



Published in final edited form as:

*J Acad Nutr Diet.* 2019 July ; 119(7): 1085–1098.e12. doi:10.1016/j.jand.2019.04.004.

## Trends in Processed Meat, Unprocessed Red Meat, Poultry, and Fish Consumption in the United States, 1999-2016

Luxian Zeng<sup>\*,1,2</sup>, Mengyuan Ruan<sup>\*,2</sup>, Junxiu Liu<sup>2</sup>, Parke Wilde<sup>2</sup>, Elena N. Naumova<sup>2</sup>, Dariush Mozaffarian<sup>2</sup>, Fang Fang Zhang<sup>2</sup>

<sup>1</sup>Guangdong Second Provincial General Hospital, Guangzhou, Guangdong, China

<sup>2</sup>Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA

### Abstract

**Background:** Accumulating evidence links excessive consumption of processed meat to an increased risk of obesity, diabetes, cardiovascular diseases, and some cancers. Yet, trends in consumption of different types of processed meat in the US have not been quantified.

**Objective:** The aim of the study was to characterize trends in consumption of different types of processed meat among US adults in relation to the consumption of unprocessed red meat, poultry, and fish/shellfish in the past 18 years and their purchase locations.

**Design:** Dietary data collected from U.S. adults aged 20+ years completing at least 1 valid 24-hour diet recall from 9 cycles of the National Health and Nutrition Examination Survey (NHANES) (1999–2016) were used to evaluate the trends in mean consumption of processed meat, unprocessed red meat, poultry, and fish/shellfish.

**Participants/setting:** Nationally representative sample of 43,995 US adults aged 20+ years.

**Main outcome measures:** Survey-weighted, energy-adjusted mean consumption of processed meat, unprocessed red meat, poultry, and fish/shellfish.

**Statistical analysis:** Trends in mean intake were assessed by treating the 2-year survey cycle as a continuous variable in survey-weighted linear regression models. Changes in mean intake was computed as the difference in mean intake between the earliest (1999–2000) and latest (2015–2016) cycle.

**Results:** The mean consumption of processed meat among US adults remained unchanged in the past 18 years (mean change = 4.22 g/wk, *p-trend* = 0.95). The top 5 processed meats consumed by US adults in 2015–2016 were luncheon meat (mean intake = 73.3 g/wk), sausage (45.5 g/wk), hot

---

**Corresponding Author:** Fang Fang Zhang, MD, PhD, Friedman School of Nutrition Science and Policy, Tufts University, 150 Harrison Ave, Boston, MA 20111 (fang\_fang.zhang@tufts.edu). Phone: 617-636-3704; Fax: 617-636-3727.

\*LZ and MR are co-first authors

**Author Contributions:** FZ designed the research; MR, LZ, and JL conducted the statistical analysis; LZ and FZ wrote the paper. All authors, including EN, DM, PW, reviewed and revised manuscript, and approval the final manuscript as submitted. FZ and MR have full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

**Publisher's Disclaimer:** This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

dog (17.5 g/wk), ham (17.5 g/wk), and bacon (8.6 g/wk), accounting for 39.3%, 24.4%, 9.4%, 9.4%, and 4.6%, respectively, of the total processed meat consumption in the US. During the same period, the mean consumption declined for unprocessed red meat (mean change = - 56.7 g/wk, *p-trend*<0.001) and increased for poultry (mean change = 47.0 g/wk, *p-trend*<0.001). The mean consumption of fish/shellfish did not change (mean change =1.55 g/wk, *p-trend*=0.14). Stores and fast-food restaurants are primary purchase locations for processed meat.

**Conclusions:** Despite growing public health concerns of processed meat consumption, there have been no changes in the amount of processed meat consumed by US adults over the last 18 years. Findings of this study can inform public health policy priorities for improving diet and reducing chronic disease burden in US.

### Keywords

NHANES; trends; meat; poultry; processed meat

## INTRODUCTION

Red meat (defined as all types of mammalian muscle meat such as beef, pork, and lamb)<sup>1</sup> is a source of protein, iron, and other nutrients that are important components of a healthful diet.<sup>2,3</sup> The United States (US) is ranked among the top nations with the largest amount of beef, pork, and lamb consumption, estimated to be 109 pounds per capita in 2017.<sup>4</sup> The per capita red meat consumption in the US is expected to further increase to 112 pounds by 2027.

Processed meat refers to meat (including red meat or poultry) transformed through salting, curing, fermentation, smoking, or with the addition of chemical preservatives.<sup>1</sup> Accumulating evidence links excessive consumption of processed meat, and to a lesser extent unprocessed red meat, to an increased risk of obesity, diabetes, cardiovascular diseases, and some cancers.<sup>1,5-7</sup> In 2015, the International Agency for Research on Cancer (IARC) classified processed meat as “carcinogenic to humans” (Group 1) based on sufficient evidence for its carcinogenicity to humans, and red meat as “probably carcinogenic to humans” (Group 2A) based on limited evidence that consumption of red meat causes cancer.<sup>8</sup> In 2018, the World Cancer Research Fund (WCRF)/ American Institute for Cancer Research (AICR) published an updated meta-analysis of prospective cohort studies, and concluded that there is “convincing” evidence that high consumption of processed and red meat increases the risk of colorectal cancer – each 50 g/d of processed meat consumption increased the risk of colorectal cancer by 16% (RR=1.16, 95% CI: 1.08–1.26)<sup>7</sup> and the risk of non-cardia stomach cancer by 18% (RR=1.18, 95% CI: 1.02–1.38),<sup>9</sup> and each 100 g/d of red meat consumption increased the risk of colorectal cancer by 12% (RR=1.12, 95% CI: 1.00–1.25).<sup>7</sup> An estimated 20,200 new cancer cases and 7,220 cancer deaths were attributable to high consumption of processed meat and unprocessed red meat in 2014 among U.S. adults aged 35 years or older.<sup>10</sup>

Given the increasing public health concern on processed meat and unprocessed red meat consumption,<sup>1</sup> the major types consumed by Americans, and associated trends and disparities by age, sex, race/ethnicity, education, and family income need to be quantified.

The primary location from which Americans purchase processed meat and unprocessed red meat also needs to be determined to inform sites of intervention. The aim of this study was to characterize trends in the consumption of different types of processed meat and unprocessed red meat among US adults in relation to poultry and fish/shellfish in the past 18 years, along with levels of consumption among population subgroups and purchase locations.

## METHODS

### Study Design and Population

Study population included 43,995 adults aged 20+ years completing at least 1 valid 24-hour diet recall, as determined by the National Center of Health Statistics (NCHS), during 9 cycles of the National Health and Nutrition Examination Survey (NHANES) from 1999–2000 through 2015–2016). The response rates of the NHANES survey ranged between 61% and 84% over the study period. NHANES sampling weights were adjusted in all analyses which account for the complex survey design (e.g. oversampling of minorities), survey non-response, post-stratification, and whether 1 or 2 days of diet recalls were completed.<sup>11</sup> During the study period, more than 87% of the NHANES survey respondents provided a single valid diet recall, among which 87.5% also provided a second valid recall. The dietary sampling weights additionally account for the dietary interview-specific non-response and day of the week for dietary intake interviews.<sup>11</sup> All analyses incorporated these survey weights and provided nationally representative estimates of dietary intake. NHANES was approved by the NCHS research ethic review board, and all participants provided written informed consent.

### Consumption of Processed Meat, Unprocessed Red Meat, Poultry, and Fish/Shellfish

Following the Automated Multiple Pass Method (AMPM), trained interviewers asked NHANES participants to recall all foods and beverages that they consumed during the previous day.<sup>12</sup> A standard set of measuring guides were used to help the respondent report the volume and dimensions of the food items consumed. The USDA Food Pattern Equivalent Database<sup>13</sup> and MyPyramid Equivalent Database,<sup>14</sup> which disaggregate mixed foods into their component parts, were harmonized and used to assess trends in consumption of 4 food groups (processed meat, unprocessed red meat, poultry, and fish/shellfish).<sup>15</sup> Food groups were further disaggregated into subgroups to evaluate trends by subcategories, such as processed meat subcategory (luncheon meat, sausage, ham, bacon, hot dog, smoked/cured/corned meat, dried/pickled meat, and other processed meat); unprocessed red meat subcategory (beef, pork, other red meat, and unspecified red meat); poultry subcategory (chicken, turkey, other poultry, and unspecified poultry); and fish/shellfish subcategory (high and low omega-3 fish and shellfish). Intake of all food groups was energy-adjusted using the residual method to evaluate trends independent of changes in total energy intake, which could relate to non-dietary changes, such as physical activity, and to minimize measurement error in dietary estimates.<sup>16</sup>

## Purchase Location

Purchase location was defined by answers to the question, “Where did you get this or most of the ingredients for this”, regardless of the location where the food was consumed, and was categorized into four groups based on the NHANES Dietary Interviewers Procedures Manual: stores (including supermarket, grocery store, convenience store, and other food stores), fast-food restaurants (including pizza delivery/takeout), full-service restaurants (including restaurant with waiter/waitress, bar/tavern/lounge, and restaurant no additional information), and others (including cafeteria, community food program, gifts, and others).<sup>17</sup>

## Statistical Analyses

The nationally representative population mean intake of processed meat, unprocessed red meat, poultry, and fish/shellfish was estimated for each NHANES cycle by incorporating the weights from the complex NHANES survey sample design to account for different sampling probabilities and participation rates. Trends in mean intake were assessed by treating the 2-year survey cycle as a continuous variable in survey-weighted linear regression models. Changes in dietary intake were computed as the difference in mean intake between the earliest (1999–2000) and latest (2015–2016) cycle.

The mean consumption of processed meat, unprocessed red meat, poultry, and fish/shellfish was further assessed by purchase location and among population subgroups by age, sex, race/ethnicity, education, and family income. Race/ethnicity was categorized as non-Hispanic white, non-Hispanic black, Hispanic, and others (including mixed-race). Family income was categorized as family-income-to-poverty ratio (FIPR) <1.30, 1.30–1.84, 1.85–2.99, and 3.00.<sup>18</sup> Finally, potentially heterogeneous trends of consumption by population subgroups were evaluated using a survey-weighted Wald test by fitting an interaction term between 2-year survey cycle and population subgroup. As a sensitivity analysis, trends in consumption of processed meat, unprocessed red meat, poultry, and fish/shellfish were evaluated after adjustments of age, sex, race/ethnicity, education, and family income.

All statistical analyses were two sided and significance was considered at  $\alpha$  level of 0.05. SAS 9.4 was used for all statistical analyses.<sup>19</sup>

## RESULTS

Survey-weighted characteristics of NHANES participants aged 20 years or older in each cycle are presented in Table 1. Over time, the proportion of older adults increased and the proportion of younger adults decreased. The proportion of non-Hispanic whites decreased whereas the proportion of the other race/ethnicity group increased. Education attainment increased, with the proportion of US adults who completed college or above education increased from 21% in 1999–2000 to 32% in 2015–2016.

### Trends in processed meat, unprocessed red meat, poultry, and fish/shellfish consumption

**Processed meat.**—In the past 18 years, the consumption of processed meat remained unchanged among US adults (Figure 1). The mean consumption was 182 g/wk in 1999–2000 and 187 g/wk in 2015–2016 (mean change = 4.22 g/wk, 95% CI: –18.4 to 26.8, p-

trend=0.95) (Table 2). The top category of processed meat consumed by US adults was luncheon meat (mean intake ranging from 67.0 to 80.4 g/wk from 1999 to 2016), followed by sausage (ranging from 41.4 to 52.2 g/wk), hot dog (ranging from 17.5 to 26.8 g/wk), ham (ranging from 16.6 to 22.2 g/wk), other processed meat (ranging from 7.29 to 16.5 g/wk), bacon (ranging from 6.66 to 10.6 g/wk), smoked/cured/corned meat (ranging from 3.50 to 6.92 g/wk), and dried/pickled meat (ranging from 0.67 to 2.22 g/wk). From 1999 to 2016, the consumption did not change for most processed meat subcategories except for a decreasing trend of hot dog (mean change =  $-9.28$  g/wk, 95% CI:  $-17.8$  to  $-0.79$  g/wk, p-trend=0.003) and an increasing trend of bacon (mean change =  $1.94$  g/wk, 95% CI:  $0.11$  to  $3.76$  g/wk, p-trend=0.03) and other processed meat (mean change =  $9.09$  g/wk, 95% CI:  $6.77$  to  $11.4$  g/wk, p-trend<0.001).

**Unprocessed red meat.**—There was a decreasing trend of unprocessed red meat consumption among US adults (Figure 1), from 340 g/wk in 1999–2000 to 284 g/wk in 2015–2016 (mean change =  $-56.7$  g/wk, 95% CI:  $-88.0$  to  $-25.4$  g/wk, p-trend<0.001) (Table 2). Among red meat subcategories, beef consumption decreased (mean change =  $-78.3$  g/wk, 95% CI:  $-112$  to  $-45.0$  g/wk, p-trend<0.001), whereas the consumption of pork and other red meat remained unchanged, and the consumption of unspecified red meat increased (mean change =  $28.7$  g/wk, 95% CI:  $20.1$  to  $37.3$  g/wk, p-trend<0.001). Despite a decreasing trend in consumption, beef remains the top category of unprocessed red meat consumed by US adults in the past 18 years (ranging from 172 g/wk to 254 g/wk), followed by pork (ranging from 46.8 g/wk to 61.8 g/wk), unspecified red meat (ranging from 17.4 g/wk to 49.4 g/wk), and other red meat (ranging from 6.9 g/wk to 12.4 g/wk).

**Poultry.**—There was an increasing trend of poultry consumption among US adults, from 256 g/wk in 1999–2000 to 303 g/wk in 2015–2016 (mean change =  $47.0$  g/wk, 95% CI:  $12.0$  to  $82.0$  g/wk, p-trend<0.001) (Table 2). The top category of poultry consumed by US adults was chicken (ranging from 175 g/wk to 230 g/wk), followed by unspecified poultry (ranging from 40.1 g/wk to 68.2 g/wk), turkey (ranging from 11.5 g/wk to 22.4 g/wk), and other poultry (ranging from 0.37 g/wk to 2.69 g/wk). From 1999 to 2016, there was an increasing trend of chicken (mean change =  $34.4$  g/wk, 95% CI:  $4.9$  to  $63.9$  g/wk, p-trend<0.001) and unspecified poultry ( $16.1$  g/wk, 95% CI:  $4.3$  to  $28.0$  g/wk, p-trend=0.001) consumption whereas the consumption of turkey and other poultry remained unchanged.

**Fish/shellfish.**—In the past 18 years, the consumption of fish/shellfish among US adults did not change (Figure 1). The mean consumption was 115 g/wk in 1999–2000 and 116 g/wk in 2015–2016 (mean change =  $1.55$  g/wk, 95% CI:  $-22.5$  to  $25.6$  g/wk, p-trend = 0.14) (Table 2). US adults consumed a higher proportion of low omega-3 fish (ranging from 78.4 g/wk to 95.9 g/wk) than high omega-3 fish (ranging from 28.6 g/wk to 38.1 g/wk). The consumption of neither low (mean change =  $-0.19$  g/wk, 95% CI:  $-20.7$  to  $20.3$  g/wk, P-trend=0.29) nor high omega-3 fish/shellfish (mean change =  $1.74$  g/wk, 95% CI:  $-10.2$  to  $13.6$  g/wk, p-trend=0.17) changed from 1999 to 2016.

### **Purchase location of processed meat, unprocessed red meat, poultry, and fish/shellfish**

Store was the primary purchase location for processed meat, unprocessed red meat, poultry, and fish/shellfish consumed by US adults in 2015–2016 (Figure 2 and Table 3). Store purchase accounted for 73.2% of the total processed meat (mean intake = 137 g/wk), 61.6% of unprocessed red meat (mean intake = 175 g/wk), 61.5% of poultry (mean intake = 186 g/wk), and 59.7% of fish/shellfish (mean intake = 69.4 g/wk) consumed by US adults in 2015–2016, respectively. Fast-food restaurant was the secondary purchase location for poultry, unprocessed red meat, and processed meat, accounting for 19.2% of total poultry consumption (mean intake = 58.1 g/wk), 16.4% of the total unprocessed red meat consumption (mean intake = 46.6 g/wk), and 12.5% of total processed meat (mean intake = 23.3 g/wk) among US adults in 2015–2016. Full-service restaurant was the secondary purchase location for fish/shellfish, accounting for 23.0% of the fish/shellfish consumption (mean intake = 26.7 g/wk) whereas fast-food restaurants contributed to less than 10% of fish/shellfish consumption among US adults (mean intake = 8.64 g/wk).

### **Consumption of processed meat, unprocessed red meat, poultry, and fish/shellfish by age, sex, race/ethnicity, education, and family income**

In the most recent NHANE cycle (2015–2016), older individuals consumed less poultry than younger ones, and individuals aged 35–64 years consumed more unprocessed red meat and fish/shellfish than younger (aged 20–34 years) or older (aged 65+ years) individuals (Table 4). Men consumed higher levels of processed meat, unprocessed red meat, and poultry than women but had similar levels of fish/shellfish consumption. Non-Hispanic whites consumed the highest level of processed meat and lowest level of poultry and fish/shellfish whereas non-Hispanic blacks consumed the highest level of poultry and the lowest level of unprocessed red meat. Hispanics consumed the highest level of unprocessed red meat. Individuals with some college, college or above education consumed a lower level of unprocessed red meat compared to those with high school or less than high school education. Poultry and fish/shellfish consumption did not differ by levels of education. For processed meat, individuals with the highest (i.e. college graduate or above) or lowest (less than high school) level of education had the lowest consumption. Family income was not associated with the consumption of processed meat and unprocessed red meat, although individuals with FIPR of 1.30–1.84 had the highest consumption of fish/shellfish and those with FIPR < 1.30 had the highest consumption of poultry.

Trends in the consumption of processed meat, unprocessed red meat, poultry, and fish/shellfish in the past 18 years did not change after adjustments of changes in age, sex, race/ethnicity, education, and family income among US adults over time (Table 5 online only and Table 6 online only). Overall, trends in processed meat, unprocessed red meat, poultry, and fish/shellfish consumption were similar across age, sex, race/ethnicity, education, and family income subgroups, except that the declining trend in unprocessed red meat ( $p$  for interaction = 0.03) and increasing trend in poultry consumption ( $p$  for interaction = 0.02) were more apparent among younger (20–49 years) vs. older (65+ years) participants. The increasing trend in poultry consumption was also more apparent among participants with lower (less than high school, high school graduate or GED) vs. higher (some college, college graduate or above) levels of education ( $p$  for interaction = 0.047), and among participants with either

FIPR<1.30 or FIPR of 1.84–2.99 vs. other income groups (p for interaction =0.03). Hispanic was the only racial/ethnic group with an increasing trend in fish/shellfish consumption in the past 18 years (p for interaction =0.001) (Figure 1 and Tables 7–10 online only).

## DISCUSSION

While there are growing public health concerns of processed meat consumption,<sup>1,8,20</sup> there have been no changes in the amount of processed meat consumed by US adults over the past 18 years. Meanwhile, the consumption of unprocessed red meat decreased, the consumption of poultry increased, and the consumption of fish/shellfish did not change. Grocery store or supermarket was the primary purchase location and fast-food restaurant was the secondary purchase location for processed meat consumed by US adults.

NHANES is the only data source that provides estimates of trends in processed meat consumption in the US. The current analysis and a previous investigation on dietary trends from 1999 to 2012 are among the first to suggest no reduction in processed meat consumption among US adults.<sup>15</sup> Concerns of health and price are often the two major determinants of consumption levels of various food groups.<sup>21</sup> Although processed meat has now been classified as a carcinogen,<sup>8</sup> the arising awareness may have occurred only recently. The 2015–2020 Dietary Guidelines for Americans,<sup>22</sup> the federal dietary guidelines that play important roles in informing nutrition policies in the US, does not mention processed meat being a carcinogen despite mentioning low processed meat intakes among characteristics of healthy diet patterns. The lack of widespread awareness of health risks associated with processed meat may have contributed to the lack of consumption change in the past 18 years. In addition, there has been no apparent changes in the price of processed meat products from 1999 to 2016. For example, among all US urban consumers, the 2016 Consumer Price Index (CPI) for bacon and sausage was 3% below the 1999 CPI and the 2016 CPI for ham was 1% below the 1999 CPI, after adjusting for CPI increase of all items from 1999 to 2016.<sup>23</sup> The current study provided additional information on the subcategories of processed meat consumed by US adults. For example, luncheon meat and sausage were the most frequently consumed processed meat, accounting for 39.3% and 24.3%, respectively, of all processed meat consumption by US adults in 2015–2016. It is important to note that nearly a quarter (range: 23.4–24.5%) of the total meat and poultry consumed by US adult in 1999–2016 was processed meat. Across all NHANES cycles, US adults consumed more processed meat than fish/shellfish. Given the strong evidence on processed meat consumption and cancer risk,<sup>8</sup> the current study findings support further actions to increase the public's awareness of the health risks associated with processed meat. Future research is needed to identify barriers to reducing processed meat consumption as well as to evaluate the effectiveness of potential public health interventions and policies to reduce processed meat consumption in the US, such as nutrition quality standards and health warning labels.<sup>24</sup>

On the contrary, there has been a decreasing trend in unprocessed red meat consumption and an increasing trend in poultry consumption among US adults. The price increase of unprocessed red meat accompanied by the price decrease of poultry may have contributed to the observed trends. For example, the 2016 Consumer Price Index (CPI) for beef and veal

was 56% above the CPI in 1999, whereas the 2016 CPI for poultry was only 2% below the 1999 CPI.<sup>23</sup> The American Cancer Society (ACS)<sup>25</sup> and the World Cancer Research Funds (WCRF)/American Cancer Institute for Cancer Research (AICR) recommendations for limiting red meat consumption for cancer prevention<sup>26</sup> may have also affected consumers' preference of consuming white meat over red meat.<sup>27</sup> Indeed, in a recent survey of US adults, more than half of the participants who reported eating less meat now as compared to three years ago ranked cost and health as the two primary reasons of reducing meat consumption.<sup>28</sup> Overall, these trends are consistent with those of per capita consumption derived from the food availability data of the USDA.<sup>29</sup> From 1999 to 2016, the per capita consumption of unprocessed red meat, defined as the amount of the commodity available for consumption after exclusion of non-edible food parts and food loss decreased by 13.0%, whereas the per capital US consumption of poultry increased by 14.1%.<sup>29</sup> In the two most recent NHANES cycles (2013–2014 and 2015–2016), the consumption level of poultry exceeded that of unprocessed red meat for the first time, although the current findings suggest that one-fourth of the US adults still consume unprocessed red meat beyond the recommended level (less than 500 g/wk or less than 3 servings/wk).<sup>30</sup> The USDA projected an expansion of beef and pork production in the next decade; for example, beef and pork production were projected to grow by 10.2% and 13.2%, respectively, between 2017 and 2027, which may potentially contribute to a future increase in consumption of unprocessed red meat.<sup>4</sup>

There were no significant trends in fish/shellfish consumption among US adults in the past 18 years. The USDA disappearance data also revealed no substantial changes in per capita US consumption of fish/shellfish from 1999 to 2016.<sup>29</sup> The current findings suggest that the mean level of fish/shellfish consumption among US adults in 2015–2016 (116 g/wk or 4.1 oz/wk) was only about half of the recommended level in the 2015–2020 Dietary Guideline for Americans (8-oz/wk),<sup>22</sup> and less than 15% of the US adults met the recommended intake. Along the same line, the USDA food availability data suggested that meat and poultry dominated the consumption of total protein foods (meat, poultry, fish/shellfish, eggs, legumes, nuts/seeds, and soy foods) whereas fish/shellfish only accounted for 5% of the total protein food consumption in the US.<sup>29</sup> The low consumption of fish/shellfish could be due to its high retail price, lack of awareness of its health benefits, and concerns about mercury contamination in certain fish, although the scientific evidence suggests that the benefits of fish intake exceed the potential risks.<sup>31</sup> Prior studies also suggest that the variety of fish/shellfish consumed by Americans is limited.<sup>29</sup> Future efforts need to be placed to promote the consumption of fish/shellfish especially those high in the omega-3 fatty acids and increase the variety of seafood consumed by Americans.<sup>31</sup>

Stores provided the majorities of the processed meat (73%), unprocessed red meat (62%), poultry (62%), and fish/shellfish (60%) consumed by US adults in 2015–2016. Thus, future nutrition intervention strategies to reduce processed meat consumption should consider stores as one of the primary targets for intervention. For example, excise tax for processed meat may effectively reduce consumption at a low cost to the government. On the other hand, making fish/shellfish a more affordable price can potentially increase the consumption. Not surprisingly, fast-food restaurant is the secondary source of processed meat consumption in the US. Nutrition quality standards for fast-food restaurants, such as



limiting the use of processed meat in fast-food meals, and restrictions on advertising processed meat, especially to children, may decrease processed meat consumption in the US.

This study also provided interesting findings of processed meat, unprocessed red meat, poultry, and fish consumed by some population subgroups, which may reflect the social, cultural, and economic influences on diet preference and intake.<sup>32–34</sup> Both this study and a previous one<sup>35</sup> found that African Americans consumed a higher level of fish/shellfish than whites, although it may be largely driven by higher intakes of fried fish in African Americans. When non-fried fish was examined, the consumption level was similar in African Americans and whites.<sup>35</sup>

The current study has several strengths. The inclusion of 9 cycles of nationally representative data provided the most up-to-date evaluation of recent trends. This study is the first to assess trends and location of different types of processed meat consumption in relation to unprocessed red meat, poultry and fish/shellfish, providing a comprehensive portrait of processed meat consumption in US adults. Potential limitations should also be considered. Self-reported dietary intake is subject to measurement error.<sup>16</sup> However, NHANES incorporated one or two standardized, 24-hour diet recalls per person which were energy-adjusted and averaged whenever possible, reducing measurement error.<sup>36</sup> Although one or two 24-hour diet recalls per individual may inaccurately estimate habitual long-term intake for a specific individual, this method is excellent for estimating the mean intake of a group or population stratum,<sup>16</sup> the unit in the current analyses. Social desirability may result in biases in reporting<sup>37</sup> although it seems unlikely that such biases would be observed across the entire population. Because such biases are likely to occur similarly in each cycle with no strong indication of changing social desirability over time, its influence on the trend findings is unlikely to be large. Last, although levels of meat consumption were evaluated by demographic and lifestyle factors, the cross-sectional nature of the NHANES survey precludes conclusions to be made on demographic/lifestyle factors contributing to these trends.

## CONCLUSION

Despite growing public health concerns of processed meat consumption, there have been no changes in the amount of processed meat consumed by US adults over the last 18 years. Findings of this study can inform public health policy priorities for improving diet and reducing chronic disease burden in the US. Because stores and fast-food restaurants are main purchase locations for processed meat, future policies may prioritize these as primary sites of intervention.

## Acknowledgement:

We thank Lauren Lizewski who assisted the analysis of the USDA food availability data and provided technical assistance to the preparation of this manuscript. Permission from Lauren Lizewski in the acknowledgement has been obtained.

**Funding Disclosure:** This study was supported by NIH/ NIMHD 1R01MD011501 (FFZ), NIH/ NHLBI R01HL115189 (DM), and American Heart Association postdoctoral fellowship (JXL). The funding sources had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review or approval of the manuscript; and decision to submit the manuscript for publication.

**Conflict of Interest (COI) Statement:** Dr. Mozaffarian reports research funding from the National Institutes of Health and the Gates Foundation; personal fees from GOED, DSM, Nutrition Impact, Pollock Communications, Bunge, Indigo Agriculture, Amarin, Acasti Pharma, and America's Test Kitchen; scientific advisory board, Omada Health, Elysium Health, and DayTwo; and chapter royalties from UpToDate; all outside the submitted work.

## REFERENCES

1. International Agency for Research on Cancer. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Red Meat and Processed Meat Volume 114 2018; <https://monographs.iarc.fr/wp-content/uploads/2018/06/mono114.pdf>. Accessed Feb. 15, 2019.
2. Sharma S, Sheehy T, Kolonel LN. Contribution of meat to vitamin B(1)(2), iron and zinc intakes in five ethnic groups in the USA: implications for developing food-based dietary guidelines. *J Hum Nutr Diet* 2013;26(2):156–168. [PubMed: 23398393]
3. Wyness L The role of red meat in the diet: nutrition and health benefits. *Proc Nutr Soc* 2016;75(3):227–232. [PubMed: 26643369]
4. Interagency Agricultural Projections Committee. USDA Agricultural Projections to 2027 [https://www.usda.gov/oce/commodity/projections/USDA\\_Agricultural\\_Projections\\_to\\_2027.pdf](https://www.usda.gov/oce/commodity/projections/USDA_Agricultural_Projections_to_2027.pdf). Accessed Feb.15, 2019.
5. Micha R, Wallace SK, Mozaffarian D. Red and processed meat consumption and risk of incident coronary heart disease, stroke, and diabetes mellitus: a systematic review and meta-analysis. *Circulation* 2010;121(21):2271–2283. [PubMed: 20479151]
6. Rouhani MH, Salehi-Abargouei A, Surkan PJ, Azadbakht L. Is there a relationship between red or processed meat intake and obesity? A systematic review and meta-analysis of observational studies. *Obes Rev* 2014;15(9):740–748. [PubMed: 24815945]
7. World Cancer Research Fund/American Institute for Cancer Research. Continuous Update Project Report: Diet, Nutrition, Physical Activity and Colorectal Cancer Revised 2018 <http://www.aicr.org/continuous-update-project/reports/colorectal-cancer-2017-report.pdf>. Accessed Feb. 15, 2019.
8. Bouvard V, Loomis D, Guyton KZ, et al. Carcinogenicity of consumption of red and processed meat. *Lancet Oncol* 2015;16(16):1599–1600. [PubMed: 26514947]
9. World Cancer Research Fund/American Institute for Cancer Research. Continuous Update Project Report: Diet, Nutrition, Physical Activity and Stomach Cancer. Revised 2018 <https://www.wcrf.org/sites/default/files/Stomach-cancer-report.pdf>. Accessed Feb. 15, 2019.
10. Islami F, Goding Sauer A, Miller KD, et al. Proportion and number of cancer cases and deaths attributable to potentially modifiable risk factors in the United States. *CA: a cancer journal for clinicians* 2018;68(1):31–54. [PubMed: 29160902]
11. Centers for Disease Control and Prevention. Key Concepts About the NHANES Sample Weights <https://www.cdc.gov/nchs/tutorials/nhanes/surveydesign/sampledesign/info1.htm>. Accessed Feb. 15, 2019.
12. Moshfegh AJ, Rhodes DG, Baer DJ, et al. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *Am J Clin Nutr* 2008;88(2):324–332. [PubMed: 18689367]
13. Bowman SA, Clemens JC, Shimizu M, Friday JE, Moshfegh AJ. Food Patterns Equivalents Database 2015–2016: Methodology and User Guide 2018; <http://www.ars.usda.gov/nea/bhnrc/fsrg> Accessed Feb.15, 2019.
14. Bowman SA, Friday JE, Moshfegh AJ. MyPyramid Equivalents Database, 2.0 for USDA Survey Foods, 2003–2004 2008; <http://www.ars.usda.gov/ba/bhnrc/fsrg> Accessed Feb.15, 2019.
15. Rehm CD, Penalvo JL, Afshin A, Mozaffarian D. Dietary Intake Among US Adults, 1999–2012. *JAMA* 2016;315(23):2542–2553. [PubMed: 27327801]
16. Willett WC. *Nutritional Epidemiology* In: Edition T, ed. 3rd ed New York: Oxford University Press; 2013.
17. Centers for Disease Control and Prevention (CDC)., National Center for Health Statistics (NCHS). National Health and Nutrition Examination Survey Interview Procedures Manual 2016; [https://wwwn.cdc.gov/nchs/data/nhanes/2015-2016/manuals/2016\\_Interviewer\\_Procedures\\_Manual.pdf](https://wwwn.cdc.gov/nchs/data/nhanes/2015-2016/manuals/2016_Interviewer_Procedures_Manual.pdf). Accessed Feb.15, 2019.

18. United States Census Bureau. Current Population Survey <https://www.census.gov/programs-surveys/cps/technical-documentation/subject-definitions.html>. Accessed Feb. 15, 2019.
19. SAS Version 9.4 [computer program] Cary, NC: SAS Institute Inc.; 2018.
20. Domingo JL, Nadal M. Carcinogenicity of consumption of red meat and processed meat: A review of scientific news since the IARC decision. *Food Chem Toxicol* 2017;105:256–261. [PubMed: 28450127]
21. Andreyeva T, Long MW, Brownell KD. The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. *Am J Public Health* 2010;100(2): 216–222. [PubMed: 20019319]
22. U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015 – 2020 Dietary Guidelines for Americans <https://health.gov/dietaryguidelines/2015/guidelines/>. Accessed March 2, 2019.
23. Bureau of Labor Statistics. Consumer Price Index <https://www.bls.gov/cpi/>. Accessed Feb. 15, 2019.
24. Haid MA. Processed meat as carcinogen: Time for health warning labels? *Journal of Cancer Policy* 2016;8:9.
25. Kushi LH, Doyle C, McCullough M, et al. American Cancer Society Guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA Cancer J Clin* 2012;62(1):30–67. [PubMed: 22237782]
26. World Cancer Research Fund/American Institute for Cancer Research. Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective. A Summary of the Third Expert Report 2018; <https://www.wcrf.org/sites/default/files/Summary-third-expert-report.pdf>. Accessed Feb.15, 2019.
27. United States Department of Agriculture. Agriculture Fact Book 2001–2002. Chapter 2: Profiling Food Consumption in America <https://assets.documentcloud.org/documents/2461300/usda-chapter2.pdf>. Accessed Feb.15, 2019.
28. Neff RA, Edwards D, Palmer A, Ramsing R, Righter A, Wolfson J. Reducing meat consumption in the USA: a nationally representative survey of attitudes and behaviours. *Public health nutrition* 2018;21(10):1835–1844. [PubMed: 29576031]
29. Economic Research Service (ERS). Food Availability (Per Capita) Data System. In: (USDA) USDoA, ed2017.
30. World Cancer Research Fund/American Institute for Cancer Research. Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective 2007; [http://www.aicr.org/assets/docs/pdf/reports/Second\\_Expert\\_Report.pdf](http://www.aicr.org/assets/docs/pdf/reports/Second_Expert_Report.pdf). Accessed Feb.15, 2019.
31. Mozaffarian D, Rimm EB. Fish intake, contaminants, and human health: evaluating the risks and the benefits. *Jama* 2006;296(15):1885–1899. [PubMed: 17047219]
32. Beydoun MA, Wang Y. How do socio-economic status, perceived economic barriers and nutritional benefits affect quality of dietary intake among US adults? *Eur J Clin Nutr* 2008;62(3):303–313. [PubMed: 17342164]
33. Daniel CR, Cross AJ, Koebnick C, Sinha R. Trends in meat consumption in the USA. *Public Health Nutr* 2011;14(4):575–583. [PubMed: 21070685]
34. Guenther PM, Jensen HH, Batres-Marquez SP, Chen CF. Sociodemographic, knowledge, and attitudinal factors related to meat consumption in the United States. *Journal of the American Dietetic Association* 2005;105(8):1266–1274. [PubMed: 16182644]
35. Nahab F, Le A, Judd S, et al. Racial and geographic differences in fish consumption: the REGARDS study. *Neurology* 2011;76(2):154–158. [PubMed: 21178096]
36. Willett WC, Howe GR, Kushi LH. Adjustment for total energy intake in epidemiologic studies. *Am J Clin Nutr* 1997;65(4 Suppl):1220S–1228S; discussion 1229S–1231S. [PubMed: 9094926]
37. Hebert JR, Clemow L, Pbert L, Ockene IS, Ockene JK. Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. *International journal of epidemiology* 1995;24(2):389–398. [PubMed: 7635601]

## RESEARCH SNAPSHOT

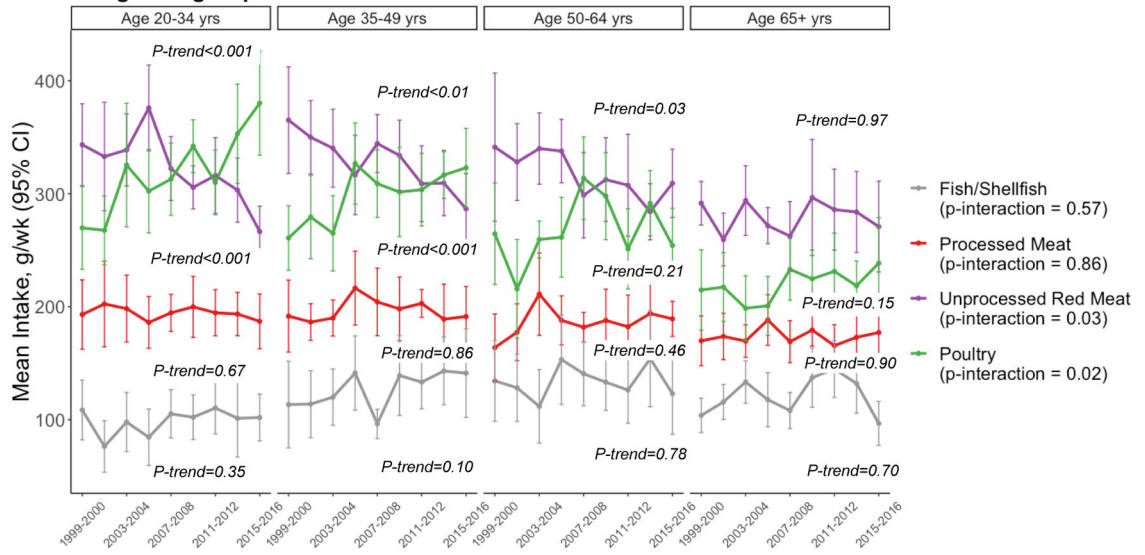
**Research Question:**

What are the trends of processed meat consumption among US adults over the past 18 years?

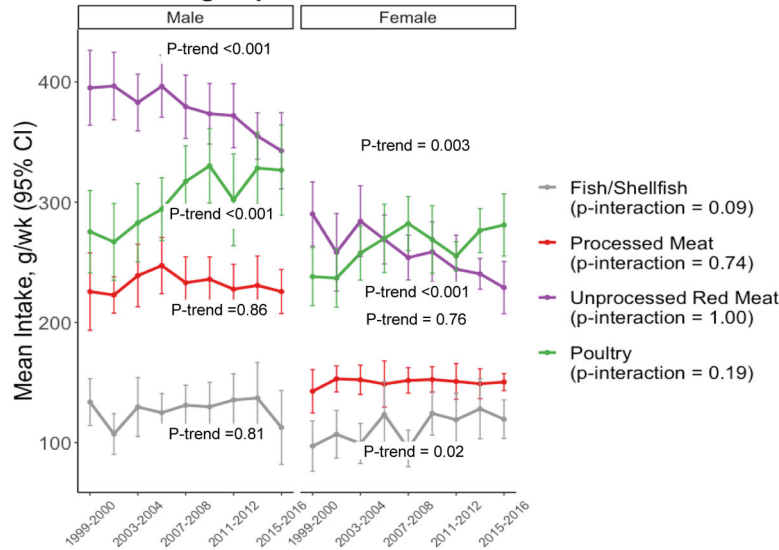
**Key findings:**

Despite growing public health concerns of processed meat consumption, there have been no changes in the amount of processed meat consumed among US adults in the past 18 years. The top 5 processed meats consumed by US adults in 2015–2016 were luncheon meat (mean intake = 73.3 g/wk), sausage (45.5 g/wk), hot dog (17.5 g/wk), ham (17.5 g/wk), and bacon (8.6 g/wk), accounting for 39.3%, 24.3%, 9.4%, 9.4%, and 4.6%, respectively, of the total processed meat consumption in the US.

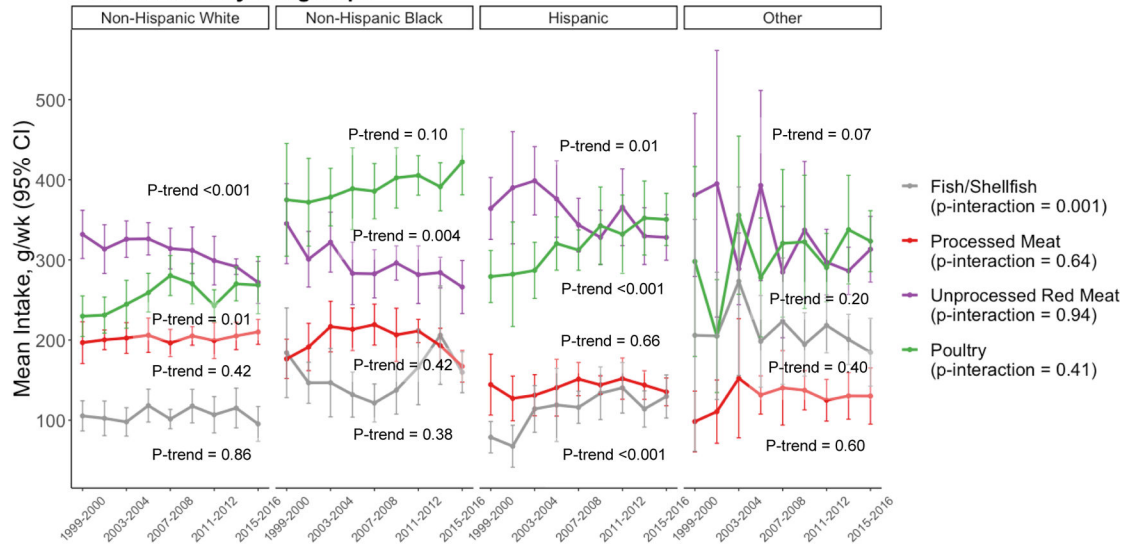
**A. Age Subgroups**



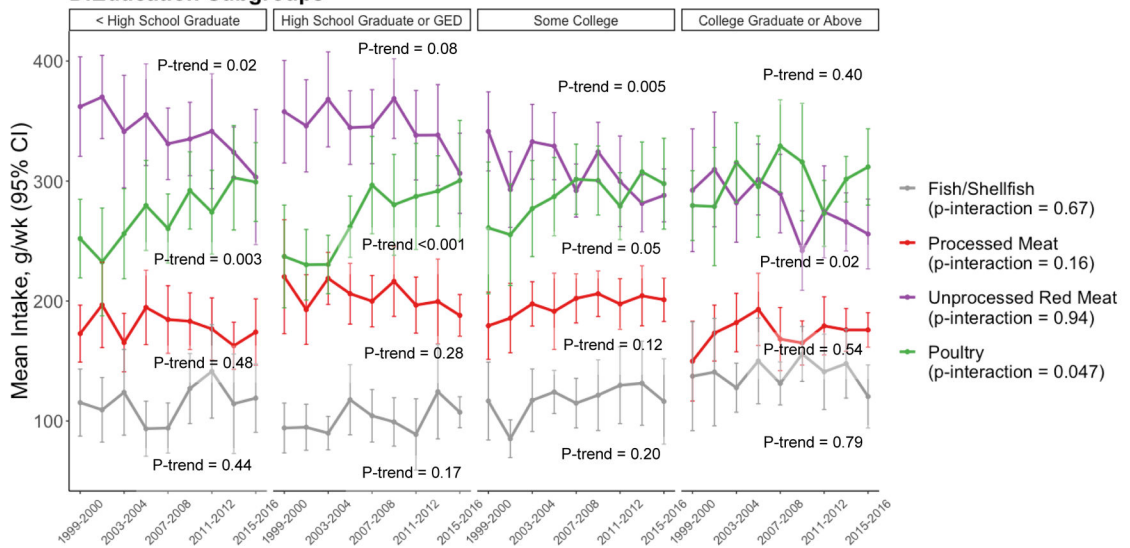
**B. Sex Subgroups**

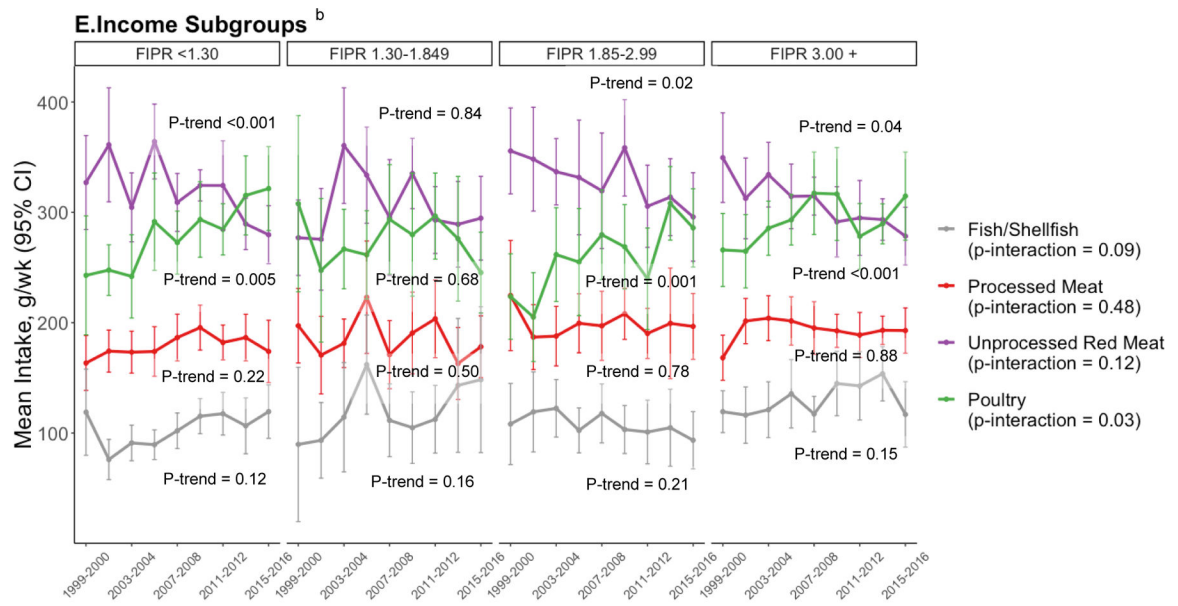


**C. Race/Ethnicity Subgroups**



**D. Education Subgroups <sup>a</sup>**

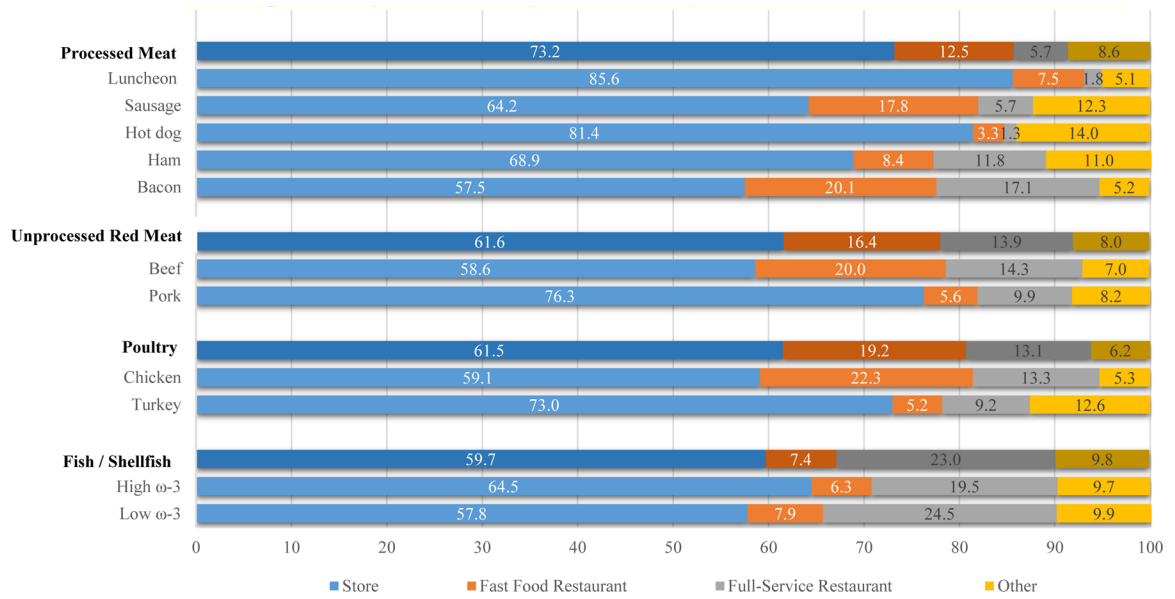




<sup>a</sup> GED = general equivalency diploma

<sup>b</sup> Income was represented by the family income-to-poverty ratio (FIPR). FIPR < 1.30 indicates a lower level of income and the FIPR ≥ 3 indicates a higher level of income

**Figure 1.** Trends of Processed Meat, Unprocessed Red Meat, Poultry, and Fish/Shellfish Consumption among US Adults by (A) Age, (B) Sex, (C) Race/Ethnicity, (D) Education, and (E) Family Income, 1999–2016.



**Figure 2.** Percent (%) of Processed Meat, Unprocessed Red Meat, Poultry, and Fish/Shellfish Consumption among U.S. Adults Aged 20+ Years by Purchase Location, NHANES 2015–2016



Table 1.

Demographics of US Adults Aged 20+ Years in Each NHANES Cycle, 1999–2016<sup>a</sup>

	NHANES Cycle									
	1999–2000 (n=4237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4801)	2013–2014 (n=5047)	2015–2016 (n=5017)	
<b>Age group (years)</b>	N (Weighted %)									
20–34	1136 (30%)	1320 (28%)	1207 (29%)	1378 (28%)	1260 (28%)	1442 (28%)	1317 (28%)	1321 (28%)	1273 (28%)	1273 (28%)
35–49	1035 (31%)	1258 (33%)	1044 (29%)	1141 (30%)	1368 (30%)	1522 (29%)	1178 (27%)	1322 (26%)	1244 (25%)	1244 (25%)
50–64	929 (21%)	1011 (22%)	901 (24%)	953 (24%)	1395 (26%)	1419 (26%)	1274 (28%)	1298 (27%)	1290 (26%)	1290 (26%)
65	1137 (18%)	1155 (17%)	1296 (18%)	1048 (18%)	1396 (17%)	1379 (17%)	1032 (18%)	1106 (19%)	1210 (21%)	1210 (21%)
<b>Sex</b>										
Male	1978 (48%)	2250 (48%)	2135 (48%)	2163 (48%)	2661 (47%)	2789 (48%)	2394 (49%)	2414 (48%)	2415 (48%)	2415 (48%)
Female	2259 (52%)	2494 (52%)	2313 (52%)	2357 (52%)	2758 (53%)	2973 (52%)	2407 (51%)	2633 (52%)	2602 (52%)	2602 (52%)
<b>Race/Ethnicity</b>										
Non-Hispanic White	1891 (70%)	2494 (73%)	2391 (73%)	2276 (73%)	2547 (70%)	2786 (69%)	1842 (67%)	2233 (66%)	1711 (64%)	1711 (64%)
Non-Hispanic Black	792 (11%)	890 (11%)	867 (11%)	1012 (11%)	1136 (11%)	1025 (11%)	1274 (11%)	1009 (11%)	1060 (11%)	1060 (11%)
Hispanic	1421 (15%)	1200 (12%)	1016 (11%)	1049 (11%)	1525 (13%)	1647 (14%)	932 (14%)	1125 (15%)	1543 (15%)	1543 (15%)
Other	133 (5%)	160 (4%)	174 (5%)	183 (5%)	211 (5%)	304 (6%)	753 (8%)	680 (8%)	703 (10%)	703 (10%)
<b>Education level</b>										
Less than high school graduate	1633 (25%)	1421 (19%)	1288 (18%)	1234 (17%)	1665 (20%)	1634 (19%)	1102 (16%)	1028 (15%)	1150 (14%)	1150 (14%)
High school graduate or GED <sup>c</sup>	957 (26%)	1110 (25%)	1111 (26%)	1093 (25%)	1340 (26%)	1316 (22%)	1008 (20%)	1141 (22%)	1108 (21%)	1108 (21%)
Some college	954 (28%)	1240 (29%)	1216 (32%)	1290 (31%)	1398 (29%)	1624 (31%)	1463 (33%)	1578 (33%)	1492 (33%)	1492 (33%)
College graduate or above	679 (21%)	967 (27%)	827 (23%)	901 (26%)	1012 (25%)	1175 (28%)	1225 (31%)	1297 (30%)	1265 (32%)	1265 (32%)
<b>Ratio of family income to poverty level<sup>d</sup></b>										
<1.30	1106 (21%)	1190 (20%)	1209 (20%)	1115 (17%)	1498 (20%)	1746 (21%)	1564 (24%)	1592 (24%)	1429 (19%)	1429 (19%)
1.30–1.849	516 (10%)	572 (10%)	570 (10%)	540 (9%)	699 (11%)	702 (10%)	594 (10%)	519 (10%)	658 (10%)	658 (10%)
1.85–2.99	664 (15%)	840 (17%)	830 (19%)	838 (19%)	985 (17%)	923 (16%)	702 (17%)	749 (15%)	916 (18%)	916 (18%)
3.00	1354 (42%)	1827 (48%)	1602 (46%)	1832 (52%)	1752 (45%)	1857 (46%)	1574 (44%)	1826 (45%)	1534 (44%)	1534 (44%)

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey<sup>b</sup>Percentages (%) were adjusted for survey weights.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

<sup>c</sup>GED = general equivalency diploma

<sup>d</sup>Ratio of family income to poverty level is the ratio of family income to the federal poverty threshold adjusted for household size. For reference, the federal threshold in 2014 for a family of four was \$23,850/y. A family of four earning \$44,123/y would have a ratio of 1.85. A ratio < 1.30 indicates a lower level of income and a ratio > 3 indicates a higher level of income.

Table 2.

Trends in Processed Meat, Unprocessed Red Meat, Poultry, and Fish/Shellfish Consumption among US Adults Aged 20+ Years, NHANES 1999–2016<sup>a</sup>

	Weighted Mean Intake (95% CI) <sup>b</sup> g/wk										P-Trend	Mean Change from 1999–2000 to 2015–2016 (95% CI) <sup>b</sup>
	1999–2000 (n=4237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4891)	2013–2014 (n=5047)	2015–2016 (n=5017)			
<b>Processed meat</b>	182 (163, 202)	187 (176, 197)	194 (179, 209)	196 (177, 216)	190 (177, 203)	193 (180, 206)	188 (176, 201)	189 (175, 203)	187 (176, 197)	187 (176, 197)	0.95	4.22 (-18.4, 26.8)
Luncheon meat	67.0 (51.9, 82.1)	80.1 (68.9, 91.4)	69.5 (60.6, 78.4)	77.2 (67.8, 86.6)	70.9 (61.8, 80.0)	78.2 (72.9, 83.5)	71.5 (62.0, 81.0)	80.4 (71.8, 88.9)	73.3 (65.9, 80.6)	73.3 (65.9, 80.6)	0.50	6.30 (-10.5, 23.1)
Sausage	46.2 (39.6, 52.8)	41.4 (34.1, 48.7)	52.2 (47.2, 57.2)	47.0 (39.8, 54.1)	46.5 (42.1, 50.9)	43.3 (39.8, 46.9)	42.7 (37.9, 47.5)	42.2 (36.2, 48.3)	45.5 (39.6, 51.4)	45.5 (39.6, 51.4)	0.35	-0.70 (-9.55, 8.14)
Hot dog	26.8 (19.4, 34.3)	26.1 (20.0, 32.1)	24.0 (19.8, 28.2)	21.2 (17.7, 24.7)	25.6 (20.8, 30.5)	26.1 (19.5, 32.6)	20.8 (17.1, 24.5)	18.1 (14.1, 22.2)	17.5 (13.5, 21.6)	17.5 (13.5, 21.6)	<0.01	-9.28 (-17.8, -0.79)
Ham	21.3 (16.5, 26.1)	18.4 (12.9, 23.9)	19.0 (14.5, 23.6)	21.9 (14.7, 29.2)	22.2 (18.2, 26.1)	20.6 (15.9, 25.2)	20.3 (15.8, 24.8)	16.6 (10.9, 22.3)	17.5 (11.0, 24.1)	17.5 (11.0, 24.1)	0.37	-3.77 (-11.9, 4.36)
Bacon	6.66 (5.44, 7.88)	6.95 (5.64, 8.27)	9.03 (6.90, 11.2)	10.6 (8.8, 12.3)	9.72 (8.64, 10.8)	10.1 (8.9, 11.3)	8.61 (7.42, 9.80)	9.15 (8.09, 10.2)	8.60 (7.24, 9.95)	8.60 (7.24, 9.95)	0.03	1.94 (0.11, 3.76)
Smoked/ cured/ corned	6.45 (3.56, 9.34)	3.50 (1.83, 5.16)	6.01 (3.87, 8.14)	5.00 (3.28, 6.71)	6.13 (3.97, 8.28)	5.60 (3.53, 7.68)	6.92 (4.00, 9.84)	4.95 (2.37, 7.54)	6.36 (3.89, 8.83)	6.36 (3.89, 8.83)	0.46	-0.09 (-3.89, 3.71)
Dried/ pickled	0.67 (0.05, 1.29)	0.81 (0.09, 1.52)	1.38 (0.25, 2.50)	1.71 (0.48, 2.95)	0.90 (0.39, 1.41)	0.92 (0.31, 1.54)	1.00 (0.34, 1.66)	2.22 (0.02, 4.41)	1.40 (0.59, 2.22)	1.40 (0.59, 2.22)	0.21	0.73 (-0.29, 1.76)
Unspecified	7.29 (6.15, 8.44)	9.47 (8.17, 10.8)	12.8 (10.5, 15.2)	11.5 (10.0, 13.0)	8.11 (6.42, 9.79)	7.88 (6.60, 9.16)	16.5 (13.8, 19.3)	15.0 (12.6, 17.4)	16.4 (14.4, 18.4)	16.4 (14.4, 18.4)	<0.001	9.09 (6.77, 11.4)
<b>Unprocessed red meat</b>	340 (314, 367)	325 (302, 348)	332 (313, 351)	330 (313, 348)	313 (295, 331)	314 (292, 336)	306 (280, 333)	296 (287, 305)	284 (267, 300)	284 (267, 300)	<0.001	-56.7 (-88.0, -25.4)
Beef	250 (221, 279)	245 (220, 270)	242 (225, 259)	254 (241, 266)	230 (213, 247)	228 (206, 251)	210 (191, 228)	196 (187, 205)	172 (155, 188)	172 (155, 188)	<0.001	-78.3 (-112, -45.0)
Pork	61.8 (51.7, 71.9)	53.4 (43.0, 63.8)	55.9 (49.6, 62.3)	46.8 (41.0, 52.7)	49.7 (43.0, 56.4)	58.8 (51.0, 66.5)	47.4 (39.5, 55.4)	53.8 (46.0, 61.7)	53.8 (44.3, 63.2)	53.8 (44.3, 63.2)	0.38	-8.05 (-21.9, 5.81)
Other <sup>c</sup>	7.65 (4.40, 10.9)	9.30 (4.13, 14.5)	12.4 (8.3, 16.6)	7.45 (3.89, 11.0)	10.4 (6.4, 14.4)	9.16 (6.48, 11.8)	8.18 (4.57, 11.8)	6.86 (3.79, 9.92)	8.70 (4.97, 12.4)	8.70 (4.97, 12.4)	0.47	1.06 (-3.89, 6.00)
Unspecified	20.7 (15.7, 25.8)	17.4 (14.5, 20.4)	21.4 (18.1, 24.7)	22.1 (18.7, 25.4)	22.9 (20.7, 25.1)	17.7 (14.7, 20.6)	41.1 (34.0, 48.2)	39.7 (35.7, 43.8)	49.4 (42.4, 56.4)	49.4 (42.4, 56.4)	<0.001	28.7 (20.1, 37.3)
<b>Poultry</b>	256 (234, 278)	251 (233, 270)	270 (245, 294)	282 (258, 305)	299 (275, 322)	299 (272, 325)	278 (255, 301)	302 (283, 321)	303 (276, 330)	303 (276, 330)	<0.001	47.0 (12.0, 82.0)
Chicken	195 (176, 215)	175 (162, 188)	196 (176, 216)	204 (183, 225)	206 (193, 220)	213 (193, 232)	198 (179, 217)	213 (197, 228)	230 (208, 252)	230 (208, 252)	<0.001	34.4 (4.90, 63.9)
Turkey	19.7 (13.6, 25.8)	15.0 (8.5, 21.5)	22.4 (13.9, 30.8)	16.6 (10.9, 22.2)	22.4 (16.7, 28.0)	20.0 (14.6, 25.5)	11.5 (8.0, 14.9)	20.3 (12.3, 28.3)	16.4 (10.9, 21.8)	16.4 (10.9, 21.8)	0.53	-3.32 (-11.5, 4.83)
Other <sup>c</sup>	0.87 (-0.41, 2.15)	2.69 (0.17, 5.20)	0.45 (-0.06, 0.96)	0.99 (-0.39, 2.36)	1.96 (-0.57, 4.50)	0.37 (0.18, 0.56)	0.84 (0.27, 1.41)	0.67 (0.11, 1.22)	0.69 (0.16, 1.22)	0.69 (0.16, 1.22)	0.16	-0.18 (-1.57, 1.20)
Unspecified	40.1 (32.1, 48.1)	58.7 (44.5, 72.9)	51.1 (40.2, 62.0)	60.0 (51.4, 68.5)	68.2 (59.0, 77.5)	65.4 (56.2, 74.6)	67.8 (59.8, 75.8)	67.8 (60.9, 74.6)	56.2 (47.5, 65.0)	56.2 (47.5, 65.0)	<0.01	16.1 (4.30, 28.0)
<b>Fish/shellfish</b>	115 (99.0, 131)	107 (91.0, 124)	114 (97.0, 131)	124 (106, 142)	112 (100, 124)	127 (109, 144)	127 (107, 147)	132 (107, 158)	116 (98, 134)	116 (98, 134)	0.14	1.55 (-22.5, 25.6)
Low ω-3	82.4 (68.9, 96.0)	78.4 (66.2, 90.7)	83.8 (71.0, 96.6)	94.0 (78.7, 109)	79.2 (69.4, 88.9)	93.9 (79.0, 109)	95.9 (79.3, 113)	94.3 (69.9, 119)	82.2 (66.8, 97.6)	82.2 (66.8, 97.6)	0.29	-0.19 (-20.7, 20.3)
High ω-3	32.2 (23.1, 41.3)	28.6 (20.4, 36.9)	30.1 (21.6, 38.6)	30.1 (23.8, 36.5)	32.9 (28.8, 37.0)	33.0 (28.6, 37.5)	31.1 (24.0, 38.2)	38.1 (32.5, 43.8)	33.9 (26.3, 41.6)	33.9 (26.3, 41.6)	0.17	1.74 (-10.2, 13.6)

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey

<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for survey weights, and for total energy intake to 2000 kcal/d using the residual method.

<sup>c</sup>Examples of other red meats include game, lamb, goat, veal, and deer; and examples of poultry include duck, goose, ostrich, quail, and pheasant.

Table 3.

Purchase Location of Processed Meat, Unprocessed Red Meat, Poultry, and Fish/Shellfish among US Adults Aged 20+ Years, NHANES 2015–2016<sup>a</sup>

	Store		Fast-Food Restaurant		Full-Service Restaurant		Other	
	%	Weighted Mean, g/wk (95% CI) <sup>b</sup>	%	Weighted Mean, g/wk (95% CI) <sup>b</sup>	%	Weighted Mean, g/wk (95% CI) <sup>b</sup>	%	Weighted Mean, g/wk (95% CI) <sup>b</sup>
<b>Processed meat</b>								
Luncheon	73.2	137 (127, 146)	12.5	23.3 (19.2, 27.4)	5.7	10.7 (8.28, 13.2)	8.6	16.0 (10.8, 21.1)
Sausage	85.6	62.7 (56.1, 69.3)	7.5	5.49 (3.06, 7.92)	1.8	1.33 (0.63, 2.02)	5.1	3.76 (2.20, 5.31)
Hot dog	64.2	29.2 (24.7, 33.7)	17.8	8.08 (5.80, 10.4)	5.7	2.60 (1.67, 3.52)	12.3	5.59 (1.84, 9.35)
Ham	81.4	14.3 (10.1, 18.5)	3.3	0.58 (0.25, 0.91)	1.3	0.22 (-0.03, 0.48)	14.0	2.46 (1.42, 3.50)
Bacon	68.9	12.1 (6.27, 17.9)	8.4	1.47 (0.60, 2.35)	11.8	2.06 (0.92, 3.20)	11.0	1.92 (-0.17, 4.02)
Smoked/ cured/ corned	57.5	4.95 (4.13, 5.76)	20.1	1.73 (1.15, 2.31)	17.1	1.47 (0.78, 2.16)	5.2	0.45 (0.26, 0.64)
Dried/ pickled	59.6	3.79 (1.49, 6.10)	28.3	1.80 (0.24, 3.36)	8.1	0.52 (-0.08, 1.11)	3.9	0.25 (-0.04, 0.54)
Unspecified	92.1	1.29 (0.42, 2.17)	0.0	0.00 (0.00, 0.00)	2.2	0.03 (-0.04, 0.10)	5.7	0.08 (-0.07, 0.23)
<b>Unprocessed red meat</b>								
Beef	50.6	8.29 (6.13, 10.5)	25.4	4.16 (3.31, 5.01)	15.2	2.49 (1.78, 3.19)	8.9	1.45 (0.81, 2.10)
Pork	61.6	175 (160, 189)	16.4	46.6 (39.9, 53.3)	13.9	39.4 (32.3, 46.6)	8.0	22.8 (18.3, 27.4)
Other	58.6	101 (87.0, 115)	20.0	34.4 (27.0, 41.8)	14.3	24.6 (17.1, 32.1)	7.0	12.1 (8.92, 15.2)
Unspecified <sup>c</sup>	76.3	41.0 (31.5, 50.6)	5.6	3.02 (2.12, 3.91)	9.9	5.30 (3.08, 7.52)	8.2	4.41 (2.68, 6.14)
<b>Poultry</b>								
Chicken	45.2	3.93 (0.88, 6.99)	2.3	0.20 (-0.03, 0.43)	20.8	1.81 (0.38, 3.24)	31.7	2.76 (0.68, 4.83)
Turkey	58.9	29.1 (22.5, 35.7)	18.3	9.02 (6.21, 11.8)	15.6	7.71 (5.43, 9.98)	7.3	3.58 (2.17, 5.00)
Other	61.5	186 (166, 207)	19.2	58.1 (48.2, 68.0)	13.1	39.6 (26.9, 52.3)	6.2	18.9 (12.8, 25.1)
Unspecified <sup>c</sup>	59.1	136 (122, 150)	22.3	51.3 (41.6, 61.0)	13.3	30.5 (20.4, 40.6)	5.3	12.2 (8.13, 16.3)
<b>Fish/shellfish</b>								
Low ω-3	73.0	11.9 (6.53, 17.3)	5.2	0.86 (-0.38, 2.09)	9.2	1.50 (-0.34, 3.35)	12.6	2.06 (0.71, 3.40)
High ω-3	60.5	0.42 (0.04, 0.79)	0.0	0.00 (0.00, 0.00)	33.8	0.23 (-0.07, 0.54)	5.7	0.04 (-0.04, 0.12)
Unspecified <sup>c</sup>	68.1	38.3 (31.0, 45.6)	10.5	5.93 (3.72, 8.13)	13.2	7.39 (1.12, 13.67)	8.2	4.62 (1.87, 7.37)
Low ω-3	59.7	69.4 (56.3, 82.4)	7.4	8.64 (6.75, 10.5)	23.0	26.7 (18.3, 35.2)	9.8	11.4 (8.27, 14.6)
High ω-3	57.8	47.5 (37.8, 57.2)	7.9	6.49 (5.44, 7.54)	24.5	20.1 (10.7, 29.6)	9.9	8.12 (5.34, 10.9)
Unspecified <sup>c</sup>	64.5	21.9 (15.4, 28.3)	6.3	2.15 (0.85, 3.46)	19.5	6.61 (3.91, 9.31)	9.7	3.29 (1.27, 5.31)

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for survey weights, and for total energy intake to 2000 kcal/d using the residual method.<sup>c</sup>Examples of other red meats include game, lamb, goat, veal, and deer; and examples of poultry include duck, goose, ostrich, quail, and pheasant.

**Table 4.**

Consumption of Processed Meat, Unprocessed Red Meat, Poultry, and Fish/Shellfish among US Adults Aged 20+ Years by Age, Sex, Race/Ethnicity, Education, and Family Income, NHANES 2015–2016<sup>a</sup>

	Processed Meat	Unprocessed Red Mea	Poultry	Fish/Shellfish
Weighted Mean Intake (95% CI), g/wk <sup>b</sup>				
<b>Age group, years</b>				
20–34	187 (161, 213)	267 (243, 291)	380 (331, 430)	102 (80, 124)
35–49	191 (163, 220)	287 (253, 320)	323 (285, 361)	141 (99, 183)
50–64	189 (173, 206)	309 (277, 342)	254 (219, 290)	123 (84, 162)
65	177 (154, 200)	271 (228, 314)	239 (195, 282)	97 (76, 118)
	<i>P-difference = 0.60</i>	<i>P-difference = 0.02</i>	<i>P-difference &lt;0.001</i>	<i>P-difference &lt;0.001</i>
<b>Sex</b>				
Male	226 (206, 245)	343 (309, 377)	327 (286, 367)	113 (79, 146)
Female	150 (143, 158)	229 (205, 252)	281 (253, 309)	120 (102, 137)
	<i>P-difference &lt;0.001</i>	<i>P-difference &lt;0.001</i>	<i>P-difference &lt;0.001</i>	<i>P-difference = 0.42</i>
<b>Race/ Ethnicity</b>				
Non-Hispanic White	210 (193, 227)	272 (244, 300)	269 (230, 307)	95 (72, 119)
Non-Hispanic Black	167 (146, 189)	266 (230, 302)	422 (378, 467)	160 (132, 187)
Hispanic	135 (117, 154)	328 (297, 359)	351 (315, 386)	130 (101, 159)
Other	130 (92, 168)	313 (269, 358)	323 (282, 364)	185 (139, 230)
	<i>P-difference &lt;0.001</i>	<i>P-difference &lt;0.001</i>	<i>P-difference &lt;0.001</i>	<i>P-difference &lt;0.001</i>
<b>Education level</b>				
<High school graduate	174 (144, 204)	303 (243, 364)	299 (264, 335)	119 (88, 150)
High school graduate or GED <sup>c</sup>	188 (169, 207)	306 (270, 342)	300 (246, 355)	107 (93, 121)
Some college	201 (182, 221)	288 (264, 312)	298 (257, 339)	116 (78, 155)
College graduate or above	176 (160, 191)	256 (225, 287)	312 (277, 346)	121 (92, 149)
	<i>P-difference = 0.03</i>	<i>P-difference &lt;0.01</i>	<i>P-difference = 0.77</i>	<i>P-difference = 0.73</i>
<b>Ratio of family income to poverty level<sup>d</sup></b>				
<1.30	174 (143, 204)	280 (251, 308)	322 (281, 363)	119 (93, 145)
1.30–1.84	178 (148, 208)	295 (254, 336)	245 (206, 285)	148 (77, 220)
1.85–2.99	197 (164, 229)	296 (253, 339)	286 (248, 324)	93 (65, 121)
3.00	193 (171, 215)	278 (250, 307)	315 (272, 358)	117 (85, 149)
	<i>P-difference = 0.17</i>	<i>P-difference = 0.60</i>	<i>P-difference &lt;0.01</i>	<i>P-difference = 0.01</i>

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey

<sup>b</sup>CI = confidence interval. Means and 95% CIs were adjusted for survey weights, and for total energy intake to 2000 kcal/d using the residual method.

<sup>c</sup>GED = general equivalency diploma

<sup>d</sup>Ratio of family income to poverty level is the ratio of family income to the federal poverty threshold adjusted for household size. For reference, the federal threshold in 2014 for a family of four was \$23,850/y. A family of four earning \$44,123/y would have a ratio of 1.85. A ratio < 1.30 indicates a lower level of income and a ratio > 3 indicates a higher level of income.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 5 online only.

Age, Sex, and Race/Ethnicity-Adjusted Trends in Processed Meat, Poultry, and Fish/Shellfish Consumption among US Adults Ages 20 Years or Older, NHANES 1999–2016<sup>a</sup>

	Weighted Mean Intake (95% CI) <sup>b</sup> , g/wk											P-Trend	Mean Change from 1999–2000 to 2015–2016 (95% CI) <sup>b</sup>
	1999–2000 (n=4237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4801)	2013–2014 (n=5047)	2015–2016 (n=5017)				
<b>Processed meat</b>	159 (141, 177)	161 (151, 171)	168 (154, 182)	170 (152, 188)	167 (154, 179)	170 (158, 182)	166 (153, 179)	168 (155, 181)	168 (156, 179)	168 (156, 179)	0.38	8.70 (-13.2, 30.6)	
Luncheon meat	51.0 (36.3, 65.8)	63.3 (52.7, 73.9)	52.5 (44.3, 60.8)	60.6 (51.7, 69.6)	55.1 (45.5, 64.7)	62.8 (57.0, 68.5)	56.6 (47.3, 66.0)	66.1 (57.7, 74.4)	60.0 (52.8, 67.1)	60.0 (52.8, 67.1)	0.20	8.90 (-7.60, 25.5)	
Sausage	43.6 (37.1, 50.0)	38.1 (30.7, 45.5)	48.8 (43.5, 54.2)	43.5 (36.4, 50.6)	43.7 (39.0, 48.4)	40.6 (36.9, 44.2)	40.1 (35.2, 45.0)	39.9 (33.7, 46.2)	43.8 (37.7, 49.9)	43.8 (37.7, 49.9)	0.60	0.20 (-8.90, 9.30)	
Hot dog	25.3 (18.1, 32.5)	24.3 (18.7, 30.0)	22.3 (17.9, 26.6)	19.5 (15.7, 23.2)	24.1 (19.4, 28.9)	24.6 (18.3, 30.8)	19.3 (15.5, 23.2)	16.8 (12.6, 21.1)	16.5 (12.4, 20.6)	16.5 (12.4, 20.6)	0.005	-8.80 (-17.3, -0.40)	
Ham	19.0 (14.3, 23.8)	15.8 (10.6, 21.0)	16.4 (12.0, 20.9)	19.3 (12.6, 25.9)	19.9 (15.6, 24.1)	18.3 (13.6, 23.0)	18.1 (14.1, 22.1)	14.4 (9.1, 19.7)	15.4 (8.9, 21.8)	15.4 (8.9, 21.8)	0.45	-3.70 (-11.9, 4.60)	
Bacon	6.37 (5.11, 7.63)	6.58 (5.23, 7.92)	8.65 (6.59, 10.7)	10.2 (8.4, 12.0)	9.40 (8.20, 10.6)	9.80 (8.46, 11.2)	8.34 (7.12, 9.55)	8.93 (7.84, 10.0)	8.46 (7.14, 9.77)	8.46 (7.14, 9.77)	0.01	2.10 (0.30, 3.90)	
Smoked/ cured/comed	6.88 (3.91, 9.86)	3.86 (1.89, 5.83)	6.34 (4.03, 8.66)	5.29 (3.48, 7.11)	6.52 (4.22, 8.82)	5.96 (3.84, 8.08)	7.26 (4.36, 10.2)	5.29 (2.86, 7.72)	6.67 (4.00, 9.34)	6.67 (4.00, 9.34)	0.50	-0.20 (-4.10, 3.60)	
Dried/ pickled	0.51 (-0.26, 1.29)	0.64 (-0.22, 1.49)	1.20 (0.05, 2.35)	1.55 (0.16, 2.93)	0.74 (0.12, 1.37)	0.76 (0.04, 1.48)	0.84 (0.08, 1.59)	2.07 (0.11, 4.02)	1.28 (0.45, 2.11)	1.28 (0.45, 2.11)	0.20	0.80 (-0.30, 1.80)	
Unspecified	6.22 (4.96, 7.49)	8.40 (6.91, 9.90)	11.8 (9.5, 14.1)	10.5 (8.9, 12.0)	7.11 (5.24, 8.98)	6.89 (5.49, 8.28)	15.6 (12.9, 18.3)	14.1 (11.8, 16.3)	15.6 (13.4, 17.8)	15.6 (13.4, 17.8)	<0.001	9.40 (7.00, 11.7)	
<b>Unprocessed red meat</b>	344 (315, 372)	328 (306, 351)	336 (317, 355)	335 (315, 355)	317 (298, 336)	317 (293, 340)	308 (283, 333)	298 (286, 310)	287 (269, 304)	287 (269, 304)	<0.001	-57.0 (-90.0, -24.0)	
Beef	246 (216, 277)	241 (216, 267)	239 (222, 257)	252 (237, 267)	227 (210, 245)	225 (202, 248)	206 (188, 224)	192 (181, 203)	169 (152, 187)	169 (152, 187)	<0.001	-77.0 (-111, -43.0)	
Pork	69.2 (58.3, 80.0)	60.6 (49.7, 71.4)	63.2 (56.3, 70.1)	53.8 (47.2, 60.5)	56.6 (49.7, 63.5)	65.2 (56.8, 73.6)	53.3 (45.3, 61.3)	59.6 (51.7, 67.6)	59.4 (49.9, 68.9)	59.4 (49.9, 68.9)	0.20	-9.70 (-23.4, 4.00)	
Other <sup>c</sup>	7.56 (3.99, 11.1)	9.08 (3.78, 14.4)	12.2 (7.9, 16.5)	7.20 (3.74, 10.7)	10.2 (6.0, 14.4)	8.96 (6.17, 11.7)	7.94 (4.23, 11.7)	6.63 (3.68, 9.57)	8.47 (4.71, 12.2)	8.47 (4.71, 12.2)	0.45	0.90 (-4.10, 5.90)	
Unspecified	20.3 (15.1, 25.6)	17.2 (13.5, 20.8)	21.3 (17.6, 24.9)	22.0 (18.3, 25.7)	22.7 (19.8, 25.5)	17.4 (14.0, 20.7)	40.7 (34.0, 47.5)	39.4 (35.2, 43.5)	49.1 (42.4, 55.9)	49.1 (42.4, 55.9)	<0.001	29.0 (20.0, 37.0)	
<b>Poultry</b>	282 (260, 304)	279 (261, 296)	297 (277, 317)	309 (285, 333)	325 (305, 344)	324 (299, 349)	302 (284, 320)	326 (309, 343)	329 (304, 353)	329 (304, 353)	<0.001	47.0 (14.0, 80.0)	
Chicken	218 (199, 237)	200 (186, 213)	220 (204, 237)	229 (208, 250)	229 (218, 241)	235 (217, 253)	220 (205, 234)	235 (222, 247)	253 (234, 271)	253 (234, 271)	<0.001	35.0 (8.0, 61.0)	
Turkey	22.0 (15.2, 28.8)	17.3 (10.7, 23.8)	24.6 (15.8, 33.3)	18.7 (12.6, 24.7)	24.6 (18.8, 30.3)	22.2 (16.5, 27.9)	13.6 (10.1, 17.2)	22.5 (14.5, 30.4)	18.6 (13.3, 23.9)	18.6 (13.3, 23.9)	0.53	-3.40 (-11.80, 4.90)	
Other <sup>c</sup>	1.71 (-0.09, 3.50)	3.50 (0.99, 6.02)	1.24 (0.38, 2.11)	1.75 (0.30, 3.21)	2.74 (-0.19, 5.67)	1.10 (0.40, 1.79)	1.50 (0.68, 2.32)	1.31 (0.41, 2.21)	1.28 (0.50, 2.07)	1.28 (0.50, 2.07)	0.09	-0.40 (-1.90, 1.10)	
Unspecified	40.0 (31.8, 48.2)	58.4 (44.6, 72.2)	50.9 (40.0, 61.9)	59.8 (51.1, 68.5)	67.9 (58.5, 77.2)	65.0 (56.1, 74.0)	67.3 (59.1, 75.5)	67.3 (59.9, 74.8)	56.0 (47.4, 64.5)	56.0 (47.4, 64.5)	0.002	16.0 (4.0, 28.0)	
<b>Fish/shellfish</b>	143 (126, 160)	135 (118, 153)	142 (123, 161)	151 (133, 170)	139 (126, 151)	153 (136, 170)	151 (131, 170)	156 (131, 181)	139 (122, 155)	139 (122, 155)	0.40	-4.40 (-27.2, 18.4)	
Low ω-3	107 (91, 122)	103 (89, 116)	108 (93, 122)	117 (101, 134)	102 (92, 113)	116 (101, 131)	117 (101, 133)	115 (91, 139)	102 (87, 116)	102 (87, 116)	0.63	-4.70 (-24.3, 15.0)	
High ω-3	36.4 (28.2, 44.7)	32.6 (24.4, 40.8)	34.0 (24.8, 43.2)	33.8 (27.2, 40.4)	36.7 (31.9, 41.6)	36.6 (31.5, 41.6)	34.3 (27.1, 41.5)	41.2 (35.7, 46.8)	36.7 (29.3, 44.0)	36.7 (29.3, 44.0)	0.31	0.30 (-11.5, 12.0)	

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for age, sex, race/ethnicity and survey weights, and for total energy intake to 2000 kcal/d using the residual method.<sup>c</sup>Examples of other red meats include game, lamb, goat, veal, and deer; and examples of poultry include duck, goose, ostrich, quail, and pheasant.

Age, Sex, Race/ethnicity, Education and Income-Adjusted Trends in Processed Meat, Unprocessed Red Meat, Poultry, and Fish/Shellfish Consumption among US Adults Aged 20 Years or Older, NHANES 1999–2016<sup>a</sup>

**Table 6 online only.**

	Weighted Mean Intake (95% CI) <sup>b</sup> g/wk											P-Trend	Mean Change from 1999–2000 to 2015–2016 (95% CI) <sup>b</sup>
	1999–2000 (n=6237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4801)	2013–2014 (n=5047)	2015–2016 (n=5017)				
<b>Processed meat</b>	155 (136, 175)	163 (153, 174)	165 (153, 178)	172 (154, 191)	167 (154, 179)	172 (160, 184)	168 (155, 182)	169 (156, 182)	170 (158, 181)	0.16	15.0 (−8.0, 37.0)		
Lunchmeat	52.1 (36.9, 67.2)	63.7 (52.9, 74.5)	52.2 (43.7, 60.7)	60.8 (51.1, 70.4)	53.9 (45.0, 62.8)	63.5 (57.2, 69.8)	56.8 (47.2, 66.4)	65.1 (57.3, 73.0)	59.2 (52.1, 66.3)	0.30	7.10 (−9.50, 23.7)		
Sausage	39.8 (33.1, 46.5)	38.1 (30.7, 45.4)	48.3 (42.5, 54.1)	44.0 (36.8, 51.1)	44.0 (39.5, 48.4)	40.3 (36.7, 43.9)	40.9 (36.2, 45.6)	39.8 (33.8, 45.8)	44.5 (38.2, 50.9)	0.86	4.70 (−4.50, 14.0)		
Hot dog	25.6 (17.5, 33.8)	25.2 (19.4, 31.1)	22.4 (17.8, 27.0)	19.7 (15.7, 23.7)	24.8 (19.7, 29.8)	25.8 (19.5, 32.1)	19.4 (15.4, 23.3)	18.1 (13.7, 22.5)	16.9 (12.9, 20.9)	0.01	−8.70 (−17.9, 0.50)		
Ham	17.6 (12.4, 22.9)	16.7 (11.6, 21.9)	15.0 (11.7, 18.3)	20.7 (13.6, 27.7)	21.2 (16.7, 25.7)	19.9 (14.8, 24.9)	19.3 (15.0, 23.7)	15.7 (10.0, 21.5)	16.5 (9.8, 23.2)	0.97	−1.10 (−10.0, 7.70)		
Bacon	6.38 (4.92, 7.85)	6.65 (5.17, 8.14)	8.39 (6.57, 10.2)	10.2 (8.2, 12.3)	9.43 (8.18, 10.7)	9.76 (8.26, 11.3)	8.63 (7.36, 9.90)	9.01 (7.80, 10.2)	8.94 (7.52, 10.4)	0.006	2.60 (0.50, 4.60)		
Smoked/cured/ corned	7.30 (3.91, 10.7)	3.76 (1.65, 5.86)	6.32 (3.93, 8.72)	5.07 (3.24, 6.90)	6.03 (3.95, 8.10)	5.63 (3.17, 8.08)	6.91 (3.81, 10.0)	5.05 (2.52, 7.58)	6.96 (4.10, 9.83)	0.60	−0.30 (−4.60, 3.90)		
Dried/ pickled	0.22 (−0.62, 1.05)	0.61 (−0.31, 1.53)	1.18 (−0.04, 2.39)	1.37 (−0.02, 2.76)	0.72 (0.05, 1.39)	0.76 (−0.01, 1.53)	0.84 (0.05, 1.64)	2.08 (0.16, 4.00)	1.38 (0.46, 2.29)	0.12	1.20 (0.00, 2.30)		
Unspecified	6.34 (4.88, 7.80)	8.61 (7.12, 10.1)	11.4 (9.0, 13.9)	10.5 (8.9, 12.0)	6.87 (5.08, 8.66)	6.77 (5.51, 8.03)	15.4 (12.6, 18.2)	14.2 (11.7, 16.7)	15.6 (13.4, 17.7)	<0.001	9.20 (6.80, 11.7)		
<b>Unprocessed red meat</b>	334 (308, 361)	326 (303, 349)	331 (311, 352)	330 (309, 351)	313 (296, 329)	317 (293, 341)	308 (284, 332)	299 (286, 312)	290 (272, 307)	<0.001	−45.0 (−76.0, −13.0)		
Beef	242 (213, 271)	239 (215, 264)	236 (218, 254)	248 (232, 263)	225 (208, 241)	226 (202, 249)	208 (189, 226)	192 (181, 204)	170 (153, 188)	<0.001	−72.0 (−105, −39.0)		
Pork	67.3 (55.1, 79.5)	60.9 (49.8, 72.0)	62.3 (54.6, 70.0)	53.0 (45.8, 60.2)	55.5 (47.7, 63.4)	65.1 (56.2, 73.9)	52.1 (44.7, 59.5)	60.1 (52.6, 67.7)	60.1 (50.0, 70.3)	0.36	−7.10 (−22.3, 8.00)		
Other <sup>c</sup>	5.93 (2.35, 9.51)	8.35 (3.16, 13.6)	11.7 (7.0, 16.4)	6.81 (3.31, 10.3)	8.98 (5.16, 12.8)	8.44 (5.85, 11.0)	7.84 (4.03, 11.6)	6.33 (3.19, 9.47)	8.60 (4.45, 12.8)	0.85	2.70 (−2.60, 8.00)		
Unspecified	18.6 (13.5, 23.8)	17.5 (13.9, 21.2)	21.2 (17.2, 25.3)	22.4 (18.3, 26.4)	23.3 (20.5, 26.1)	17.7 (14.2, 21.2)	40.4 (33.6, 47.3)	40.3 (36.2, 44.4)	50.4 (43.5, 57.3)	<0.001	32.0 (23.0, 40.0)		
<b>Poultry</b>	284 (261, 307)	274 (255, 292)	295 (278, 312)	306 (281, 331)	322 (303, 342)	322 (296, 348)	295 (274, 316)	318 (301, 335)	323 (299, 348)	<0.001	39.0 (6.0, 72.0)		
Chicken	223 (202, 243)	196 (182, 210)	218 (202, 235)	227 (204, 250)	227 (215, 240)	235 (215, 254)	215 (198, 232)	229 (216, 242)	249 (230, 268)	0.002	26.0 (−1.0, 54.0)		
Turkey	22.4 (15.4, 29.4)	16.0 (9.9, 22.1)	24.7 (15.7, 33.7)	18.6 (12.3, 24.8)	25.0 (19.1, 30.9)	22.3 (16.2, 28.4)	13.2 (9.5, 16.9)	22.1 (14.0, 30.1)	17.7 (12.3, 23.2)	0.47	−4.70 (−13.3, 3.90)		
Other <sup>c</sup>	0.38 (−0.15, 0.91)	2.83 (0.39, 5.28)	0.63 (−0.07, 1.33)	1.15 (−0.16, 2.46)	1.32 (0.33, 2.30)	0.57 (0.01, 1.12)	0.99 (0.26, 1.73)	0.78 (−0.09, 1.64)	0.80 (−0.02, 1.62)	0.26	0.40 (−0.10, 1.00)		
Unspecified	38.4 (30.8, 46.1)	58.7 (45.0, 72.4)	51.2 (40.9, 61.5)	59.5 (51.7, 67.3)	68.7 (59.6, 77.8)	64.7 (55.6, 73.8)	66.0 (57.6, 74.4)	66.1 (58.0, 74.3)	55.9 (46.8, 65.1)	0.002	18.0 (6.0, 29.0)		
<b>Fish/shellfish</b>	143 (126, 160)	133 (116, 151)	142 (121, 162)	149 (129, 169)	140 (125, 155)	151 (134, 169)	148 (127, 168)	154 (129, 180)	136 (118, 155)	0.49	−6.70 (−30.3, 16.9)		
Low ω-3	106 (91, 121)	102 (89, 115)	109 (93, 124)	118 (100, 135)	104 (91, 116)	118 (103, 133)	116 (99, 133)	116 (91, 140)	102 (86, 118)	0.56	−3.80 (−23.6, 16.0)		
High ω-3	37.2 (27.7, 46.7)	31.4 (22.6, 40.2)	32.9 (23.8, 42.1)	30.9 (23.6, 38.2)	36.1 (30.7, 41.4)	33.6 (28.3, 38.9)	31.7 (24.8, 38.6)	38.6 (33.2, 44.1)	34.3 (26.8, 41.9)	0.67	−2.90 (−15.7, 10.0)		

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey

<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for age, sex, race/ethnicity, education, income and survey weights, and for total energy intake to 2000 kcal/d using the residual method.

<sup>c</sup>Examples of other red meats include game, lamb, goat, veal, and deer; and examples of poultry include duck, goose, ostrich, quail, and pheasant.



Table 7 online only.

Trends in Processed Meat Consumption among Age, Sex, Race/Ethnicity, Education, and Income Subgroups of US Adults Aged 20 Years or Older, NHANES 1999–2016<sup>a</sup>

Age group, years	Weighted Mean Intake, g/wk (95% CI) <sup>b</sup>										P-Trend	Mean Change from 1999–2000 to 2015–2016 (95% CI) <sup>b</sup>
	1999–2000 (n=4237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4801)	2013–2014 (n=5047)	2015–2016 (n=5147)	P-interaction		
20–34	195 (162, 224)	202 (165, 240)	198 (169, 228)	186 (163, 209)	195 (178, 211)	200 (173, 227)	195 (174, 215)	194 (174, 213)	187 (163, 211)	0.67	-6.04 (-45.2, 33.0)	
35–49	192 (160, 224)	186 (170, 203)	190 (174, 206)	217 (184, 249)	204 (174, 234)	198 (170, 226)	203 (191, 215)	189 (158, 220)	191 (165, 218)	0.86	-0.37 (-41.8, 41.1)	
50–64	164 (134, 194)	177 (152, 203)	211 (175, 248)	188 (166, 210)	182 (169, 195)	188 (160, 216)	182 (154, 210)	194 (166, 222)	189 (174, 205)	0.46	25.3 (-8.1, 58.8)	
65	170 (148, 192)	174 (153, 194)	170 (155, 184)	188 (166, 211)	169 (150, 188)	179 (165, 193)	166 (147, 184)	173 (152, 194)	177 (156, 198)	0.90	7.31 (-23.2, 37.8)	
									P-interaction	0.86	0.31	
<b>Sex</b>												
Male	226 (193, 258)	225 (208, 238)	239 (213, 265)	247 (224, 271)	233 (212, 255)	236 (217, 254)	228 (207, 248)	231 (206, 255)	226 (207, 244)	0.86	0.06 (-37.0, 37.1)	
Female	143 (125, 161)	155 (142, 164)	152 (140, 165)	149 (130, 168)	152 (141, 162)	153 (142, 163)	151 (136, 166)	149 (137, 161)	150 (143, 157)	0.76	7.65 (-11.8, 27.1)	
									P-interaction	0.74	0.69	
<b>Race/Ethnicity</b>												
Non-Hispanic White	197 (171, 223)	200 (188, 213)	203 (183, 222)	206 (185, 227)	196 (179, 213)	205 (194, 217)	199 (177, 222)	205 (188, 222)	210 (195, 226)	0.42	13.4 (-16.9, 43.7)	
Non-Hispanic Black	177 (152, 201)	191 (162, 221)	217 (185, 248)	213 (187, 240)	219 (194, 245)	206 (173, 240)	211 (197, 226)	193 (171, 215)	167 (148, 187)	0.42	-9.23 (-40.8, 22.3)	
Hispanic	144 (106, 182)	127 (99, 155)	131 (105, 157)	141 (105, 176)	151 (131, 172)	144 (133, 155)	152 (126, 178)	144 (126, 162)	135 (118, 153)	0.66	-9.05 (-50.8, 32.7)	
Other	98.4 (60.4, 136)	111 (71, 150)	152 (78, 227)	132 (108, 155)	140 (94, 187)	137 (113, 162)	125 (99, 151)	130 (101, 159)	130 (95, 165)	0.60	31.9 (-19.8, 83.5)	
									P-interaction	0.64	0.41	
<b>Education level</b>												
<High school graduate	173 (149, 197)	197 (161, 232)	165 (141, 190)	195 (164, 226)	185 (156, 213)	183 (160, 207)	177 (151, 203)	163 (143, 182)	174 (147, 202)	0.48	1.32 (-35.1, 37.8)	
High school graduate or GED <sup>c</sup>	220 (173, 268)	193 (164, 222)	219 (197, 241)	206 (181, 231)	200 (178, 221)	216 (187, 246)	197 (173, 220)	200 (164, 235)	188 (171, 205)	0.28	-32.2 (-82.8, 18.3)	
Some college	179 (151, 207)	186 (157, 215)	198 (179, 216)	191 (160, 223)	202 (182, 223)	206 (187, 225)	198 (176, 219)	204 (179, 229)	201 (183, 219)	0.12	21.6 (-11.7, 55.0)	
College graduate or above	150 (117, 183)	173 (150, 197)	182 (158, 206)	193 (163, 223)	168 (142, 195)	165 (147, 183)	179 (155, 204)	176 (158, 194)	176 (162, 190)	0.54	26.0 (-10.2, 62.2)	
									P-interaction	0.16	0.07	
<b>Ratio of family income to poverty level<sup>d</sup></b>												
<1.30	163 (139, 188)	174 (155, 193)	173 (154, 192)	174 (151, 196)	187 (165, 208)	196 (175, 216)	182 (166, 198)	186 (165, 208)	174 (146, 202)	0.22	10.5 (-27.1, 48.2)	
1.30–1.849	197 (163, 231)	171 (135, 206)	181 (159, 203)	223 (172, 274)	171 (140, 202)	191 (154, 228)	203 (168, 239)	163 (130, 196)	178 (150, 206)	0.50	-19.0 (-62.9, 24.8)	
1.85–2.99	225 (175, 275)	187 (158, 216)	188 (161, 215)	199 (173, 226)	197 (166, 229)	208 (185, 231)	190 (167, 213)	199 (149, 249)	197 (167, 226)	0.78	-28.0 (-86.1, 30.2)	
3.00	168 (148, 189)	201 (181, 222)	204 (184, 224)	202 (180, 223)	195 (171, 219)	193 (178, 208)	189 (168, 209)	193 (180, 206)	193 (172, 213)	0.88	24.6 (-4.3, 53.6)	
									P-interaction	0.48	0.14	

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey

<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for survey weights, and for total energy intake to 2000 kcal/d using the residual method.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

<sup>c</sup> GED = general equivalency diploma

<sup>d</sup> Represents the ratio of family income, the federal poverty threshold, adjusting for household size. For reference, the federal threshold in 2014 for a family of 4 was \$23,850/y. A family of 4 earning \$44,123/y would have a ratio of 1.85. A ratio < 1.30 indicates a lower level of income and a ratio > 3 indicates a higher level of income

Table 8 online only.

Trends in Unprocessed Red Meat Consumption among Age, Sex, Race/Ethnicity, Education, and Income Subgroups of US Adults Aged 20 Years or Older, NHANES 1999–2016<sup>a</sup>

Age group, years	Weighted Mean Intake, g/wk (95% CI) <sup>b</sup>										P-Trend	Mean Change from 1999–2000 to 2015–2016 (95% CI) <sup>b</sup>
	1999–2000 (n=4237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4801)	2013–2014 (n=5047)	2015–2016 (n=5147)	P-interaction		
20–34	343 (307, 380)	333 (285, 381)	339 (307, 371)	376 (338, 414)	322 (294, 351)	306 (287, 325)	316 (283, 350)	303 (275, 332)	267 (244, 289)	<0.001	-76.8 (-119, -34.2)	
35–49	365 (318, 412)	350 (318, 382)	340 (306, 375)	317 (281, 352)	344 (319, 370)	334 (303, 365)	309 (275, 342)	309 (281, 338)	287 (255, 318)	<0.001	-78.5 (-135, -21.9)	
50–64	341 (276, 407)	328 (294, 362)	340 (308, 372)	338 (310, 366)	299 (261, 337)	313 (275, 350)	308 (262, 353)	284 (259, 309)	309 (279, 339)	0.03	-32.0 (-104, 40.2)	
65	292 (272, 311)	259 (236, 283)	294 (263, 325)	272 (256, 288)	263 (232, 293)	297 (245, 348)	286 (250, 322)	284 (248, 320)	271 (231, 311)	0.97	-20.7 (-65.3, 23.9)	
<b>Sex</b>									P-interaction	0.03	0.20	
Male	395 (364, 426)	397 (369, 425)	383 (359, 407)	396 (371, 422)	379 (353, 406)	374 (348, 399)	372 (345, 399)	355 (336, 374)	343 (311, 374)	<0.001	-52.4 (-96.8, -7.9)	
Female	290 (264, 317)	258 (226, 291)	284 (253, 314)	269 (249, 289)	254 (235, 272)	259 (234, 284)	244 (216, 273)	240 (228, 253)	229 (207, 251)	<0.001	-61.2 (-95.7, -26.8)	
<b>Race/Ethnicity</b>									P-interaction	1.00	0.71	
Non-Hispanic White	332 (302, 362)	314 (283, 344)	326 (303, 349)	326 (306, 346)	314 (289, 340)	312 (283, 341)	299 (269, 330)	292 (282, 301)	272 (246, 298)	<0.001	-60.0 (-99.9, -20.0)	
Non-Hispanic Black	345 (295, 395)	301 (266, 336)	322 (285, 360)	283 (244, 322)	283 (253, 313)	296 (275, 318)	282 (246, 318)	284 (265, 303)	266 (233, 299)	0.004	-79.1 (-139, -19.2)	
Hispanic	364 (326, 403)	390 (320, 460)	399 (356, 441)	376 (328, 424)	344 (310, 377)	328 (294, 362)	366 (318, 414)	330 (294, 365)	328 (300, 357)	0.01	-36.1 (-84.1, 11.8)	
Other	381 (279, 483)	395 (229, 561)	289 (244, 334)	393 (274, 511)	285 (203, 367)	337 (252, 423)	297 (256, 338)	286 (257, 316)	313 (272, 354)	0.07	-67.8 (-178, 42.0)	
<b>Education level</b>									P-interaction	0.94	0.49	
<High school graduate	362 (321, 404)	370 (335, 405)	341 (294, 388)	355 (313, 398)	331 (301, 361)	335 (304, 366)	342 (294, 389)	324 (303, 345)	303 (247, 360)	0.02	-58.7 (-129, 11.3)	
High school graduate or GED <sup>c</sup>	358 (315, 401)	346 (308, 384)	368 (328, 408)	345 (314, 375)	345 (314, 376)	369 (335, 402)	338 (301, 376)	338 (296, 380)	306 (273, 340)	0.08	-51.3 (-106, 2.9)	
Some college	341 (308, 374)	293 (261, 324)	333 (302, 364)	329 (301, 357)	292 (270, 314)	324 (300, 349)	300 (262, 338)	281 (258, 305)	288 (266, 310)	0.005	-53.3 (-93.0, -13.7)	
College graduate or above	292 (241, 344)	310 (262, 357)	282 (249, 315)	301 (272, 331)	290 (257, 322)	242 (209, 275)	274 (236, 313)	266 (242, 290)	256 (227, 285)	0.02	-36.5 (-95.3, 22.4)	
<b>Ratio of family income to poverty level<sup>d</sup></b>									P-interaction	0.94	0.94	
<1.30	327 (285, 370)	361 (310, 413)	305 (273, 336)	364 (330, 398)	309 (283, 335)	324 (310, 339)	324 (284, 365)	290 (266, 313)	280 (253, 306)	0.005	-47.3 (-97.4, 2.7)	
1.30–1.849	277 (243, 311)	276 (229, 322)	361 (308, 413)	334 (290, 377)	295 (243, 348)	335 (303, 367)	293 (263, 323)	289 (250, 328)	295 (257, 333)	0.84	17.7 (-33.4, 68.7)	
1.85–2.99	356 (317, 395)	348 (301, 395)	337 (307, 367)	332 (280, 384)	320 (267, 372)	359 (315, 402)	306 (268, 343)	314 (279, 349)	296 (256, 336)	0.02	-59.8 (-116, -3.9)	
3.00	350 (309, 390)	313 (276, 349)	334 (305, 364)	314 (285, 344)	315 (298, 332)	291 (260, 323)	295 (261, 329)	294 (275, 312)	278 (252, 305)	<0.001	-71.1 (-119, -22.8)	

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey

<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for survey weights, and for total energy intake to 2000 kcal/d using the residual method.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

<sup>c</sup> GED = general equivalency diploma

<sup>d</sup> Represents the ratio of family income, the federal poverty threshold, adjusting for household size. For reference, the federal threshold in 2014 for a family of 4 was \$23,850/y. A family of 4 earning \$44,123/y would have a ratio of 1.85. A ratio < 1.30 indicates a lower level of income and a ratio > 3 indicates a higher level of income

Table 9 online only.

Trends in Poultry Consumption among Age, Sex, Race/Ethnicity, Education, and Income Subgroups of US Adults Aged 20 Years or Older, NHANES 1999–2016 <sup>a</sup>

Age group, years	Weighted Mean Intake, g/wk (95% CI) <sup>b</sup>										P-Trend	Mean Change from 1999–2000 to 2015–2016 (95% CI) <sup>b</sup>
	1999–2000 (n=4237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4801)	2013–2014 (n=5047)	2015–2016 (n=5147)	P-interaction		
20–34	270 (233, 306)	268 (237, 298)	325 (271, 380)	302 (265, 339)	313 (281, 345)	342 (319, 365)	310 (281, 339)	353 (309, 397)	380 (334, 426)	<0.001	110 (51.5, 169)	
35–49	261 (232, 289)	279 (242, 316)	265 (232, 298)	327 (291, 363)	309 (279, 339)	302 (262, 341)	304 (271, 336)	317 (296, 337)	323 (288, 358)	0.002	62.3 (17.2, 107)	
50–64	265 (220, 309)	216 (172, 260)	260 (243, 276)	261 (226, 297)	314 (277, 350)	298 (259, 336)	251 (216, 287)	292 (263, 320)	254 (221, 287)	0.21	-10.3 (-66.0, 45.3)	
65	215 (179, 250)	217 (187, 248)	199 (170, 227)	201 (175, 227)	233 (206, 260)	225 (199, 250)	231 (197, 265)	219 (197, 240)	239 (198, 279)	0.15	23.7 (-30.1, 77.5)	
										0.02	0.01	
<b>Sex</b>												
Male	275 (241, 310)	267 (235, 299)	283 (250, 315)	294 (268, 320)	317 (288, 347)	330 (299, 361)	302 (264, 340)	328 (299, 358)	327 (289, 364)	<0.001	51.2 (0.4, 102)	
Female	238 (214, 262)	237 (213, 261)	258 (235, 280)	270 (241, 298)	282 (260, 305)	269 (241, 297)	255 (243, 267)	276 (258, 295)	281 (255, 307)	0.003	43.0 (7.6, 78.3)	
										0.19	0.75	
<b>Race/Ethnicity</b>												
Non-Hispanic White	230 (204, 255)	231 (209, 254)	245 (215, 275)	259 (235, 283)	281 (256, 305)	270 (245, 295)	243 (223, 263)	270 (249, 291)	269 (233, 304)	0.01	38.8 (-5.0, 82.5)	
Non-Hispanic Black	375 (305, 445)	372 (317, 427)	378 (342, 414)	389 (338, 440)	386 (351, 420)	402 (365, 440)	406 (381, 430)	391 (361, 421)	422 (381, 463)	0.10	47.3 (-34.1, 129)	
Hispanic	279 (247, 312)	282 (217, 347)	287 (252, 322)	320 (287, 354)	312 (287, 337)	343 (295, 391)	332 (283, 381)	352 (306, 398)	351 (318, 383)	<0.001	71.3 (25.3, 117)	
Other	298 (180, 417)	205 (135, 275)	356 (257, 454)	278 (204, 352)	321 (229, 413)	323 (239, 406)	290 (248, 333)	338 (270, 406)	323 (285, 361)	0.20	25.3 (-99.1, 150)	
										0.41	0.65	
<b>Education level</b>												
<High school graduate	252 (219, 285)	233 (188, 277)	256 (219, 294)	280 (242, 317)	260 (232, 289)	292 (260, 324)	274 (239, 309)	303 (259, 346)	299 (266, 332)	0.003	47.2 (0.8, 93.5)	
High school graduate or GED <sup>c</sup>	237 (194, 280)	230 (201, 260)	230 (206, 255)	262 (236, 287)	297 (256, 337)	280 (238, 322)	287 (243, 331)	292 (262, 321)	300 (250, 351)	<0.001	63.3 (-2.6, 129)	
Some college	261 (206, 316)	255 (213, 298)	277 (237, 317)	287 (254, 320)	301 (272, 331)	300 (272, 329)	279 (251, 307)	308 (283, 333)	298 (260, 336)	0.05	36.8 (-29.8, 103)	
College graduate or above	280 (250, 309)	279 (229, 328)	315 (282, 349)	295 (253, 338)	329 (291, 368)	316 (267, 365)	273 (246, 300)	302 (283, 321)	312 (280, 344)	0.40	32.2 (-10.9, 75.3)	
										0.047	0.77	
<b>Ratio of family income to poverty level <sup>d</sup></b>												
<1.30	243 (189, 297)	248 (225, 271)	242 (204, 280)	292 (247, 336)	273 (244, 301)	294 (259, 328)	285 (261, 308)	315 (280, 351)	322 (284, 360)	<0.001	78.7 (12.7, 145)	
1.30–1.849	308 (228, 388)	247 (182, 313)	267 (231, 303)	262 (221, 302)	294 (244, 343)	280 (224, 335)	297 (258, 336)	276 (220, 333)	245 (209, 282)	0.68	-62.5 (-150, 25.4)	
1.85–2.99	224 (185, 262)	205 (165, 245)	262 (219, 304)	255 (206, 304)	280 (239, 320)	269 (230, 307)	240 (194, 286)	308 (275, 342)	286 (250, 321)	0.001	62.2 (9.7, 115)	
3.00	266 (233, 299)	265 (232, 298)	286 (261, 310)	293 (270, 316)	317 (280, 355)	317 (275, 359)	278 (248, 308)	290 (271, 308)	315 (275, 355)	0.04	48.8 (-3.1, 101)	
										0.03	0.03	

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey

<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for survey weights, and for total energy intake to 2000 kcal/d using the residual method.

<sup>c</sup>GED = general equivalency diploma

<sup>d</sup>Represents the ratio of family income, the federal poverty threshold, adjusting for household size. For reference, the federal threshold in 2014 for a family of 4 was \$23,850/y. A family of 4 earning \$44,123/y would have a ratio of 1.85. A ratio < 1.30 indicates a lower level of income and a ratio > 3 indicates a higher level of income

Trends in Fish/Shellfish Consumption among Age, Sex, Race/Ethnicity, Education, and Income Subgroups of US Adults Aged 20 Years or Older, NHANES 1999–2016 <sup>a</sup>

**Table 10 online only.**

Age group, years	Weighted Mean Intake, g/wk (95% CI)										P-Trend	Mean Change from 1999–2000 to 2015–2016 (95% CI) <sup>b</sup>
	1999–2000 (n=4237)	2001–2002 (n=4744)	2003–2004 (n=4448)	2005–2006 (n=4520)	2007–2008 (n=5419)	2009–2010 (n=5762)	2011–2012 (n=4801)	2013–2014 (n=5047)	2015–2016 (n=5147)	P-interaction		
20–34	109 (82, 135)	76.4 (53.5, 99.2)	97.9 (71.7, 124)	84.5 (59.5, 109)	105 (84, 127)	102 (82, 122)	110 (87, 133)	101 (67, 136)	102 (81, 123)	0.35	-6.62 (-40.2, 27.0)	
35–49	113 (75, 152)	114 (84, 143)	120 (95, 145)	141 (108, 174)	96.3 (83.4, 109)	139 (104, 174)	133 (110, 157)	143 (113, 173)	141 (102, 180)	0.10	27.8 (-27.1, 82.7)	
50–64	134 (99, 170)	128 (99, 158)	112 (79, 144)	153 (114, 193)	141 (112, 169)	133 (108, 158)	126 (97, 156)	154 (112, 197)	123 (87, 159)	0.78	-11.3 (-62.0, 39.5)	
65	104 (89, 119)	116 (100, 131)	133 (115, 152)	118 (94, 142)	108 (92, 124)	137 (111, 164)	145 (120, 170)	132 (106, 158)	96.7 (77.3, 116)	0.70	-7.10 (-31.8, 17.6)	
										0.57	0.67	
<b>Sex</b>												
Male	134 (114, 153)	107 (90, 124)	130 (105, 154)	125 (109, 141)	131 (115, 148)	130 (109, 150)	135 (114, 157)	137 (107, 167)	113 (82, 143)	0.81	-21.1 (-57.5, 15.3)	
Female	97.1 (76.1, 118)	107 (87, 127)	99.3 (82.6, 116)	123 (96, 151)	95.1 (80.0, 110)	124 (106, 142)	119 (97, 141)	128 (103, 153)	119 (103, 136)	0.02	22.4 (-4.0, 48.8)	
										0.09	0.04	
<b>Race/Ethnicity</b>												
Non-Hispanic White	105 (87, 124)	102 (81, 124)	97.9 (80.2, 116)	118 (98, 139)	101 (89, 113)	118 (97, 139)	107 (84, 129)	115 (91, 140)	95.4 (73.7, 117)	0.86	-10.0 (-38.8, 18.7)	
Non-Hispanic Black	184 (128, 240)	147 (121, 172)	147 (104, 190)	132 (104, 160)	121 (98, 145)	138 (108, 167)	166 (119, 213)	206 (145, 267)	160 (134, 185)	0.38	-24.4 (-85.8, 37.0)	
Hispanic	78.8 (59.2, 98.3)	67.6 (41.4, 93.7)	114 (85, 143)	119 (73, 165)	116 (96, 136)	134 (101, 167)	140 (109, 172)	114 (91, 137)	130 (103, 157)	<0.001	50.9 (17.7, 84.1)	
Other	206 (61, 351)	205 (126, 285)	273 (156, 391)	198 (141, 256)	224 (145, 302)	195 (155, 234)	218 (184, 252)	201 (169, 232)	185 (142, 227)	0.40	-21.2 (-172, 130)	
										0.001	0.001	
<b>Education level</b>												
<High school graduate	115 (87, 143)	109 (82, 136)	124 (88, 160)	93.6 (70.7, 117)	94.2 (73.4, 115)	127 (98, 156)	141 (102, 180)	114 (73, 156)	119 (91, 148)	0.44	3.72 (-36.2, 43.6)	
High school graduate or GED	94.2 (73.5, 115)	94.8 (75.6, 114)	89.9 (76.0, 104)	118 (89, 147)	104 (82, 126)	99.3 (79.1, 119)	88.9 (59.2, 118)	124 (85, 164)	107 (94, 120)	0.17	13.2 (-11.3, 37.6)	
Some college	117 (84, 149)	85.3 (69.6, 101)	117 (91, 143)	124 (106, 142)	115 (94, 136)	122 (92, 151)	130 (98, 162)	131 (96, 167)	116 (81, 152)	0.20	-0.32 (-48.5, 47.8)	
College graduate or above	137 (92, 183)	141 (96, 186)	128 (107, 148)	150 (114, 186)	131 (113, 149)	156 (133, 179)	141 (110, 172)	148 (119, 177)	120 (94, 147)	0.79	-16.9 (-69.3, 35.5)	
										0.67	0.80	
<b>Ratio of family income to poverty level</b> <sup>d</sup>												
<1.30	119 (80, 158)	76.0 (57.8, 94.2)	91.0 (74.9, 107)	89.4 (76.0, 102)	102 (86, 118)	115 (99, 131)	117 (98, 137)	106 (81, 132)	119 (95, 144)	0.12	0.53 (-45.4, 46.5)	
1.30–1.849	89.7 (19.7, 159)	93.4 (59.1, 127)	114 (65, 164)	162 (117, 207)	111 (79, 144)	105 (72, 137)	112 (82, 143)	143 (82, 204)	148 (82, 214)	0.16	58.7 (-37.6, 155)	
1.85–2.99	108 (71, 145)	119 (83, 155)	122 (96, 148)	102 (82, 123)	118 (91, 144)	103 (81, 125)	101 (72, 130)	105 (70, 140)	93.4 (67.5, 119)	0.21	-14.7 (-59.7, 30.3)	
3.00	119 (100, 138)	116 (91, 142)	121 (96, 146)	136 (105, 167)	117 (101, 133)	145 (116, 174)	143 (112, 174)	154 (129, 178)	117 (87, 147)	0.15	-2.47 (-37.7, 32.7)	
										0.09	0.63	

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

<sup>a</sup>NHANES = National Health and Nutrition Examination Survey

<sup>b</sup>CI = confidence interval. Means, mean changes and 95% CIs were adjusted for survey weights, and for total energy intake to 2000 kcal/d using the residual method.

<sup>c</sup>GED = general equivalency diploma

<sup>d</sup>Represents the ratio of family income, the federal poverty threshold, adjusting for household size. For reference, the federal threshold in 2014 for a family of 4 was \$23,850/y. A family of 4 earning \$44,123/y would have a ratio of 1.85. A ratio < 1.30 indicates a lower level of income and a ratio > 3 indicates a higher level of income