

Manuscript Title: The contribution of beef consumed as a part of the National School Lunch Program to nutrient intake and adequacy: a National Health and Nutrition Examination Survey 2003-2018 Analysis

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Study Headline: Beef intake within the National School Lunch Program (NSLP) was low with a median intake of 0.5 oz (14 g) per lunch meal. The NSLP participants who ate beef had meaningfully higher zinc and vitamin B12 intakes and were more likely to meet zinc intake requirements than those who did not consume beef in their school lunch.

Background: The National School Lunch Program (NSLP), administered by the United States Department of Agriculture (USDA), provides nutritionally balanced, low- or no-cost lunches to approximately 30 million students each school day, with 94% of U.S. schools participating. Previous research has demonstrated that NSLP participation is associated with higher diet quality and that NSLP lunches are more nutrient-dense than lunches brought from home,^{1,2} reflecting program nutrition standards aligned with the Dietary Guidelines for Americans.

Beef is a nutrient-dense, high-quality protein food that contributes key micronutrients to children's and adolescents' diets, particularly iron, zinc, and B vitamins (B6, B12, and niacin). Beef is offered as a meat/meat alternates meal component. The meat/meat alternates category includes animal protein foods (beef, poultry, seafood, eggs) and plant-based or dairy alternatives (beans, peas, lentils, tofu, nuts, cheese, and yogurt).

Given the increased interest in incorporating more plant-based and vegetarian options into the NSLP for health and sustainability reasons, it is important to understand how commonly consumed meats, including beef, contribute to overall nutrient intakes when provided as part of NSLP meals. The specific contribution of beef consumed as part of the NSLP to nutrient intake and adequacy has not previously been examined.

¹ Vernarelli JA, O'Brien B. A vote for school lunches: School lunches provide superior nutrient quality than lunches obtained from other sources in a nationally representative sample of US children. *Nutrients.* 2017 Aug 24;9(9):924. doi: 10.3390/nu9090924.

² Kinderknecht K, Harris C, Jones-Smith J. Association of the Healthy, Hunger-Free Kids Act with dietary quality among children in the US National School Lunch Program. *JAMA.* 2020 Jul 28;324(4):359-368. doi: 10.1001/jama.2020.9517.

Objective: To examine nutrient intake and nutrient adequacy in NSLP participants who consumed beef as a part of school lunch as compared to NSLP participants who did not consume beef at school lunch. Data was analyzed overall, by gender/age categories and by food security status.

Study Design: In this cross-sectional data analysis, dietary recall data from the National Health and Nutrition Examination Survey (NHANES) 2003-2018 database was used to determine a nationally representative sample of US school age children and adolescents aged 5-18 years. While NHANES does not directly inquire about NSLP participation, NSLP participation was defined using a previously published method based on reporting lunch between 10:00-14:00 around cafeteria-sourced components and usual lunch frequency. Beef intake was quantified using the Food and Nutrient Database for Dietary Studies (FNDDS) together with the Food Pattern Equivalents Database and Food Pattern Ingredients Database (FPED). Daily nutrient intake was assessed using data from the first 24-hour dietary recall while usual intake was assessed using both 24-hour dietary recalls with the National Cancer Institute Method and was further used to estimate nutrient adequacy using the percentage below the Estimated Average Requirement (EAR) or above the Adequate Intake (AI) for a given nutrient. Data exclusions included unreliable dietary recalls as well as dietary recalls reporting zero energy and data collected from pregnant or lactating females.

Key Findings:

NHANES is a nationally representative dataset of the U.S. civilian, non-institutionalized population (n = 19,482). In the current study, an analytical sample of 3,046 school age children and adolescents (5-18 year olds) were identified as NSLP participants.

Total daily nutrient intake (NSLP participants vs NSLP non-participants)

NSLP participants have higher intake of protein, fiber, calcium, magnesium, phosphorus, potassium, riboflavin, thiamin, vitamin B12 and D, and zinc compared with NSLP non-participants. This demonstrates the contribution that the NSLP makes to ensure dietary adequacy in children and adolescents.

- The total daily nutrient intakes of NSLP participants were similar for total calorie intake (~2000 kcal), higher intakes of calcium (14% higher, 146mg), fiber (8% higher, 1.1g), phosphorus (9% higher, 117mg), potassium (9% higher, 207mg), protein (5% higher, 3.7g), magnesium (4% higher, 8.9mg), riboflavin (10% higher, 0.2mg), thiamin (6% higher, 0.06mg), and vitamins A (+74 retinol equivalents), vitamin B12 (+0.4µg), vitamin D (+1.3µg), and zinc (+0.6mg), and lower intake of vitamin E (6% lower, 0.4mg) compared with NSLP non-participants (See Table 2 in study publication).

- For NSLP participants, the NSLP school lunch meal provided 339 kcal, ~17% of total daily calories (2049 kcal).

NSLP participants who consumed beef at school lunch

- Of the 3,046 NSLP participants, 38% (1,153) consumed beef as a part of their lunch meal [NSLP beef consumers] and 62% (1,893) did not [NSLP beef non-consumers].
- The most common beef-containing items in NSLP school lunch meals were meat mixed dishes, burritos/tacos, burgers, frankfurter sandwiches, nachos, pasta mixed dishes, and pizza.
- A higher proportion of NSLP beef consumers were Mexican American. No other demographic differences were statistically significant.
- Among the NSLP beef consumers, the median beef intake at lunch was 14g (0.5 oz). For context, beef consumers within the general U.S. children and adolescent population (previously analyzed using NHANES 2011-2018 data) an average 62g (2.2oz) of beef per day was reported.³ For NSLP beef consumers, beef provided ~39% of total calories consumed in the NSLP school lunch meal, which equates to ~6% of total daily caloric intake. Additionally, the beef contributed 53% of the total zinc and 57% of the total vitamin B12 of the NSLP school lunch meal.
- Among 14-18 y adolescent NSLP beef consumers, the median beef intake was 8 g (8 g in males and 6 g in females).

Nutrient intake (NSLP beef consumers vs. NSLP beef non-consumers)

- Intakes of vitamin B12 and zinc of NSLP beef consumers were approximately 10% higher than NSLP beef non-consumers, as well as saturated fat (8.7% higher, 2.3 g) and total fat (2.6% higher, 2.0 g) (See Table 3 in study publication). NSLP beef consumers had significantly lower intake of carbohydrates (3% lower, -6.2 g), niacin (6% lower, -1.4 mg), and Vitamin E (7% lower, -0.5 mg) in their total daily intakes, compared to NSLP beef non-consumers.
- NSLP beef consumers had higher total daily intake of meat processed/cured meat along with lower intakes of nuts and seeds, poultry and omega-3-rich seafood than NSLP beef non-consumers. NSLP beef consumers' higher intake of saturated fat may partially be explained by the contribution of saturated fat from beef and processed meats, displacing foods lower in saturated fat.

³ Lau CS, Fulgoni VL 3rd, Van Elswyk ME, McNeill SH. Trends in Beef Intake in the United States: Analysis of the National Health and Nutrition Examination Survey, 2001-2018. *Nutrients*. 2023 May 26;15(11):2475. doi: 10.3390/nu15112475.

- Female adolescents who consumed beef at school lunch had lower intakes of fiber, copper, magnesium, niacin, vitamin B6, vitamin E, and selenium compared with nonconsumers while male beef consumers at school lunch had higher intakes of calcium, phosphorus, vitamin B12, and zinc compared with nonconsumers.
 - For 9–13 y males and females, NSLP beef consumers had higher saturated fat, vitamin B12, and zinc intakes compared to NSLP beef non-consumers.
 - For 14–18 y males, NSLP beef consumers had higher intakes of total fat, calcium, phosphorus, vitamin B12 and zinc and lower intake of carbohydrate compared to NSLP beef non-consumers.
 - For 14–18 y females, NSLP beef consumers had lower dietary fiber, copper, magnesium, niacin, selenium, vitamin B6, and vitamin e intakes compared to NSLP beef non-consumers.
- Although saturated fat intake was higher among 14–18 y NSLP beef consumers in both sexes, their median beef intake of 8 g (8 g in males; 6 g in females) was lower than the overall median of 14 g. Given this low level of beef intake, it is unlikely that the observed differences in nutrient intakes in the adolescent NSLP beef consumers were due to their beef intake.

Nutrient adequacy (NSLP beef consumers vs. NSLP beef non-consumers)

- Limited differences were observed across age and gender categories for nutrient adequacy of NSLP beef consumers compared to NSLP beef non-consumers.
- NSLP beef consumers were more likely to meet recommended intake for zinc as compared to NSLP beef non-consumers (–3.94 percentage points).
- Among 5–8 y and 9–13 y females, NSLP beef consumers were less likely to meet their vitamin E recommendation (i.e., above the EAR for vitamin E) compared with NSLP beef non-consumers.
- Among 9–13 y males, NSLP beef consumers were less likely to meet the potassium recommendation (i.e., above the AI for potassium) compared with NSLP beef non-consumers.

Food security status (See Table 5 in study publication)

- Among food-secure NSLP participants (those who have reliable access to enough food), NSLP beef consumers were more likely to have adequate calcium intake (i.e., above the EAR) compared to NSLP beef non-consumers. A difference of 7.14 percentage points is reported.

- Among low food security NSLP participants, NSLP beef consumers were less likely to have adequate vitamin D intake compared to NSLP beef non-consumers. A difference of 14.83 percentage points is reported.
- Among very low food security NSLP participants, NSLP beef consumers were more likely to have adequate intakes of iron (difference of 7.76 percentage points), magnesium (difference of 23.40 percentage points) and vitamin B12 (difference of 5.09 percentage points) compared to NSLP beef non-consumers.
- The authors noted that the food security subgroups were small in numbers, limiting the statistical power.

Study Implications:

- Beef intake as part of the NSLP is currently low and has a relatively modest and limited contribution to overall nutrient intake of school age children and adolescents consuming school meals. An increased amount of beef intake at school lunch would be needed to have a meaningful impact on micronutrient intake and adequacy.
 - The low intake of beef at NSLP by adolescents may be a contributing factor that limited the researchers' ability to detect the contribution of beef at school lunch to nutrient intake/adequacy.
- For NSLP participants with low food security (a sub-population at increased risk for reduced nutrient intake and adequacy) beef consumed as a part of NSLP was associated with lower rates of inadequacy for Iron, Magnesium and Vitamin B12. The authors suggest beef as a part of meals in the NSLP may help ensure adequate intake of these nutrients in vulnerable children.
- NSLP beef consumers had higher saturated fat intake in their total daily diet. This is partly due to the higher intake of processed/cured meats served in the NSLP as well as the displacement of protein foods lower in saturated fat, such as poultry, nuts and seeds, and seafood.
 - The authors recommend a continued emphasis on serving unprocessed, lean meats within the NSLP.
- Given this low beef intake, it is unlikely that the observed differences in nutrient intakes in adolescents who consumed beef at school lunch were caused by beef intake per se. These findings should be interpreted cautiously, given risk of confounding.

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