



# Sandwiches Are Major Contributors of Sodium in the Diets of American Adults: Results from What We Eat in America, National Health and Nutrition Examination Survey 2009-2010



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## ABSTRACT

Efforts to sharpen the focus of sodium reduction strategies include identification of major food group contributors of sodium intake. Although sandwiches are a staple of the American diet, previous examinations of their contribution to sodium intake captured only a small subset of sandwiches. One day of dietary intake data from 5,762 adults aged 20 years and older in What We Eat in America, National Health and Nutrition Examination Survey 2009-2010 was analyzed. Sandwiches were defined in a manner that more accurately reflected their frequency of consumption. Two-sided *t* tests were used to compare percentages of men and women reporting sandwiches; contributions of sandwiches to energy and sodium intakes (amounts in kilocalories and milligrams, respectively, and percent of daily totals) by sex; and total energy, total sodium, and sodium density (mg/1,000 kcal) by sandwich reporting status (reporter/nonreporter). On any given day, 49% of American adults ate sandwiches. A significantly higher percentage of men than women reported sandwiches (54% vs 44%, respectively;  $P < 0.001$ ), and sandwiches accounted for higher percentages of men's total energy and sodium intakes. Compared with individuals who did not report a sandwich on the intake day, sandwich reporters had significantly higher energy and sodium intakes; however, sodium density of the diet did not vary by sandwich reporting status. Although much national attention is appropriately focused on reducing sodium in the food supply, consumer choices still play a vital role. Due to sandwiches' frequent consumption and considerable contributions to sodium intake, substituting lower-sodium for higher-sodium ingredients in sandwiches could significantly influence sodium intakes.

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**S**ODIUM INTAKE BY AMERICANS IS CONSIDERABLY higher than national recommendations.<sup>1,2</sup> The Institute of Medicine determined that achieving lower sodium intakes in the US population is a critical public health focus necessitating new government standards for sodium intake, reductions in the sodium content of foods by manufacturers and restaurants, and efforts to support consumers in making behavior changes.<sup>3</sup>

To inform public health efforts by increasing understanding of eating behavior, researchers have identified food categories that make significant contributions to sodium intake of different populations.<sup>4-11</sup> A relatively small number of food categories contribute a large portion of the total daily sodium intake. Two studies using slightly different food groups reported that 10 food categories accounted for 44%<sup>7</sup> and 66%<sup>9</sup> of total sodium intake. Ranked among the top food group contributors to sodium are many common sandwich ingredients—for example, bread, cold cuts, and cheese.<sup>4-11</sup> The few studies that included sandwiches per se as a food

group found them also to be among the top contributors of sodium.<sup>7,9</sup> It is noteworthy that in those studies only foods that were represented by a single food code denoting a sandwich were categorized as sandwiches. Thus, it may be that substantial proportions of the bread, cheese, and cold cuts in those studies were actually consumed as sandwich ingredients.

Several of those studies used dietary data from What We Eat in America (WWEIA), the dietary intake interview component of the National Health and Nutrition Examination Survey (NHANES).<sup>6-8,11</sup> In WWEIA data files, many sandwiches (often fast-food items) are represented by a single food code, such as the code described as “Cheeseburger with tomato and/or catsup, on bun.” These are referred to as “single-code sandwiches.” Other sandwiches are represented in the data by two or more food codes that are linked and identified as a “sandwich combination.” For example, if a respondent reported a tomato sandwich, the food would be represented by several lines of data (eg, bread, tomato,

lettuce, and spread) linked as a sandwich combination. Sandwich combinations are an untapped resource that can enhance our knowledge of the context in which sodium is being consumed.

The objectives of our study were to examine and contrast men and women in terms of sandwich reporting and the contributions to energy and sodium intakes (discrete amounts and percentages of daily totals) from sandwiches, and determine whether sandwich reporting status (reporter/nonreporter) was associated with energy and/or sodium intake or with sodium density (mg/1,000 kcal). To better assess the magnitude of sandwiches' influence on sodium intake, the definition of sandwiches included both sandwich combinations and single-code sandwiches.

## METHODS

### Sample

Estimates were based on 1-day data from 5,762 adults aged 20 years and older (2,973 women and 2,789 men) with a complete 24-hour recall in WWEIA, NHANES 2009-2010,<sup>12</sup> the most recent nationwide dietary intake data available at the time of the study. NHANES used a complex, multistage probability sampling design to select a sample representative of the civilian, non-institutionalized household population of the United States,<sup>13,14</sup> with oversampling of people aged 60 years and older, low-income people, non-Hispanic blacks, and Hispanics to improve the accuracy of related estimates.<sup>13</sup> The survey protocol was reviewed and approved by the National Center for Health Statistics Research Ethics Review Board. Our study was a secondary analysis and was deemed exempt from further review under federal regulation 45 CFR 46.101(b).

### Dietary Intake Data Collection and Coding

Dietary intake data were collected using the US Department of Agriculture (USDA) Automated Multiple-Pass Method for the 24-hour recall (AMPM).<sup>15-17</sup> Recalls were conducted by trained interviewers fluent in English and Spanish.<sup>12</sup> We used the first day of intake data, which was collected in person. Though attempts had been made to schedule interviews uniformly throughout the week, proportionally more intakes occurred on weekend days than on weekdays, resulting in more recall days being Fridays and Saturdays.<sup>12</sup> WWEIA 2009-2010 dietary intake data are available online.<sup>18</sup>

All foods reported in WWEIA, NHANES 2009-2010 were coded using one or more USDA food codes from the USDA Food and Nutrient Database for Dietary Studies (FNDDS; version 5.0, 2012 [updated 2013], USDA). Most foods are assigned a single food code. However, it is not feasible to include in the FNDDS a precise match for every possible permutation of the way people eat foods. For that reason, food codes may be linked in "combinations" to represent foods that are ingredients in a multi-ingredient food, such as bread, egg, cheese, vegetables, and spread in a sandwich.<sup>12,17</sup> Although more than 200 food codes representing sandwiches are available in FNDDS 5.0 (for example, USDA food code 27540350, "Turkey submarine sandwich with cheese, lettuce, tomato, and spread"), most sandwiches are coded as sandwich ingredients linked together in combinations.

The AMPM question sequence for sandwiches asks whether the sandwich was homemade or from a fast-food

restaurant, school cafeteria, or another place. The majority of fast-food sandwiches were coded with a food code that falls into the WWEIA Food Category named "Mixed dishes—sandwiches (single code)."<sup>19</sup> However, it was necessary to code others using multiple food codes linked together to achieve a good match for the nutrient profile of the sandwich. For sandwiches obtained from any place besides a fast-food restaurant, the AMPM asks for full details, including separate amounts, for all components. When the respondent provides this information, each sandwich ingredient is coded with its own food code and amount, a combination food number is assigned to identify that the components were all part of the sandwich, and a value of 5 for the combination food type variable is assigned.<sup>12,17</sup>

### Definition of a Sandwich

In our study, sandwiches were defined as line items from the WWEIA, NHANES Individual Foods File with food codes that fell into the WWEIA Food Category "Mixed dishes—sandwiches (single code)"<sup>19</sup> and/or that were consumed as part of a sandwich combination.

Although this definition did not require that sandwich combinations contain a bread-type item, nearly all (>99%) did. Through a detailed examination of the line items in each combination, we reviewed all sandwich combinations to verify that they appeared similar to the foods included in the WWEIA food category "Mixed dishes—sandwiches (single-code)." We excluded a small number of combinations whose ingredients suggested they would have been more appropriately categorized as tortilla product combinations (combination type 11) based on unpublished internal instructions to food coders (USDA Food Surveys Research Group, February 2009). Ingredients of nonsandwich combinations were also reviewed to determine whether they contained sandwich-type ingredients, and a few such combinations (eg, bratwurst and bread) were included as sandwiches.

### Statistical Analysis

Analyses were carried out using SAS release 9.3 (2011, SAS Institute Inc). SUDAAN release 11.0 (2012, Research Triangle Institute) was used to adjust for survey design effects resulting from NHANES' complex, multistage probability sampling.<sup>13</sup> All analyses used sample weights to produce nationally representative estimates.

All estimates were calculated by age for all adults collectively and for men and women separately.

Descriptive statistics included percentages reporting sandwiches, amounts of energy (kilocalories) and sodium (milligrams) provided by sandwich intake, and percentages of total energy and sodium intake contributed by sandwiches. To detect differences between men and women within age group in percentages reporting, mean intakes, and percentage contributions to total daily intakes of energy and sodium, *t* tests were used.

Total intakes of energy and sodium from all foods and beverages were calculated for sandwich reporters and non-reporters. Linear regression was used to provide estimates adjusted for variables related to dietary intake. Adjustment variables examined were age; race/ethnicity; income as a percentage of poverty<sup>20</sup>; weight status<sup>21</sup>; smoking status (never, former, or current); and physical activity level (<150

**Table 1.** Sandwiches<sup>a</sup>: Percent reporting and contributions to mean daily total intakes of energy and sodium, adults aged 20 years and older, What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2009-2010, 1 day<sup>b</sup>

Sex and age (y)	n <sup>c</sup>	Sandwich reporters %±SE <sup>d</sup>	Energy Contribution of Sandwiches		Sodium Contribution of Sandwiches	
			Kilocalories±SE	% of total energy±SE	Milligrams±SE	% of total sodium±SE
<b>Men</b>						
20-39	905	51±2.7	372±24.1	14±0.8	955±69.9	21±1.5
40-59	951	57±2.7	367±23.7	14±0.8	963±65.3	22±1.3
60+	933	53±2.8	283±17.2	14±0.7	710±41.6	20±1.1
Total 20+	2,789	54±2.0	350±14.3	14±0.5	902±34.4	21±0.7
<b>Women</b>						
20-39	1,023	49±2.8	241±17.5*	13±0.9	595±39.5*	19±1.3
40-59	984	40±2.8*	184±15.7*	10±0.8	446±39.2*	15±1.2*
60+	966	44±2.5*	167±12.8*	10±0.7*	408±28.6*	15±0.9*
Total 20+	2,973	44±2.2*	200±10.6*	11±0.6*	489±27.2*	16±0.9*
<b>All</b>						
20-39	1,928	50±2.1	307±16.1	13±0.7	776±43.4	20±1.2
40-59	1,935	48±2.4	272±16.1	13±0.7	696±44.7	19±1.2
60+	1,899	48±2.4	219±14.2	12±0.7	543±32.6	17±1.0
Total 20+	5,762	49±1.9	272±10.8	13±0.5	688±27.1	19±0.7

<sup>a</sup>Sandwiches were defined as line items from the WWEIA, NHANES Individual Foods File that were assigned food codes that fell into the WWEIA Food Category "Mixed Dishes—sandwiches (single code)"<sup>19</sup> and/or consumed as part of a sandwich combination (indicated by a value of 5 for the "combination food type" variable<sup>12</sup>).

<sup>b</sup>Sample weights designed for dietary analysis were used to produce estimates representative of the US population for the years of collection.

<sup>c</sup>Unweighted.

<sup>d</sup>SE=standard error.

\*Percentage or mean contribution differs significantly from that of men in the same age group ( $P<0.001$ ).

minutes, 150 to 299 minutes, or  $\geq 300$  minutes of moderate activity per week).<sup>22,23</sup> Both unadjusted and adjusted estimates were compared between sandwich reporters and nonreporters (all adults, men, and women by age) with *t* tests. Similarly, sodium density (mg/1,000 kcal) of food/beverage intake was calculated for sandwich reporters and nonreporters. Unadjusted and adjusted estimates were contrasted by sandwich reporting status.

Findings of significance were the same regardless of whether unadjusted or adjusted estimates of energy intake, sodium intake, and sodium density were compared between sandwich reporters and nonreporters, so only unadjusted results are presented.

All *P* values presented apply to two-sided tests. Because multiple comparisons were performed, a significance level of  $P<0.001$  was used in lieu of a Bonferroni-type correction to reduce the chance of a type I error.

## RESULTS AND DISCUSSION

During 2009-2010, only about 20% of all sandwiches were represented by a single food code (data not shown). For that reason, previously published estimates of sandwich contributions to sodium intakes that were based on only single-code sandwiches are considerable underestimates.<sup>7,9</sup>

Nearly half of American adults (49%) ate a sandwich on the intake day (Table 1). A significantly larger percentage of

men aged 20 years and older than of women the same age reported at least one sandwich, reflecting the significant differences seen in the middle-aged (40 to 59 years) and older (60 years and older) groups.

The mean contribution of sandwiches to energy intakes of all adults (ie, sandwich reporters and nonreporters combined) was 350 kcal for men and 200 kcal for women. This is 14% and 11% of total energy intake for men and women, respectively.\*

The mean contribution of sandwiches to men's sodium intake was 902 mg. This is 39% of the 2010 Dietary Guidelines for Americans (DGA) daily limit of 2,300 mg recommended for Americans in general and 60% of the stricter limit for adults older than age 50 years, African Americans, and people with diabetes, hypertension, or chronic kidney disease.<sup>2</sup> Women's intake of sodium from sandwiches (489 mg), although significantly lower than men's, was still considerable. This difference by sex is probably due at least in part to women's lower food intake overall and the lower percentage of women consuming sandwiches. Sandwiches provide 21%

\*Estimates of mean total energy and sodium intake per day by sex and age, race/ethnicity, and income (in dollars and as percent of poverty) are available at <http://www.ars.usda.gov/Services/docs.htm?docid=18349>.

**Table 2.** Mean daily total intakes of energy and sodium by sandwich<sup>a</sup> reporting status, adults aged 20 years and older, What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2009-2010, 1 day<sup>b</sup>

Sex and age (y)	Energy (kcal)		Sodium (mg)	
	Sandwich Reporters	Sandwich Nonreporters	Sandwich Reporters	Sandwich Nonreporters
	←—————mean±standard error of the mean—————→			
<b>Men</b>				
20-39	2,858±57.9	2,490±70.9	4,783±91.8	4,102±111.6*
40-59	2,717±63.2	2,456±75.2	4,724±140.4	4,013±126.4
60+	2,203±38.9	1,926±38.4*	3,817±75.2	3,338±92.0
Total 20+	2,653±36.5	2,347±48.0*	4,541±51.5	3,892±72.1*
<b>Women</b>				
20-39	2,025±34.7	1,764±39.1*	3,305±56.3	2,973±104.5
40-59	1,850±40.1	1,730±40.1	3,186±71.0	2,883±68.1
60+	1,684±43.4	1,580±32.2	2,900±88.9	2,613±44.6
Total 20+	1,875±19.6	1,701±23.0*	3,157±33.2	2,841±46.8*
<b>All</b>				
20-39	2,457±32.4	2,120±46.2*	4,072±58.9	3,526±78.2*
40-59	2,346±39.0	2,020±41.4*	4,066±72.8	3,334±58.0*
60+	1,942±30.0	1,719±31.6*	3,355±65.9	2,905±57.9*
Total 20+	2,290±22.2	1,981±28.5*	3,895±32.5	3,296±36.9*

<sup>a</sup>Sandwiches were defined as line items from the WWEIA, NHANES Individual Foods File that were assigned food codes that fell into the WWEIA Food Category "Mixed Dishes—sandwiches (single code)"<sup>19</sup> and/or consumed as part of a sandwich combination (indicated by a value of 5 for the "combination food type" variable<sup>13</sup>).

<sup>b</sup>Sample weights designed for dietary analysis were used to produce estimates representative of the US population for the years of collection.

\*Within sex and age, intake for sandwich nonreporters differs significantly from that of reporters ( $P<0.001$ ).

of men's and 16% of women's overall sodium intake. These levels are much higher than the 3.9% reported as being contributed by single-code sandwiches.<sup>7</sup>

Mean daily total energy and sodium intake estimates for sandwich reporters and nonreporters appear in Table 2. In the "Total 20+" groups of men, women, and all adults, both energy and sodium intakes were significantly higher for sandwich reporters than for nonreporters. All sex and age groups of both reporters and nonreporters had mean sodium intakes that exceeded the DGA recommendation of 2,300 mg per day. Sodium intake by male sandwich reporters aged 20 years and older was 4,541 mg, nearly twice the 2,300 mg recommendation. The difference in mean daily sodium intake between male sandwich reporters and nonreporters aged 20 years and older was 649 mg. Women's pattern of sodium intake by sandwich reporting status mirrored that of men, but was on a somewhat smaller scale, likely due to their lower overall food intake and lower percentage reporting sandwiches.

The unanticipated finding that sandwich consumption is associated with higher overall intake of energy underscores the importance of making healthful choices of sandwich ingredients. For both male and female sandwich reporters (especially men aged 20 to 59 years), mean energy intake exceeded the estimated calorie needs specified in DGA appendix 6 for people of that age who are sedentary,<sup>2</sup> the activity level applicable to most American adults based

on accelerometer studies.<sup>24,25</sup> Many sandwiches (such as burgers and franks) and common sandwich components (such as yeast breads, cheese, and cured meats) are among the top contributors not only to sodium<sup>2,6,7,9</sup> but also to energy<sup>2,11</sup> in the diets of adult Americans. Reducing not only the sodium content but also the energy content of sandwiches would be beneficial.

Comparisons of sodium density (mg sodium/1,000 kcal energy) between sandwich reporters and nonreporters are presented in Table 3. Regardless of sandwich reporting status, sodium density was approximately 1,700 to 1,800 mg per 1,000 kcal, suggesting that the higher sodium levels of sandwich reporters are explained by their higher energy intake. Other studies have found that sodium intake is positively correlated with energy intake.<sup>3,6</sup> This finding highlights the importance of current efforts to reduce sodium content of the food supply.

It has been shown that typical food choices exceed recommendations not only for sodium, but also for energy, fat, saturated fat, and empty calories.<sup>26</sup> However, Guenther and colleagues<sup>27</sup> have demonstrated that it is possible to choose nutritionally adequate diets at recommended sodium levels, and registered dietitian nutritionists may find their description of how they selected lowest-sodium items useful when determining options for healthier, lower-sodium sandwiches. For example, in creating their "lower-sodium model," they used no-salt-added foods when available, substituted cooked

**Table 3.** Sodium density: Mean intake of sodium (mg) per 1,000 kcal energy intake, by sandwich<sup>a</sup> reporting status, adults aged 20 years and older, What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2009-2010, 1 day<sup>b</sup>

Sex and age (y)	Sodium Density (mg/1,000 kcal)		P value <sup>c</sup>
	Sandwich reporters	Sandwich nonreporters	
← mean ± standard error of the mean →			
<b>Men</b>			
20-39	1,728 ± 28.1	1,679 ± 32.2	0.249
40-59	1,781 ± 48.1	1,662 ± 33.5	0.079
60+	1,763 ± 34.2	1,750 ± 38.5	0.838
Total 20+	1,757 ± 16.5	1,689 ± 24.4	0.018
<b>Women</b>			
20-39	1,683 ± 33.0	1,717 ± 45.4	0.589
40-59	1,775 ± 24.3	1,723 ± 49.2	0.308
60+	1,758 ± 31.3	1,705 ± 22.4	0.237
Total 20+	1,735 ± 19.0	1,716 ± 22.2	0.525
<b>All</b>			
20-39	1,706 ± 21.0	1,698 ± 28.6	0.836
40-59	1,779 ± 25.0	1,698 ± 37.1	0.131
60+	1,760 ± 25.1	1,723 ± 25.8	0.377
Total 20+	1,747 ± 9.1	1,705 ± 18.3	0.041

<sup>a</sup>Sandwiches were defined as line items from the WWEIA, NHANES Individual Foods File that were assigned food codes that fell into the WWEIA Food Category "Mixed Dishes—sandwiches (single code)"<sup>19</sup> and/or consumed as part of a sandwich combination (indicated by a value of 5 for the "combination food type" variable<sup>13</sup>).

<sup>b</sup>Sample weights designed for dietary analysis were used to produce estimates representative of the US population for the years of collection.

<sup>c</sup>A value of  $P < 0.001$  was considered statistically significant.

fresh meats for luncheon meats, and compared sodium levels on Nutrition Facts labels for similar products. Some other changes that could have a substantial positive effect on total dietary intake of sodium by American adults include incorporating foods lower in sodium and calories (such as vegetables) in sandwiches and reducing portion sizes.

WWEIA, NHANES is a large, nationally representative sample, and 1 day of 24-hour dietary recall data may be used to describe the average daily intake of the US population. However, our study does have some limitations. First, underreporting is a recognized problem in self-reported dietary data. To address this issue, the AMPM used in collecting WWEIA data has undergone extensive methodologic testing to enhance food recall and minimize forgotten food items.<sup>17</sup> It is unknown whether sandwiches or sandwich ingredients are underreported to a greater or lesser extent than other foods. Second, sodium intakes were based only on food and beverage (including water) intakes and do not include salt added at the table or sodium from dietary supplements or

antacids. However, these sources account for a very small proportion of total sodium intake—6.2% from salting at the table<sup>28</sup> and 1% or less from supplements, even among supplement users.<sup>29</sup> A third issue concerns how sandwiches were defined. Expanding or restricting what foods or combinations of foods are considered a sandwich would alter all the estimates reported here. For that reason, it is not appropriate to compare the sodium contribution of sandwiches as operationalized in this study to that reported in other studies that analyzed only single-code sandwiches and did not take sandwich combinations into account.<sup>7,9</sup>

## CONCLUSIONS

Sandwiches contribute approximately one fifth of total sodium intake by American adults. For this population, sandwich consumption is associated with higher overall energy and sodium intakes, but not a higher overall sodium density of the diet. Due to the large percentage of individuals who consume sandwiches, registered dietitian nutritionists may find it fruitful to counsel clients on healthful sandwich choices along with attention to portion sizes.

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## STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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