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Impact of beef consumption on saturated fat intake in the United States adult population: Insights from modeling the influences of bovine genetics and nutrition

Shanon L. Casperson[a,*], Zach Conrad[b], Susan K. Raatz[c], Justin Derner[d], James N. Roemmich[a], Lisa Jahns[a], Matthew J. Picklo[a]

[a] Grand Forks Human Nutrition Research Center, United States Department of Agriculture, Agricultural Research Service, 2420 2nd Ave. N, Grand Forks, North Dakota 58203, United States
[b] Department of Health Sciences, College of William & Mary, 251 Ukrop Way, Williamsburg, Virginia 23185, United States
[c] Department of Food Science and Nutrition, University of Minnesota, St Paul, MN 55108, United States
[d] Rangeland Resources and Systems Research Unit, United States Department of Agriculture, Agricultural Research Service, 8408 Hildreth Road, Cheyenne, Wyoming 82009, United States

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ABSTRACT

We sought to determine the impact of breed and finishing ration that reduces the saturated fat (SFA) content of beef on SFA intake (%E) in adults. Using National Health and Nutrition Examination Surveys (2001–2016), we replaced the current fatty acid profile of beef with that from two breeds (Angus, Wagyu) and three finishing rations (pasture, 15% flaxseed supplementation, 35% wet distiller's grain (WDG) supplementation). Dietary replacement levels in the model were 10%, 25%, 50%, 100%. Overall, men consumed more beef fat than women (12.0 g (11.6–12.4 g, 95%CI) and 6.6 g (6.4–6.9 g, 95%CI), respectively). The contribution of beef fat to SFA intake was 2.1%E (2.1–2.2%E, 95%CI) in men and 1.6%E (1.6–1.7%E, 95%CI) in women. SFA intake decreased with each increased replacement level for all beef types. At 100% replacement, SFA intake decreased 0.5% (Angus), 2.8% (Wagyu), 1.9% (pasture), 4.1% (flaxseed), 2.6% (WDG). Our findings demonstrate that breed and finishing ration that reduces the SFA content of beef can decrease population-level SFA intake.

1. Introduction

More than 50% of the United States (U.S.) adult population reports eating beef daily (Nicklas, O'Neil, Zanovec, Keast, & Fulgoni, 2012). Beef per capita consumption was estimated at 57.3 pounds (26 kg) in 2018 and was projected to increase by 2.8% in 2019 with an additional 1.5% increase projected for 2020 (USDA Agricultural Projections to 2028, 2019). Although beef is a nutrient-dense protein source, the saturated fat content is associated with an increased risk of cardiovascular disease (CVD) (Bernstein et al., 2010), diabetes (Pan et al., 2011), and mortality from non-communicable diseases (NCD) (Pan et al., 2012). Contrary to these prior associations, clinical trials have demonstrated that the inclusion of beef in a healthy diet does not negatively influence disease risk factors (Adams, Walzem, Smith, Tseng, & Smith, 2010; Gilmore et al., 2011; O'Connor, Kim, & Campbell, 2017; O'Connor, Paddon-Jones, Wright, & Campbell, 2018; Roussell et al., 2012; Roussell et al., 2014). Furthermore, a recent meta-analysis showed that out of the top 15 dietary components related to NCD risk, a diet high in red meat was ranked as the lowest dietary factor related to increased risk (G.B.D. Diet Collaborators, 2019). These inconsistencies may be attributed to recent advancements in beef production practices that have already altered the fat content and fatty acid (FA) profile of consumed meat.

Beef production is dynamic, with production practices increasingly changing to meet consumer demands. Over the last decades, the beef production industry has worked to identify ways to produce a high-quality meat that meets the prevailing consumer demand, primarily focusing on the fat content (Drouillard, 2018). However, alterations in beef FA composition may better explain reported discrepancies in the health risks associated with beef consumption (Adams et al., 2010; Bernstein et al., 2010; Gilmore et al., 2011; O'Connor et al., 2017; O'Connor et al., 2018; Pan et al., 2011; Pan et al., 2012; Roussell et al., 2012; Roussell et al., 2014). Two important drivers of the fat content and FA profile of beef are breed (genotype) and nutrition management

* Corresponding author at: USDA-ARS, Grand Forks Human Nutrition Research Center, 2420 2nd Ave. North, Grand Forks, ND 58203-9034, United States.
E-mail address: shanon.casperson@ars.usda.gov (S.L. Casperson).

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practices (finishing diet). Breeds exhibit differences in gene expressions of enzymes involved in FA synthesis and technological advances provide potential to select animals with a more desirable FA profile. For example, the Wagyu breed has increased Δ9-desaturase which increases the monounsaturated fatty acids (MUFA) content of the beef (Adams et al., 2010; Smith, Gill, Lunt, & Brooks, 2009). However, nutrition management practices may play a more influential role in altering the FA profile of beef (Scollan et al., 2006; Smith et al., 2009). Beef from cattle fed a steam-flaked corn diet supplemented with 10% flaxseed (LaBrune, Reinhardt, Dikeman, & Drouillard, 2008) has a greater polyunsaturated fatty acids (PUFA) content. Conversely, beef from cattle fed a 50:50 forage to concentrate ratio (based on dry matter) barley silage or grass hay diet supplemented with 15% flaxseed (Nassu et al., 2011), or pasture-raised (Leheska et al., 2008) has a greater MUFA content at the expense of the saturated fatty acids (SFA) content.

Research addressing the influence of breed and nutrition management practices on human dietary FA intake is lacking. Recent studies have used modeling methods as a tool to study the impact of replacing whole foods or food components on population-level dietary intakes (Conrad, Johnson, Roemmich, Juan, & Jahns, 2018; Lefevre et al., 2012; Raatz, Conrad, Jahns, Belury, & Picklo, 2018). Here, we modeled how decreases in the SFA content of beef from two beef cattle breeds (Angus and Wagyu) and three nutrition management practices – diets consisting of 1) mixed pasture, 2) 15% flaxseed supplementation, and 3) 35% wet distiller's grain (WDG) substituted into the typical corn-based diet – influenced the saturated fat intake of the U.S. adult population. We focused on SFA because the *Dietary Guidelines for Americans* (DGA) recommends limiting saturated fat to less than 10% of total daily energy intake (%E) (Department of Health and Human Services, 2015) and the American Heart Association (AHA) recommends less than 6%E for individuals at increased risk of CVD (Eckel et al., 2014). Our goal was to determine if recent advancements in beef production practices that reduces the SFA content of the meat decreases population-level saturated fat intake and if this decrease can help Americans meet recommended intakes. We hypothesized that reductions in the SFA content of beef would decrease saturated fat intake in the American adult population.

2. Methods

A diet model was constructed to estimate changes in saturated fat intake at the population level and by age and sex strata at current and predicted amounts of beef's SFA concentrations. The model used individual-level data on foods and food groups, nutrient intake, and the SFA content of beef. In the first part of the model, ingredient composition data were used to estimate the amount (in grams) of beef in each food reported consumed by individuals. Second, for each food containing beef as an ingredient, the beef was replaced by isometric amounts of beef with decreased SFA content from genetics and nutrition management practices (see below). The diet model was executed repeatedly to estimate the effects of these beef production practices on daily saturated fat intake in the U.S. adult diet. The diet model was performed for replacement of 10%, 25%, 50% and 100% for each beef model input. Details are provided below.

Dietary data: The participant flowchart is shown in Fig. 1. Publicly available data from U.S. adults aged 20 and older who participated in the National Health and Nutrition Examination Survey (NHANES) dietary component, What We Eat in America (WWEIA), from 2001 to 2016 were used to determine participant demographics and dietary intake using a single, in-person 24-h recall. Only dietary intake data from day 1 were used because this represents the per capita intake (National Cancer Institute, 2018). Reported consumed foods were disaggregated into smaller food components to estimate beef fat intake and determine the contribution of SFA from beef fat to total SFA intake as used in our previous research (Raatz et al., 2018) and outlined below. For instance, if a participant reported eating a mixed dish that

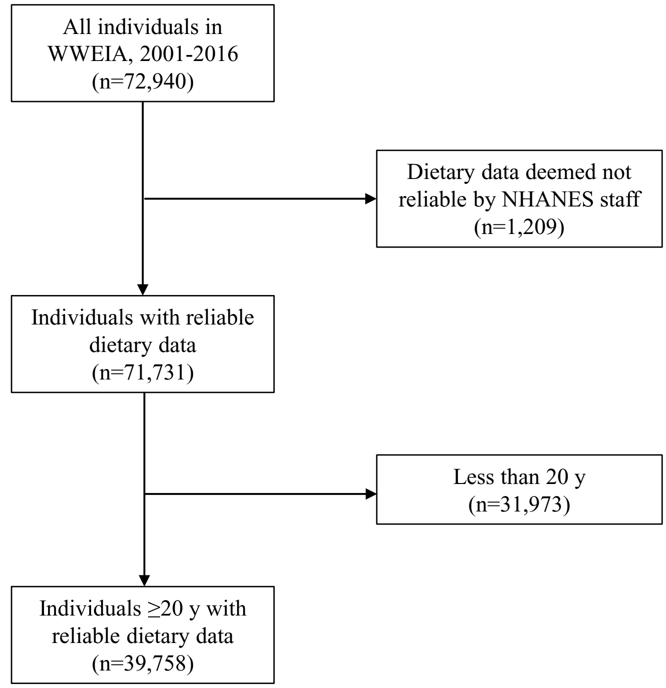

Fig. 1. Participant flowchart.

contained a beef product, such as pizza or spaghetti with meat sauce, the amount of beef fat was identified, and the amount of saturated fat and percentage of total daily energy intake from saturated fat calculated for the beef fat contained in the pizza and meat sauce.

Ingredient composition: To provide sufficient resolution of individual ingredients for the present study, the Food Commodity Intake Database (FCID) (US Environmental Protection Agency, 2005-2010) US Environmental Protection Agency, 2005–2010) was used to estimate the amount of beef fat in each reported food containing beef. FCID represents the only source of data on the amount of beef fat (in grams) contained in WWEIA mixed dishes. Data on the current FA composition of beef fat (#171400; fat, beef tallow) was acquired from the United States Department of Agriculture Food Composition Database (FCD) (US Department of Agriculture, 2016).

Fatty acid composition of beef: The FA profile of the beef sources used in the present study are presented in Table 1. Data on the FA profiles of the beef in the replacement model were obtained from the literature (Adams et al., 2010; Buttrey et al., 2013; Duckett, Neel, Lewis, Fontenot, & Clapham, 2013; Flowers et al., 2018; Nassu et al., 2011). Because of methodological differences such as age, base diet, time on diet, and breed (for the nutrition management practices), singular studies were used as model inputs to examine how reductions in SFA content alters saturated fat intake. The FA composition of the longissimus thoracis muscle was used as this data was available in the literature for each of the model inputs. Additionally, because of differences in reporting, the contribution of each FA was converted to a percentage of total FA analyzed. Model inputs for bovine genetics were from two different breeds - Angus (Flowers et al., 2018) and American Wagyu (Adams et al., 2010). Angus beef was used because it is the most popular type of beef consumed in the U.S. and American Wagyu beef used because of the increased Δ9-desaturase expression and activity that results in a substantial reduction in the SFA content of the meat. Model inputs for nutrition management practices were from cattle fed a finishing diet of 1) 35% wet distiller's grain (WDG) supplementation (Buttrey et al., 2013), 2) mixed pasture (Duckett et al., 2013), and 3) 15% flaxseed supplementation (Nassu et al., 2011). A diet supplemented with WDG was used because this has become increasingly prevalent in the industry following the expansion of corn ethanol

Table 1
Fatty acid composition (% of total fatty acid) of beef fat sources used in the diet model.

		Breed		Nutrition management		
Fatty acid	Beef tallow US Department of Agriculture, 2016)	Angus (Flowers et al., 2018)	American Wagyu (Adams et al., 2010)	35% WDG supplementation (Buttrey et al., 2013)	Mixed pasture (Duckett et al., 2013)	15% flaxseed supplementation (Nassu et al., 2011)
10:0	0	0	NR	NR	NR	NR
12:0	1	0	NR	0	NR	NR
14:0	4	3	3	3	2	3
16:0	25	30	26	25	25	23
18:0	19	14	12	14	17	12
Total SFA	50	48	41	42	44	38
16:1	4	3	0	3	3	4
18:1	36	41	55	40	38	43
20:1	0	0	NR	NR	NR	NR
Total MUFA	44	45	55	43	40	47
18:2	3	3	3	6	4	2
18:3	1	0	0	0	1	1
20:4	0	NR	NR	NR	1	1
20:5 n-3 (EPA)	0	0	NR	NR	1	0
22:5 n-3 (DPA)	0	NR	NR	NR	1	0
22:6 n-3 (DHA)	0	0	NR	NR	0	NR
Total PUFA	4	3	4	6	7	5

WDG = wet distiller's grain; NR = not reported.

production. The mixed pasture diet represents pasture-raised or grass-fed beef, which is growing in consumer interest. A diet supplemented with 15% flaxseed was used because this nutritional composition resulted in a substantial decrease in the SFA content of the meat (Nassu et al., 2011). Each genotype and feed-specific contribution to total and relative saturated fat intake was estimated at replacement levels of 10%, 25%, 50% and 100% to mimic the potential for changes in current bovine genetic and nutrition management practices in finishing diets of cattle to change the saturated fat intake of the U.S. adult population.

2.1. Statistical analyses

Daily per capita intakes of saturated fat in grams, %E, and by food source among adults were estimated overall by age-sex strata (women: 20-30y, 31-50y, 51-70y, 71 + y; men: 20-30y, 31-50y, 51-70y, 71 + y). Daily per capita intakes of beef fat in grams and %E, saturated fat from beef fat, and beef fat by food source were also estimated overall and by age-sex strata. Global Wald tests with a two-tailed distribution and $P < .05$ were used to assess differences across age categories within each sex group. Differences between the current intake of beef fat (as %E) and each of the modeled intakes (35% WDG, mixed pasture, 15% flaxseed, Angus, and American Wagyu) were tested using paired Wald tests at $P < .05$ with a two-tailed distribution, adjusted for multiple comparisons using the Bonferroni method. All analyses were adjusted for the complex sampling design of WWEIA and survey weights provided by WWEIA were used to produce nationally representative estimates. Stata 15 (StataCorp, College Station, TX) statistical software package was used for data management, modeling, and statistical analysis. Unless otherwise noted, data are presented as mean (95% confidence interval (CI)).

3. Results

Participant characteristics: Participant characteristics are presented in Table 2. A total of 39,758 individuals were included in this study, representing 20,537 (52%) and 19,221 (48%) self-reported women and men, respectively. Mean total saturated fat intake among this population was 11%E. Women and men differed in total amount of saturated fat intake ($P < .001$; 22.3 g and 31.1 g, respectively); however, there was no difference when expressed relative to energy intake ($P = .740$; 10.9%E compared to 10.9%E, respectively). Total saturated fat intake decreased with age in both women ($P < .001$) and men ($P < .001$). The %E from saturated fat was not different between the age groups for women ($P = .631$) but increased with age in men ($P = .033$).

Saturated fat intake by food source: Daily per capita intake of saturated fat in the American diet comes mainly from grain dishes (29%) including those mixed with another food item (e.g., pasta with sauce, pizza, nachos), followed by dairy (19%) and beef dishes (15%) (Supplemental Fig. 1).

Beef fat intake and saturated fat intake from beef: Daily per capita intake of beef fat and total saturated fat intake from beef among U.S. adults is presented in Table 3. Mean beef fat intakes among this population was 9.2 g, contributing 1.9%E to total saturated fat intakes. Women and men differed in the amount of beef fat consumed ($P < .001$; 6.6 g and 12.0 g, respectively), total saturated fat intake from beef consumed ($P < .001$; 3.3 g and 6.0 g; respectively), and %E saturated fat intake from beef ($P < .001$; 1.6%E and 2.1%E, respectively). Beef fat intake and total saturated fat intake from beef decreased with age in both women ($P < .001$) and men ($P < .001$). However, the %E saturated fat intake from beef did not differ among the age groups for the women ($P = .632$) but increased with age in men ($P = .009$).

Modeled changes in saturated fat intake: Fig. 2 shows the impact of replacing the current SFA content of beef with that of beef from American Wagyu (genetic input) - which has genetic alterations that result in a substantial decrease in SFA content. Modeled replacement using American Wagyu resulted in a reduction of total saturated fat intake that increased in magnitude as replacement increased from 10% to 100% in all age and gender groups. Replacing 100% of the current SFA content of beef with that of beef from American Wagyu reduced overall saturated fat intake by 2.8% (2.3% in women and 3.4% in men). However, total saturated fat intake was not decreased to the amount needed to meet the DGA or AHA recommendations for daily saturated fat intake in any population group. Modeled replacement of the current SFA content of beef using that of beef from 100% Angus is shown in Supplemental Fig. 2 (100% replacement reduced overall saturated fat intake by 0.5% - 0.4% in women and 0.6% in men).

Fig. 3 shows the impact of replacing the current SFA content of beef with that of beef from cattle fed a diet supplemented with 15% flaxseed (nutrition management practice input). This finishing diet provided the greatest decrease in the SFA content of the beef in this study. Modeled replacement using beef from cattle fed a diet supplemented with 15% flaxseed resulted in a reduction of total saturated fat intake that increased in magnitude as the replacement level increased from 10% to

Table 2
Participant characteristics and reported saturated fat intake from NHANES surveys 2001–2016.

	N[a]	% (95% CI)	Saturated fat intake (95% CI), g	P[b]	Saturated fat intake (95% CI), %E	P[b]
Total	39,758		26.5 (26.2–26.8)		10.9 (10.8–11.0)	
Women	20,537	51.9 (51.3–52.4)	22.3 (22.0–22.5)	< 0.001	10.9 (10.8–11.0)	0.631
20–30 years		10.6 (10.1–11.2)	24.1 (23.5–24.7)		10.8 (10.7–11.0)	
31–50 years		19.1 (18.4–19.7)	23.2 (22.7–23.6)		10.9 (10.8–11.1)	
51–70 years		15.9 (15.3–16.5)	21.4 (20.9–21.9)		11.0 (10.8–11.2)	
71 years and older		6.3 (6.0–6.6)	18.8 (18.3–19.3)		11.0 (10.9–11.2)	
Men	19,221	48.1 (47.6–48.7)	31.1 (30.6–31.5)	< 0.001	10.9 (10.8–11.0)	0.033
20–30 years		10.5 (10.0–11.1)	33.3 (32.4–34.3)		10.8 (10.6–10.9)	
31–50 years		18.5 (17.8–19.2)	33.1 (32.4–33.8)		10.9 (10.7–11.0)	
51–70 years		14.5 (13.9–15.0)	29.1 (28.4–29.7)		11.1 (10.9–11.2)	
71 years and older		4.6 (4.4–4.9)	24.2 (23.5–24.9)		11.2 (11.0–11.4)	

[a] Sample sizes are unweighted.
[b] Global Wald test of difference across age groups within each sex group.

100% in all age and gender groups. Replacing 100% of the current SFA content of beef with that of beef from cattle fed a diet supplemented with 15% flaxseed reduced overall saturated fat intake by 4.1% (3.6% in women and 4.6% in men). As with the American Wagyu, total saturated fat intake was not decreased to the amount needed to meet the DGA or AHA recommendations for daily saturated fat intake in any population group. Results of the modeled replacement of the current SFA content of beef using that of beef from cattle fed a diet of mixed pasture can be found in Supplemental Fig. 3 (100% replacement reduced overall saturated fat intake by 1.9% - 1.6% in women and 2.1% in men) and using that of beef from cattle fed a diet supplemented with 35% wet distiller's grain can be found in Supplemental Fig. 4 (100% replacement reduced overall saturated fat intake by 2.6% - 2.1% in women and 3.1% in men).

4. Discussion

Beef represents the third greatest contributor, behind grain and dairy dishes, to per capita saturated fat intake, contributing approximately 15% of total intake and 2% of total daily energy intake. The current work shows that decreases in the SFA content of beef through currently available genetics and nutrition management practices reduces saturated fat intake in the U.S. adult population. Each modeling scenario resulted in a decrease in saturated fat intake; however, consumption remained greater than the DGA (Department of Health and Human Services, 2015) and the AHA (Eckel et al., 2014) recommended intakes in all age and gender groups. These results demonstrate that current advancements by the beef industry to produce beef with a lower SFA content can induce meaningful reductions in total SFA intake. However, to reduce saturated fat intake to the amount needed to meet

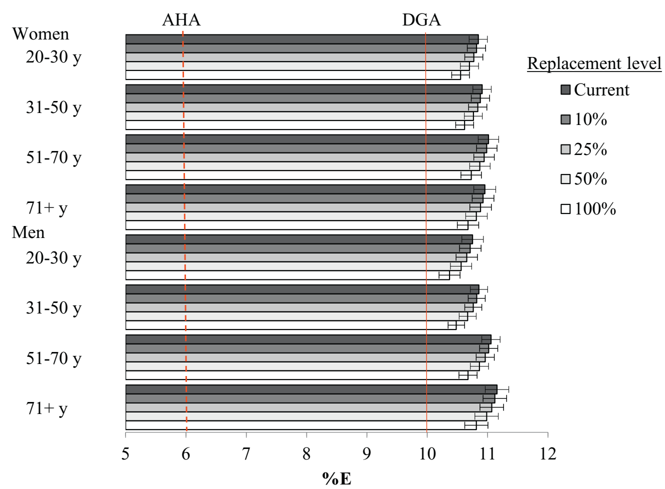

Fig. 2. Current and modeled saturated fat intake relative to energy intake under different scenarios of American Wagyu beef consumption, 2001–2016 (n = 39,758). Modeled SFA intake assuming 10%, 25%, 50%, and 100% replacement of the current fatty acid composition of beef fat with beef fat from American Wagyu. Error bars represent 95% confidence intervals. Red solid line represents Dietary Guidelines for Americans (DGA) recommendation for dietary saturated fat intake (Department of Health and Human Services, 2015). Red dashed line represents American Heart Association (AHA) recommendation for dietary saturated fat intake for individuals at increased risk for CVD (Eckel et al., 2014). All values are statistically different than current intake at $P < .001$. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 3
Daily per capita intake of beef fat (g) and saturated fat (grams) intake from beef fat and the relative proportion of saturated fat intake from beef fat to total daily energy intake (%E) in the U.S. adult population.

	Beef fat intake (95% CI), g		Saturated fat intake from beef fat (95% CI), g	P[a]	Saturated fat intake from beef fat (95% CI), %E	P[a]
Total	9.2 (9.0–9.5)		4.6 (4.5–4.7)		1.9 (1.8–1.9)	
Women	6.6 (6.4–6.9)	< 0.001	3.3 (3.2–3.4)	< 0.001	1.6 (1.6–1.7)	0.632
20–30 years	7.2 (6.7–7.7)		3.6 (3.4–3.8)		1.7 (1.6–1.8)	
31–50 years	7.1 (6.7–7.4)		3.5 (3.3–3.7)		1.7 (1.6–1.7)	
51–70 years	6.2 (5.9–6.6)		3.1 (2.9–3.3)		1.6 (1.5–1.7)	
71 years and older	5.4 (5.0–5.8)		2.7 (2.5–2.9)		1.6 (1.5–1.7)	
Men	12.0 (11.6–12.4)	< 0.001	6.0 (5.8–6.2)	< 0.001	2.1 (2.1–2.2)	0.009
20–30 years	13.1 (12.4–13.8)		6.5 (6.2–6.9)		2.2 (2.1–2.3)	
31–50 years	13.1 (12.5–13.7)		6.5 (6.2–6.8)		2.1 (2.1–2.2)	
51–70 years	11.1 (10.5–11.6)		5.5 (5.2–5.8)		2.2 (2.1–2.3)	
71 years and older	8.2 (7.7–8.7)		4.1 (3.8–4.3)		2.0 (1.8–2.1)	

[a] Global Wald test of difference across age groups within each sex group.

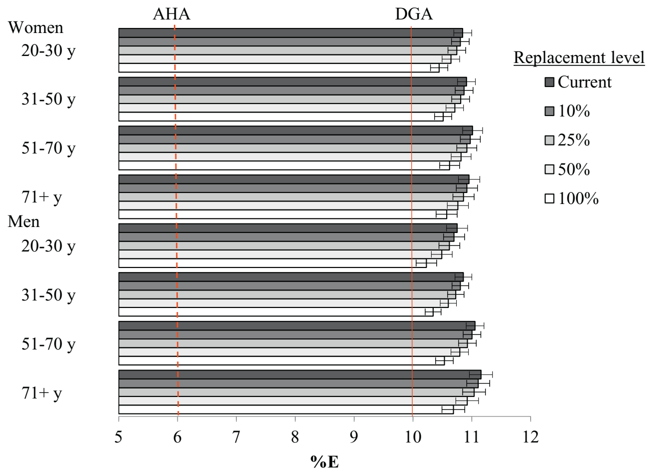

Fig. 3. Current and modeled saturated fat intake relative to energy intake under different scenarios of consuming beef from cattle fed a diet supplemented with flaxseed, 2001–2016 (n = 39,758). Modeled saturated fat intake assuming 10%, 25%, 50%, and 100% replacement of the current fatty acid composition of beef fat with beef fat from cattle fed a diet supplemented with 15% flaxseed. Error bars represent 95% confidence intervals. Red solid line represents Dietary Guidelines for Americans (DGA) recommendation for dietary saturated fat intake (Department of Health and Human Services, 2015). Red dashed line represents American Heart Association (AHA) recommendation for dietary saturated fat intake for individuals at increased risk for CVD (Eckel et al., 2014). All values are statistically different than current intake at $P < .001$. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

the DGA and AHA recommendations requires modifications in other dietary components such as grain dishes (e.g., pasta with sauce, pizza, etc.) and dairy dishes (mainly cheese) as these foods cumulatively accounted for 48% of per capita saturated fat intake (Supplemental Fig. 1).

The negative effect of consuming red meat on disease risk factors remains controversial - mainly due to inconsistencies in the literature (reviewed by Klurfeld, 2015). As a result, most health organizations continue to recommend limiting red meat consumption, beef in particular, as a way to reduce saturated fat intake (Eckel et al., 2014; World Cancer Research Fund, 2018). However, modifications in large scale production systems for a singular metric response such as decreasing the SFA content of beef may not be an effective use of limited resources. Our findings demonstrate that even the 27% decrease in the SFA content of beef that was achieved by Nassu et al. (2011) only reduced saturated fat intake around 4% (Fig. 3**)**. This substantial decrease in the SFA content of beef still was not able to reduce saturated fat intake in the U.S. adult population enough to meet recommended amounts (Department of Health and Human Services, 2015; Eckel et al., 2014). These results highlight that dietary changes aimed at reducing saturated fat intake from other sources will have a greater impact on reducing saturated fat intake to meet recommendations.

Recently, there has been a heavy investment in research on beef cattle genetics and nutrition management practices to produce a "healthier" FA profile of the meat (as reviewed by Scollan et al., 2006; Scollan, Price, Morgan, Huws, & Shingfield, 2017; Smith et al., 2009; Troy, Tiwari, & Joo, 2016). Epidemiologic, clinical, and mechanistic evidence suggests that CVD and coronary heart disease (CHD) risk is reduced when SFA is replaced by MUFA and PUFA. Research using oils has shown that replacing SFA with MUFA lowers LDL cholesterol (Abdullah, Jew, & Jones, 2017) and replacement with PUFA reduces CHD incidence (Mozaffarian, Micha, & Wallace, 2010). Similarly, the substitution of beef for other protein sources or carbohydrates into an already healthy diet, such as the DASH (dietary approaches to stop hypertension) (Roussell et al., 2012) or Mediterranean-style (O'Connor et al., 2018) diet, every day for 5 weeks decreased LDL and total cholesterol. The addition of 114 g of high MUFA beef products (1.31 MUFA:SFA ratio) to the diet 5 days per week for 5 weeks increased HDL and decreased triglycerides (Adams et al., 2010). Furthermore, Gilmore et al. (2011) demonstrated that positive changes in HDL were dependent on the FA composition of the consumed beef. Taken together, modifications of the FA profile of beef that has been accomplished through genetics and nutrition management practices may already be providing a 'healthier' option without necessitating changes in consumer eating habits.

Important considerations about this study should be noted, both strengths and potential limitations. First, dietary intake data from WWEIA was employed for the analyses. The strength of using eight 2-year WWEIA cycles is that it is a nationally representative sample of the U.S. adult population with diverse sociodemographic characteristics and provides realistic estimates of saturated fat intake stratified by age and gender. However, as with all self-reported dietary intake data, it is subject to reporting errors and has the potential for social desirability bias (Hebert et al., 2008). Second, we acknowledge that by using beef tallow, which contains lipids from kidney, pelvic and heart fat in addition to waste trim, may have overestimated the amount of saturated fat contributed by beef to the American diet and that different cuts of beef from different breeds and nutrition management practices have different fat contents and FA profiles. Furthermore, there is a large body of research on how bovine genetics and nutrition management practices alter the fat content and FA profiles; however, due to methodological constraints model inputs had to be limited. Third, the use of 10%, 25%, 50% and 100% substitution levels as an estimate of incorporation of beef with decreased SFA content from genetics or nutrition management practices into the diet may not be representative of potential changes in the production practices of beef producers. The exact proportion of change that can be reasonably instituted in the U.S. food supply is not known; however, results of this study suggest that any change in the saturated fat intake of the U.S. adult population as a result of alterations in beef production practices would be nominal. Fourth, it is important to note that although modeled replacements of beef from cattle fed a finishing diet that includes 15% flaxseed supplementation resulted in the greatest decrease in per capita saturated fat intake it also results in an "off taste" of the beef (LaBrune et al., 2008; Turner et al., 2015) which may limit its acceptance by consumers. Lastly, we did not attempt to determine the extent to which a genetic × management practice interaction would have on saturated fat intakes. It may be that feeding American Wagyu finishing rations supplemented with 15% flaxseed would decrease the SFA content of the meat to a point that may reduce saturated fat intake in the U.S. adult population enough to meet DGA recommendations (Department of Health and Human Services, 2015). Further research on the interaction of genetic and nutrition management practices are needed to determine how this would affect the SFA content of the meat and if the reduction would alter saturated fat intakes in individuals.

In conclusion, this study found that even with the relatively small contribution of beef fat to saturated fat intake (compared to grain and dairy dishes) genetic- and nutrition management-practice-based alterations in the FA profile of beef can make a substantial impact on saturated fat intake in the U.S. adult population. However, this alone does not reduce saturated fat intake to DGA- or AHA-recommended amounts and additional dietary modifications are needed to reduce saturated fat intake to recommended guidelines. Further research is needed to determine the impact of improvements in the FA profile of beef achievable through genetics or nutrition management practices, as well as their interaction, to moderate dietary FA intake and associated health outcomes.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.meatsci.2020.108225.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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