, 1988	7,969 8,450	79% 79%	Live births in 1978-80. Live births in 1984-86.
Behavioral Risk Factor Surveillance System (BRFSS)	NCCDPHP, CDC (HHS)	1992	289,059	71%	1992.
Youth Risk Behavior Survey (YRBS)	NCCDPHP, CDC (HHS)	1990, 1991	13,400 13,575	87% 90%	1990. 1991.
Pregnancy Nutrition Surveillance System (PNSS)	NCCDPHP, CDC (HHS)	1992	≈379,000 per year	NA	Records from 23 States.
Pediatric Nutrition Surveillance System (PedNSS)	NCCDPHP, CDC (HHS)	1973-1992	≈6,000,000 per year	NA	1991-1993 records.
Survey of Heights and Weights of American Indian School Children	IHS and CDC (HHS)	1990-91	9,464	NA	1990-91 school year records.
Strong Heart Dietary Survey	IHS and CDC (HHS)	1989-91	888	NA	275 from South Dakota; 316 from Oklahoma, and 297 from Arizona.

Response rates for population surveys and surveillance systems in the NNMRRP—continued

Survey or study	Sponsoring agency (department)[1]	Date	Actual sample size[2]	Response rate	Comments
Health and Diet Survey (HDS)	FDA (periodically cosponsored with NHLBI) (HHS)	1983, 1986, 1988, 1990	4,007 4,004 3,202 3,821	56% 67% 65% 68%	1983. 1986. 1988. 1990. Response rate based on number of telephone households screened. Sample size for fat and cholesterol knowledge questions in 1990 based on one replicate (N=1198).
Weight Loss Practices Survey (WLPS)	FDA and NHLBI (HHS)	1991	1,668	58%	Respondents identified by screening households for an adult member currently trying to lose weight.
Vitamin and Mineral Supplement Intake Survey	FDA (HHS)	1980	2,991	47%	Age-stratified random sample of people ≥16 years of age.
National Health Interview Survey on Vitamin and Mineral Supplements	NCHS and FDA (HHS)	1986	1,877 11,775	93% 93%	Children 2-6 years of age. Adults 18 years of age and older.
Nutrition Label Format Studies	FDA (HHS)	1990, 1991	1,460 1,216	NA NA	1990. 1991. Experimental studies, primary food shoppers.
Survey of Army Female Basic Trainees	ARIEM (DOD)	1993	171 49	98% 100%	Body composition and biochemical data. Seven-day dietary data.
Assessment of Nutritional Status and Immune Function during the Ranger Training Course	ARIEM (DOD)	1991	190 55	100% 29%	Test measurements day 0. Test measurements day 62.
Ranger School Nutrition Intervention Study	ARIEM (DOD)	1992	171 51	100% 30%	Test measurements day 0. Test measurements day 62.
Nutritional and Physiological Assessment of the Special Forces Assessment and Selection Course	ARIEM (DOD)	1993	100 31	100% 31%	Test measurements day 0. Test measurements day 21.

[1]HNIS, Human Nutrition Information Service; ARS, Agricultural Research Service; USDA, U.S. Department of Agriculture; FCS, Food and Consumer Service; BLS, Bureau of Labor Statistics; DOL, Department of Labor; NCHS, National Center for Health Statistics; CDC, Centers for Disease Control and Prevention; HHS, Department of Health and Human Services; NCI, National Cancer Institute; NCCDPHP, National Center for Chronic Disease Prevention and Health Promotion; IHS, Indian Health Service; FDA, Food and Drug Administration; NHLBI, National Heart, Lung, and Blood Institute; ARIEM, Army Research Institute of Environmental Medicine; DOD, Department of Defense. NA, not available or not applicable.
[2]The actual sample size represents the number of respondents who participated in the survey or the number of interviews that were conducted for the survey.
[3]Legislation passed on Feb. 20, 1994, transferred the functions and staff of USDA's Human Nutrition Information Service (HNIS) to the existing Agricultural Research Service (ARS) of that department.

SOURCE: LSRO, 1995.