Discontinuation of Data Processing Step: Salt Adjustment on Designated Foods Likely To Be Home Prepared

Rhonda S. Sebastian, Cecilia Wilkinson Enns, Lois C. Steinfeldt, Joseph D. Goldman, and Alanna J. Moshfegh

Abstract

The objective of this report is to describe (a) the basis for and implementation of a data processing step called salt adjustment that was performed on designated foods in United States Department of Agriculture (USDA) dietary intake surveys from 1985 through 2008, (b) the rationale for discontinuing the step, and (c) the impact and implications of its discontinuation. As implemented in What We Eat in America (WWEIA), the dietary intake interview component of the National Health and Nutrition Examination Survey (NHANES), salt adjustment was a post-collection data processing step that was based on the respondent's reply to a question about the use of salt in household cooking or food preparation. It was applied only to foods likely to be home prepared, i.e., foods that (a) generally have salt added during preparation and (b) were obtained from the store. For individuals who reported that salt was used occasionally or less often in cooking or food preparation in their household, salt adjustment removed some or all of the salt attributable to home preparation. Reasons for discontinuing this procedure include secular changes that call into question the appropriateness of using store purchase as a proxy indicator of home food preparation, a decrease in the proportion of food obtained from the store and therefore eligible for salt adjustment, and research indicating that USDA's Automated Multiple-Pass Method (AMPM) for the 24-hour dietary recall provides valid sodium intake estimates without application of the salt adjustment step. WWEIA, NHANES 2007-2008 is the final data release to contain sodium data that were salt adjusted; the step was not applied to WWEIA, NHANES 2009-2010 data and will not be performed in future survey cycles. To provide appropriate baseline estimates for tracking the success of initiatives aimed at lowering sodium intakes, this report includes 2007-2008 sodium intake estimates (mean intakes, percentile distributions of usual intakes, and percentages of the population with intakes above tolerable upper intake levels) calculated both with and without the salt adjustment processing step. In addition, files listing the salt adjustment levels for eligible foods in survey cycles from 2003-2008 are provided for use by analysts.

Introduction

Estimating the sodium intake of the United States population using nationwide dietary data is a complex task. Some factors involved are extrinsic to data collection and processing (e.g., the foods survey respondents eat and their knowledge about the salt in those foods) and others are intrinsic (e.g., the dietary data collection method, the sodium data in national nutrient databases, and the procedures used in calculating the sodium content of dietary intakes).

Dietary sodium comes from several sources. Some sodium is inherent in foods and water, but most sodium is consumed in the form of salt (sodium chloride). The sources of sodium intake in the U.S., in order of predominance, are sodium added in food processing (77 percent), sodium inherent in foods (12 percent), salt added at the table (6 percent), salt added in cooking (5

percent), and sodium inherent in water (less than 1 percent; 1). This report concerns only one of those sources, salt added during cooking or food preparation.

Recently, national attention has focused on strategies to lower sodium intakes (2). Despite long-standing national recommendations to decrease sodium intake in the United States, it remains much higher than recommended, regardless of age, gender, race/ethnicity, or income (2-5). The *Dietary Guidelines for Americans 2010* advise all individuals to reduce daily sodium intake to less than 2,300 mg (4). Further reducing intake to 1,500 mg is recommended for those who are age 51 years and over and those of any age who are African American or have hypertension, diabetes, or chronic kidney disease. The 1,500 mg recommendation applies to about one-half of the U.S. population age 2 years and over, including the majority of adults (6).

What We Eat in America (WWEIA), the dietary component of the National Health and Nutrition Examination Survey (NHANES), provides the data necessary for monitoring progress toward meeting the sodium intake recommendations outlined in the Dietary Guidelines. In 2007-2008, mean daily sodium intake was 3,330 milligrams (mg) for all individuals age 2 years and over (7). The Institute of Medicine used the same data source in assessing intake of sodium in 2003-2006 and recommended that "these surveys should continue to collect estimates of dietary sodium intake by multiple 24-hour recalls" (2).

In 2010, the Institute of Medicine published *Strategies to Reduce Sodium Intake in the United States*, based on the findings of a 14-member committee convened at the request of Congress (2). Fundamental to this report was the agreement that achieving lower sodium intakes is a critical public health focus for all Americans (2). In order to track progress toward reducing sodium intake, accurate population estimates of sodium intake are essential. Both this renewed focus on sodium and marketplace changes to the sodium content of foods have prompted the U.S. Department of Agriculture (USDA) Food Surveys Research Group (FSRG) to review multiple aspects of WWEIA dietary data collection and processing related to sodium intake. Results of that review include findings presented in this report, which led to the decision to discontinue the salt adjustment procedure.

Methods used in WWEIA, NHANES have evolved over time with constant efforts to improve their ability to reflect the food and nutrient intakes of the U.S. population. Salt adjustment in home-prepared foods, a step in the post-collection processing of survey data, is a procedure that has been used for over 25 years as a way of accounting for respondents' reports of using salt only occasionally or less often in home food preparation. A number of considerations have called into question the appropriateness and value of continuing the procedure. These considerations include an increase in the purchase of fully-prepared foods to which the consumer is unlikely to add more salt in cooking and results from a study that suggest that salt adjustment could produce estimates less reflective of actual intake as measured by urinary sodium.

This report describes (a) the basis for and the process of salt adjustment, which has been applied in USDA food surveys since 1985, (b) the rationale for discontinuing it in WWEIA, NHANES 2009-2010 and all subsequent surveys, and (c) the impact and implications of its discontinuation.

Salt adjustment in designated foods likely to be home prepared in WWEIA, NHANES

What is salt adjustment?

In all USDA nationwide food surveys since 1985 and in WWEIA, NHANES 2002 through 2008, during the processing of survey data, the amount of salt in *eligible foods* has been subject to adjustment based on respondents' answers to questions about their use of salt in cooking. Eligible foods are those that (a) are reported as being obtained from the store rather than from any type of restaurant or other location and (b) generally have salt added during cooking/preparation. Eligible foods are discussed in more detail in the next section.

The practice of salt adjustment in USDA food surveys was instituted shortly after the publication in 1980 of the first edition of the *Dietary Guidelines for Americans*. At that time, the Dietary Guidelines advised consumers to "avoid too much sodium" mainly through decreasing the use of salt in cooking and at the table, as well as avoiding excessive amounts of salty foods (8). The idea behind salt adjustment was to "give credit" to survey respondents who reported that their households cooked/prepared foods with salt only occasionally or less often.

Only salt used in food preparation has been part of the salt adjustment process used by FSRG. Although respondents are asked about salt shaker use at the table, they have never been asked to quantify the amount of salt added to their food at the table; there has never been any adjustment during processing of USDA or WWEIA, NHANES intake data based on information about salting at the table; and no change in these practices is currently envisioned for future surveys. Information on the amounts of sodium-containing condiments (e.g., soy sauce, gravy, and catsup) added to food at the table has been collected in the same manner as for food and drinks. It is worth noting that there has never been any adjustment during processing of USDA or WWEIA, NHANES intake data in the direction of adding more salt for respondents whose households use more than the typical amount of salt (nor any question that would serve as a basis for such an adjustment).

In WWEIA, NHANES 2002 through 2008, after the 24-hour recall (24HR), respondents answered a question about the frequency of salt use in food preparation in their household. If a respondent's answer indicated that the household used salt only occasionally or less often, then a portion of the sodium in eligible foods in that respondent's intake was lowered. Only the sodium from salt added during typical home food preparation, or *optional salt*, was lowered.

For each food, the baseline ("no adjustment") level of sodium per 100 grams of food is the same as the level contained in the USDA Food and Nutrient Database for Dietary Studies (FNDDS; 9), which is the database used to code dietary intakes and calculate nutrients for WWEIA, NHANES. The underlying source of food composition data for the FNDDS, including sodium values, is the USDA National Nutrient Database for Standard Reference (10). The use of salt in widely available recipes for a multitude of foods – for example, eggs (11), pasta (12), rice (13), and vegetables cooked from fresh form (14) – is accounted for in FNDDS levels of salt. Table 1 shows the wording of the salt-in-cooking question and the levels of salt adjustment associated with specific responses. All of a respondent's eligible foods had their optional salt adjusted (or not adjusted) according to the answer to this question.

Table 1. Percentages of individuals with specified responses to the question "How often is ordinary salt or seasoned salt added in cooking or preparing foods in your household?" and associated levels of salt adjustment applied to eligible[1] foods, 2007-2008

Response	Percent of individuals	Level of salt adjustment applied to eligible foods
Very often	40	No adjustment (all optional salt included)
Occasionally	37	Half the optional salt removed
Never/rarely	24	All optional salt removed

Source: What We Eat in America, NHANES 2007-2008, all individuals (excluding breastfed children), Day 1 dietary intake data, weighted.
[1]For a discussion of eligible foods, see section headed "Eligibility for salt adjustment in WWEIA, NHANES 2002-2008."

In 2007-2008, 40 percent of respondents reported that salt was used "very often" in household cooking and food preparation; no adjustment was applied to reduce the optional salt content of any of the eligible foods they consumed. Thirty-seven percent of respondents reported that salt was used "occasionally" in household cooking or preparation; half the optional salt was removed from the eligible foods consumed by these individuals. The remaining respondents (24 percent) reported that salt was "rarely" or "never" used in cooking or food preparation in their households; all of the optional salt was removed from the eligible foods consumed by these individuals.

Foods with all the optional salt removed still contain the sodium that is inherent in the other ingredients. It is only the optional salt that is lowered or removed, not the total sodium content of the food. For example, the FNDDS level of sodium in 100 grams of carrots cooked from fresh form is 296 mg. Of that amount of sodium, 58 mg is inherent in the carrots and the remaining 238 mg is from optional salt. For respondents reporting occasional household salt use, the adjustment level with half the optional salt removed is 177 mg of sodium per 100 grams of carrots (i.e., the 58 mg sodium inherent in the carrots + 238/2 = 119 mg sodium from optional salt). The sodium level for respondents whose households rarely or never use salt in cooking is 58 mg per 100 grams (i.e., only the amount of sodium that is inherent in the carrots).

Eligibility for salt adjustment in WWEIA, NHANES 2002-2008

Criteria for applying the process of salt adjustment include the food being (a) likely to be home prepared rather than processed or restaurant prepared and (b) of a type to which salt is commonly added in home preparation.

Salt adjustment is based on the assumption that when food is cooked at home, the cook or meal preparer controls the amount of salt added to the food, whereas someone outside the household controls the amount of salt in processed and restaurant foods. For that reason, only foods that were likely to have been home prepared were eligible for salt adjustment. In WWEIA, NHANES 2002-2008, only limited information was available to determine whether a food was likely to have been cooked/prepared at home or not. Obtaining an item *from a store* rather than from any other venue (including restaurants, fast food places, cafeterias, and other places) was used as a proxy indicator of probable home preparation.

Additionally, salt levels were only adjusted in specified types of food. Certain types of food are likely to have salt added during home preparation, but others are not. In general, foods likely to have been purchased in ready-to-eat form are not eligible for salt adjustment, but those likely to have been cooked after purchasing are eligible. For example, canned vegetables are not eligible for salt adjustment, but most fresh and frozen vegetables are eligible. Foods described in the FNDDS as salt free, low sodium, or reduced sodium are not eligible for salt adjustment during post-collection data processing. The FNDDS 4.1 (9) includes approximately 150 such food codes.

Over the years, as the food market has changed, there have been some differences in the specific foods eligible for salt adjustment, but the general categories of foods that are eligible have remained the same. On the whole, the types of food considered likely to have salt added in home preparation are cooked cereals, rice, and pasta; eggs; potatoes, dry beans, and other vegetables; meat, poultry, and fish; and home-made mixed dishes, casseroles, stews, and soups. On the other hand, some examples of categories that are never eligible for salt adjustment include beverages, fruits, cheese, baby food, salad dressings, and candy. It is worth noting that among the ineligible foods are not only items that are low in salt or sodium (such as beverages and fruits), but also items that are high in salt or sodium (such as cheese and salad dressings).

A brief chronology of salt adjustment in USDA surveys

The specifics of salt adjustment have varied from survey to survey, as illustrated briefly in table 2. Notable developments in selected surveys are described in subsequent sections.

Table 2. Process used by USDA to adjust optional salt in eligible foods: Selected U.S. nationwide food surveys conducted in 1985-1986; 1994-1996, 1998; and 2002-2008

Years	Survey name/ acronym	Informant	Salt question and placement	Salt adjustment level(s)	Foods to which salt adjustment was applied
1985-1986	Continuing Survey of Food Intakes by Individuals (CSFII)	Main meal planner-preparer	*Placement:* During the 24-hour recall (24HR): For each eating occasion with any food from the home food supply[1] *Question:* "Did you use salt or a salt substitute in preparing any of these items? During preparation, which foods/drinks did you use salt in and which ones did you use a salt substitute in?"	If no salt in cooking, removed all optional salt	Only foods from the home food supply[1] that were specifically identified as being prepared without salt or with salt substitute
1994-1996, 1998	CSFII	Each respondent[2]	*Placement:* During the 24HR: Question included in the Food Instruction Booklet for specific categories of foods *Question:* "Was salt used in cooking or preparing the (FOOD)?" Answer options were "don't know," "no salt," and "salt used."[3]	If no salt in cooking, removed all optional salt	Only foods specifically identified as being prepared without salt, regardless of whether they were from the home food supply or not
2002-2008	What We Eat in America (WWEIA), NHANES	Each respondent[2]	*Placement:* After the 24HR *Question:* "How often is ordinary salt or seasoned salt added in cooking or preparing foods in your household? Is it never, rarely, occasionally, or very often?"	If rarely or never, removed all optional salt; if occasionally, removed half the optional salt	Only foods purchased from the store and likely to be cooked at home

[1]Foods and beverages from the home food supply are items which were either eaten at home or brought into the home but later eaten away from home.
[2]Interviews were conducted for survey participants less than six years of age with a proxy who was generally the person most knowledgeable about the survey participant's intake. Child respondents ages 6 to 11 years were asked to provide their own food intake data assisted by an adult familiar with the child's intake.
[3]In NHANES 1999-2000, a similar question was asked with similar response options (15), and CSFII sodium data were used to modify sodium values when respondents specified that they did not use salt in preparation (16). In 2001, before the full integration of WWEIA, NHANES, the method remained the same as in NHANES 1999-2000.

1985: Salt adjustment applied to intakes of main meal-planners/preparers only

It is important for readers to be aware of the aspects of salt adjustment outlined in this and the two other survey-specific sections that follow, because several of the reasons for discontinuing salt adjustment involve considerations described in these sections.

The Continuing Survey of Food Intakes by Individuals (CSFII) 1985 was the first USDA survey to report on dietary sodium intakes of the U.S. population. Respondents were asked to report foods and drinks they consumed sequentially through the day. Each distinct time of eating and/or drinking was considered to be an "eating/drinking occasion." For each item within each occasion, the respondent was asked whether it was "eaten at your home, brought into your home but later eaten away from home, or never brought into your home." If the respondent said the item was eaten at home or brought into the home but eaten away from home, then that item was considered to be from the home food supply.

In each household, a main meal-planner/preparer (i.e., the person most responsible for planning and preparing the household's meals) was identified. If, for a given eating/drinking occasion, a main meal-planner/preparer had any foods/drinks identified as being from the home food supply, the respondent was asked, "Did you use salt or a salt substitute in preparing any of these items?" If the answer was yes, an additional question was asked: "During preparation, which foods/drinks did you use salt in and which ones did you use a salt substitute in? I have listed (FOODS/DRINKS identified as being from the home food supply)." Items prepared without salt or with a salt substitute had all their optional salt removed before their nutrient contributions were calculated. Household members other than the main meal-planner/preparer were not asked about salt in preparation, so the salt adjustment process was not applied to their intake data.

1994: A shift to food-specific questions

Starting in the CSFII 1994, the interview method shifted away from asking salt questions for each eating occasion and toward asking them only for targeted types of food. As in earlier surveys, a Food Instruction Booklet (FIB) was used to help interviewers ask appropriate questions for various categories of foods and drinks, in order to elicit the type of detail needed for coding (17). An innovation in the FIB for CSFII 1994-1996, 1998 was the inclusion of an added salt question in the probes for several food categories (cooked cereals; pasta, noodles, and macaroni; rice; eggs and egg substitutes; white potatoes; French fries and tater tots; sweet potatoes; vegetables and dry beans; beef, lamb, veal, and game meats; ham and pork; liver and organ meats; poultry; fish; and home-made mixed dishes, casseroles, stews, and soups).

This change affected respondent burden in two opposing ways. On the one hand, respondent burden was eased by restricting questions on the use of salt in cooking to a subset of foods – i.e., only those foods for which the use of salt in cooking is common. On the other hand, respondent burden was increased by asking these questions for all instances of consuming these types of foods, without regard to whether they were from the home food supply or not.

The question was "Was salt used in cooking or preparing the (FOOD)?" and the answer options were "don't know," "no salt," and "salt used." If a respondent reported that no salt was used in preparation, then during data processing all the optional salt was removed from the food item before its nutrient contributions were calculated.

Another change that was initiated in 1994 concerned the survey sampling unit. Formerly, households had been sampled. Starting in 1994, selected individuals within a household were sampled. For this reason, there was no assurance that a household's main meal-planner/preparer would be among the members of the household who were eligible for the survey. Additionally, beginning in 1994, questions about the use of salt in preparation were asked of all respondents, not just main meal-planner/preparers as in previous surveys. This change had implications for the validity of responses to questions about the use of salt in cooking and will be discussed later.

2002: Reducing respondent burden in the automated, integrated survey

In preparation for any new round of data collection, many aspects of survey methodology are examined. One tool used in attempting to improve survey methods is interviewer debriefing. As explained in the *Encyclopedia of Survey Research Methods*, "As the project staff members who most closely interact with respondents, interviewers provide a unique perspective on how questions are answered by respondents and which questions may be difficult to ask or answer" (18). Structured debriefing sessions conducted with the dozens of interviewers who collected over 41,000 days of intake data in the CSFII 1994-1996, 1998 indicated that the question on salt in preparation was repetitive and slowed down the interview. Examination of survey data revealed that nearly 60 percent of the time, respondents answered "yes" or "no" to the question about use of salt in cooking when the food in question had been obtained from a restaurant – a situation in which they could not realistically be expected to know the answer (19).

Pilot studies are often used to test the effectiveness of proposed changes in survey methods. One question addressed by a pilot study conducted in 1999-2000 was whether the method used to collect salt intake data could be streamlined. Rather than asking a question about salt in cooking for each food, the Pilot Study 1999-2000 interview method included a single question on salt in cooking that was asked after the entire day's food intake data collection was completed. That question was, "How often is ordinary salt or seasoned salt added in cooking or preparing foods in your household? Is it never, rarely, occasionally, or very often?" The answer to that question determined the level of optional salt that was applied to all of a respondent's foods that were eligible for salt adjustment.

Those adjustment levels were derived through determining, for each respondent in the CSFII 1994-1996, 1998, the proportion of eligible foods with salt added in cooking. For example, for a person who reported 4 foods eligible for salt adjustment and who said salt was used in preparing 2 of those foods and not in the other 2, the proportion of eligible foods with salt added in cooking was 50 percent. About one-third of all Pilot Study 1999-2000 responses to the household salt use question fell into each of the categories "never/rarely," "occasionally," and "very often." For that reason, respondents in the CSFII 1994-1996, 1998 were divided into three groups based on their proportion of eligible foods with salt added in cooking. The percentage at the midpoint of the intakes for each group was used as the basis for setting the adjustment level for the corresponding Pilot Study response option. In the CSFII, one-third of respondents had no eligible foods (0 percent) with salt added in cooking, so the "never/rarely" adjustment level omitted all optional salt. The midpoint of the second CSFII group was 33 percent of eligible foods with salt added in cooking, so the "occasionally" level was set at 67 percent of optional salt omitted. The midpoint of the third group was 88 percent of eligible foods with salt added in cooking, so the "very often" level was set at 12 percent of optional salt omitted. As shown in table 3, the method

used in the Pilot Study 1999-2000 yielded mean sodium intake estimates that did not differ significantly from the CSFII 1996 estimates.

Table 3. Sodium intakes from food: Mean amounts consumed per individual, CSFII 1996 and Pilot Study 1999-2000

	CSFII 1996		Pilot Study 1999-2000		Difference	
Gender and age (years)	**Sample size**	**Sodium (mg)**	**Sample size**	**Sodium (mg)**	**Sodium (mg)**	**P value**
Males 20+	1704	4009	225	4068	59	0.8434
Females 20+	1532	2768	227	2798	30	0.8166

Source: Continuing Survey of Food Intakes by Individuals 1996 and Pilot Study 1999-2000, adults age 20 years and over, Day 1 dietary intake data, weighted.

In 2000, a Dietary Methodology Review Panel composed of five university-affiliated researchers who were not Federal employees convened to assess the effectiveness of the AMPM in collecting accurate and complete dietary data. As part of their assessment, the panel was presented with the results displayed in table 3 and asked to comment on the validity of replacing food-specific questions about the use of salt in cooking with one general question. As stated in the 2001 final report (unpublished), they concluded that "using default values for … amount of salt used during cooking is an appropriate way to streamline the dietary interview and the processing of the data." The application of the response to a single question on household salt use to modify the optional salt in all foods eligible for salt adjustment was implemented in WWEIA, NHANES 2002-2008.

There were slight differences between the adjustment levels associated with the question's response options in the Pilot Study and those actually used in WWEIA, NHANES (as outlined in table 1). The adjustment level used when the respondent said salt was "never" or "rarely" used in household food preparation was the same in WWEIA, NHANES as in the Pilot Study – i.e., all optional salt (100 percent) was omitted. There were two reasons for modifying the adjustment levels applied to the other response options: (a) to make them more intuitive and easily interpretable than those used in the Pilot Study and (b) to accommodate a change in the rationale for setting the adjustment level associated with the "very often" response option. Regarding the second reason, since "always" is not among the response options for this question, it is reasonable to assume that respondents in households where salt is always or nearly always used in cooking will choose the "very often" option. In the CSFII 1994-1996, 1998, the proportion of eligible foods with salt added in cooking was 100 percent for the majority of respondents in the highest intake group. In other words, for most individuals in the highest intake group, all foods eligible for salt adjustment had salt added in cooking. For that reason, it was considered reasonable to retain all optional salt for respondents who chose "very often," the highest available response option. The remaining adjustment level, corresponding to a response of "occasionally," was then set at the midpoint of the range between the "never/rarely" and "very often" levels, i.e., 50 percent. WWEIA, NHANES 2003-2004 was the first data release that had these levels of salt adjustment applied throughout the entire survey cycle. For that period, salt intake was 4,090 mg for men age 20 years and over and 2,911 mg for women the same age.

With respect to identifying foods that require salt adjustment, the USDA Automated Multiple-Pass Method (AMPM) recall used in WWEIA, NHANES since 2002 includes a question "Did you eat this meal at home?" but does not collect information on which foods were brought into the home and eaten elsewhere. For that reason, it is no longer possible to identify all foods that were from the home food supply (and, therefore, likely to have been prepared at home) in the same manner as in earlier surveys. Beginning in 2002, the criterion that determined whether a food was considered likely to have been cooked or prepared at home was whether it was obtained from the store rather than any other location (e.g., a restaurant, fast food place, school cafeteria, and so forth).

Factors prompting discontinuation of salt adjustment of eligible foods in What We Eat in America, NHANES

A number of considerations have called into question the value, as well as the validity, of continuing the salt adjustment procedure.

Use of store purchase as a proxy indicator of home preparation is no longer appropriate

Developments in food marketing have blurred the line between "home" and "away" food. A dramatic increase has occurred not only in the range of stores that sell food (e.g., superstores, food/drug combination stores, convenience stores) but also in the availability of fully- and partially-prepared foods from those stores (20). As expressed by the Food Marketing Institute, "Many food retailers today … are entering the foodservice business" with expanded offerings of entrée and meal options (20). In a 2006 ACNielsen survey of internet users, nearly two-thirds of North American consumers said they purchased ready-to-eat meals from a store (including restaurants, but not fast food places) either frequently or occasionally (21). In that study, for the U.S. consumers who said they buy ready-to-eat meals from a store, a grocery store was the type of store from which they are most often purchased (21). Another survey, conducted by Packaged Facts (a division of MarketResearch.com) in 2010, reported that 64 percent of adult consumers had purchased a ready-to-eat or heat-and-eat food from a grocery store or supermarket in the previous month (22). In rural Texas, Creel et al. found that nearly 60 percent of the opportunities for obtaining fast food were offered by convenience stores or supermarkets/grocery stores (23).

Increased use of ready-to-eat foods suggests the likelihood that fewer store-bought foods are being cooked or prepared at home. It is known that less time is spent on cooking now than in 1985. Time use studies indicate that in 1985 women spent on average approximately 80 minutes per day on food preparation, including cleanup (24). By 2006-2008, time allotted to this task had decreased to 47 minutes per day (25). Time spent in food preparation by men (<20 minutes per day) remained low throughout the time period and did not compensate for the decrease noted among women.

This greater use of ready-to-eat foods from the store has important implications, since store-purchased foods that are in categories considered likely to be home-prepared are eligible for salt adjustment. For example, if purchased from a grocery store, a food described as roasted chicken is eligible for salt adjustment – even though it is now possible to buy a ready-to-eat roasted ("rotisserie") chicken from the store. The recent trend toward increased purchases of prepared foods from stores calls into question the assumption that the level of salt in "home" foods is at

the discretion of a cook within the household. If the criterion of being purchased from a store is no longer a good indicator that the food is home-prepared, then the application of the salt adjustment procedure could be leading to underestimation of total sodium intake.

Compounding the problem of the availability of foods in stores in varying states of preparedness (from basic ingredients to ready-to-eat form) is the fact that many respondents may not be knowledgeable about their households' food preparation practices (including whether items are cooked "from scratch" and, if so, how they are prepared). In earlier USDA surveys, the interviewer visited the home, and it was possible to compensate for a non-cooking respondent's lack of knowledge about household food preparation by consulting the main meal-planner/preparer. Now, with WWEIA interviews being conducted with selected household members in the Mobile Examination Center (day 1) or over the telephone (day 2), there is little chance of being able to supplement the respondent's knowledge by consulting another, more knowledgeable household member. Yet, as mentioned earlier, it is known from previous USDA surveys that participants will provide a response to the salt-in-cooking question even when it is highly unlikely that they really know the answer, thus compromising the validity of its application in the salt adjustment procedure.

Shift toward eating away from home translates into decreased contribution of home food to total sodium; smaller role for salt adjustment

A substantial increase in eating away from home took place between the late 1970's and the mid-1990's (26) and continued through the beginning of the 21st century (27). Even though a slight recession-driven decrease occurred in food away from home beginning in 2007 (28-29), away-from-home eating still constitutes a significant proportion of food intake, accounting for nearly half of all food dollars in 2010 (29). The percentage of total daily calories eaten away from home more than doubled over a 30-year period, from 17 percent in 1977-78 to 35 percent in 2007-2008 (30-31).

Many of the foods and beverages consumed away from home are obtained from restaurants and fast food places. In 2007-2008, the top sources of food/drink other than stores were fast food places and restaurants (unpublished data). At that time, 53 percent of individuals age 2 years and over obtained at least 1 item from a restaurant or fast food place on any given day (32). The sodium density (mg/1,000 kcal) of foods from restaurants and fast food places is higher than that of foods purchased at the store (as shown in reference 2, page 145, table 5-9). This higher density is reflected in these foods' disproportionate contribution to daily sodium intake. For individuals who reported consuming food/drink from restaurants/fast food establishments in 2007-2008, items from these sources accounted for 43 percent of daily food energy but 50 percent of sodium (32).

Since salt adjustment applies only to foods likely to be cooked at home (see table 2), the shift toward eating away from home means that a lower proportion of food overall is eligible for salt adjustment. Due to the higher sodium density of away-from-home food relative to food from home, the shift toward eating away from home means that a lower percentage of daily sodium intake is attributable to food from home. The combined effect of these factors has been to diminish the impact of salt adjustment since the time when the procedure was instituted.

AMPM sodium intake estimates compare favorably to urinary biomarker when salt adjustment is not applied

For estimating sodium intake, the analysis of urine collected during a 24-hour period is widely accepted to be the "gold standard," i.e., more accurate and reliable than dietary self-reports (2). Likewise, the AMPM has been called "the current state-of-the-art 24-hour dietary recall instrument" (33). Although 24-hour urinary sodium data are not available from nationally representative surveys in the U.S., a large validation study using this biomarker evaluated the accuracy of the AMPM method for the collection of sodium intakes (34).

The USDA AMPM Validation Study was conducted from 2002-2004 with a sample of 524 volunteers age 30 to 69 years. The primary objective of the study was to validate the AMPM 24-hour dietary recall method as a means of collecting energy intakes using the doubly-labeled water technique (35). Using data from the 472 subjects who completed at least one 24HR and collected a complete 24-hour urine corresponding to the dietary recall period, the validity of sodium intake as measured by the AMPM was assessed.

Dietary sodium intakes were estimated using the sodium values released in FNDDS 1.0 (36), which included the salt assumed to be added in cooking – in other words, without applying the salt adjustment step described in this paper. At the time when AMPM Validation Study data were collected, intake of tap and plain bottled water was not collected in the AMPM recall (37). Salting at the table was not quantified, nor was intake of sodium-containing supplements and medications collected.

Reporting accuracy was calculated as the ratio of sodium intake estimated using data collected by the AMPM dietary recall to that estimated using the urinary sodium biomarker (34). As shown in table 4, the AMPM-derived mean dietary sodium estimates reflected 92% and 90% of the biomarker-based estimates for men and women, respectively (34). Thus, the study demonstrated that the USDA AMPM is a valid measure for estimating sodium intakes at the group level.

Table 4. Sodium intakes (mg/day) estimated by dietary recall[1] and urinary biomarker[2] and reporting accuracy of recall, by gender, USDA AMPM Validation Study

	Males (n=232)		Females (n=233)	
	Sodium intake (mg/day)			
Based on:	*Geometric mean*	*95% CI*	*Geometric mean*	*95% CI*
Dietary recall[1]	4182	(3989, 4385)	3177	(3030, 3332)
Urinary biomarker[2]	4546	(4334, 4768)	3534	(3368, 3707)
	Ratio of sodium intake estimated by dietary recall to that estimated by urinary biomarker			
	Ratio	*95% CI*	*Ratio*	*95% CI*
Reporting accuracy	0.92	(0.88, 0.96)	0.90	(0.86, 0.94)

Source: USDA AMPM Validation Study (34), adults age 30-69 years, 2-days.
[1]Dietary recall data collected via USDA Automated Multiple-Pass Method (AMPM).
[2]Sodium intake based on urinary biomarker was calculated as 24h urinary sodium divided by 0.86, based on the assumption that 86 percent of ingested sodium is excreted in the urine (38).

Due to the AMPM Validation Study's exclusion of sodium from salting at the table, tap and plain bottled water, supplements, and medications (which would all be reflected in the urinary biomarker but not the dietary recall sodium estimate), the finding of reporting accuracy ratio estimates lower than 1.00 was as expected. The degree of agreement between the recall-based and biomarker-based estimates may also be affected by other factors. The dynamic nature of the U.S. food supply can result in mismatches between the amount of sodium in foods eaten by individuals and the FNDDS sodium values assigned to those foods during the coding process, potentially leading to either over- or underestimates of dietary sodium. Routine updating to keep food composition databases current is essential. Although both over- and underreporting occur when dietary intake methods rely on self-reports, on the whole the 24HR tends to underestimate total caloric intake (33, 35, 39), and sodium intake is highly correlated with total caloric intake (2, 5, 40). The net effect of these factors on the reporting accuracy in the AMPM Validation Study – or in any study – is impossible to determine. That said, if the salt adjustment data processing step, which always lowers sodium intake estimates, had been applied to the estimates in table 4, it would have led to an apparent decrease in reporting accuracy.

Process of salt adjustment is not congruent with Canadian method of estimating sodium intake

In recent years there has been a move toward harmonization of dietary assessment methodology between the U.S. and Canada, such as in the development of the Dietary Reference Intakes (DRIs) (3). Despite some differences, many aspects of food consumption in Canada and the U.S. are relatively similar (41). In the 2004 Canadian Community Health Study, the USDA Automated Multiple Pass Method was used to collect dietary intakes. No adjustment of salt levels to reflect the frequency of salt use in cooking was done in the process of estimating the

sodium intakes of the Canadian population (42). Sodium intakes are slightly lower in Canada than in the U.S. for several age groups, and differences might have been slightly greater if salt adjustment had been performed on the Canadian data (42). Mean sodium intake for Canadians age 1 year and over is 3,098 mg/day (43).

Discontinuation of salt adjustment in WWEIA, NHANES 2009-2010 onward: Impact and policy implications

It is worthwhile to collect general information about the use of salt in food preparation in order to address a number of research questions, such as whether behavior change occurs in the direction of following Dietary Guidelines messages on limiting sodium in the diet. For that reason, the question on use of salt in household food preparation will remain a part of the AMPM interview. However, application of this information in adjusting the salt content of selected foods in a specific day's intake, as described in this report, is questionable at best. Due to the several reasons discussed that call into question the value and validity of salt adjustment as it has been implemented since 2002, this procedure has been discontinued. The final data release to contain sodium data that were salt adjusted is WWEIA, NHANES 2007-2008. This salt adjustment step was not applied during processing of the 2009-2010 WWEIA, NHANES dietary data, nor will it be done in later survey cycles.

Due to the multitude of applications for which WWEIA, NHANES dietary data are used, it is important to consider how large an impact the process of salt adjustment has had and what the ramifications of ceasing this data processing step will be.

Impact on mean estimates of sodium intake

The effect of salt adjustment on 2007-2008 estimates of sodium intake is illustrated in table 5. With salt adjustment, the estimated mean daily sodium intake for all individuals age 2 years and over in 2007-2008 was 3,330 mg. Without salt adjustment, it was 3,460 mg, i.e., 3.9 percent higher. The pattern is similar across gender/age groups, and differences are statistically significant for all age groups ($p<.001$).

Sodium intakes with and without salt adjustment are presented in appendix 1 by race/ethnicity and by income as a percentage of poverty. For the inclusive age group 2 years and over, for all race/ethnicity (table A1-1) groups and income categories (table A1-2), mean daily sodium intakes were 3 to 4 percent higher without salt adjustment.

Table 5. Sodium intakes from food: Comparison of mean daily amount (mg) with and without salt adjustment, by gender and age, 2007-2008

Gender and age (years)	Sample size	Mean daily sodium intake (mg)					
		With salt adjustment	SE	Without salt adjustment[1]	SE	Difference[2] (mg)	Relative difference[3] (percent)
Males:							
2-5	455	2265	(39.5)	2339	(44.7)	73	3.2
6-11	550	3169	(104.4)	3238	(104.9)	69	2.2
12-19	607	3990	(129.2)	4093	(131.1)	103	2.6
20-29	409	4363	(174.1)	4561	(184.2)	198	4.5
30-39	451	4231	(89.3)	4382	(89.5)	151	3.6
40-49	412	4391	(156.9)	4591	(159.2)	200	4.6
50-59	431	4030	(175.9)	4207	(175.7)	177	4.4
60-69	459	3517	(123.1)	3678	(128.3)	161	4.6
70 and over	500	3012	(116.8)	3215	(117.7)	203	6.7
20 and over	2662	4043	(80.3)	4224	(81.3)	182	4.5
Females:							
2-5	377	2189	(67.4)	2251	(67.7)	62	2.8
6-11	571	2717	(95.9)	2802	(95.4)	85	3.1
12-19	549	3013	(143.6)	3096	(137.3)	83	2.8
20-29	409	3009	(119.6)	3107	(118.3)	99	3.3
30-39	482	3058	(154.7)	3161	(161.6)	103	3.4
40-49	466	3027	(121.4)	3143	(132.2)	116	3.8
50-59	413	2936	(105.9)	3031	(108.3)	96	3.3
60-69	465	2674	(71.6)	2795	(70.9)	121	4.5
70 and over	523	2364	(57.5)	2543	(58.8)	179	7.6
20 and over	2758	2884	(40.1)	3000	(42.7)	115	4.0
Males and females:							
2 and over	8529	3330	(52.1)	3460	(54.1)	130	3.9

Source: What We Eat in America, NHANES 2007-2008, individuals age 2 years and older (excluding breastfed children), Day 1 dietary intake data, weighted.

[1]For each sex/age group, sodium mean without salt adjustment differs significantly from sodium mean with salt adjustment ($p<.001$).

[2]Calculated as sodium mean without salt adjustment - sodium mean with salt adjustment.

[3]Calculated as [(sodium mean without salt adjustment - sodium mean with salt adjustment) ÷ sodium mean with salt adjustment] x 100.

Impact on usual intake distributions of sodium

In order to assess intake of a nutrient relative to DRIs such as the Adequate Intake (AI) or the Tolerable Upper Intake Level (UL), usual intake distributions should be calculated (44-45). Estimated usual intake distributions and the proportion of the population with intake above the AI and UL for sodium with and without salt adjustment applied are presented in appendix 2.

Even with salt adjustment, the mean (and median) intakes of all sex/age groups greatly exceed the AI (table 2A-1). In fact, fewer than 5 percent of individuals in any lifestage/gender group have intakes that do not exceed the AI, even with salt adjustment (tables 2A-1 and 2A-2). The prevalence of inadequate sodium intakes in the U.S. is probably extremely low.

Rather, given the nature of the concern about sodium and health in the U.S., i.e., the prevalence of high sodium intakes, the nutrition community will primarily be interested in the impact of discontinuing the salt adjustment processing step on the proportion of the population with sodium intake above the UL. As can be seen by comparing the "% above UL" columns of tables 2A-1 and 2A-2, it is estimated that, for all individuals age 1 year and over, 88 percent of the population exceeds the UL for sodium when salt adjustment is not conducted, versus 84 percent when salt adjustment is conducted. For the 22 sex/age groups, when the salt adjustment step was performed on 2007-2008 intakes, the percentage of the group with intake above the UL ranged from 52 percent of women age 70 years and over to over 97 percent of boys age 9 to 13 and men age 19 to 50 years (table A2-1). When intakes for the same survey years were estimated without salt adjustment, the percentage of the group with intake above the UL was from 1 to 13 percentage points higher in all groups (except those that had already reached the highest level presented, i.e., over 97 percent; table A2-2). The biggest difference was for women age 70 years and over.

Implications for analysis

As noted earlier, there is intense interest in the ability to monitor sodium consumption and track the success of efforts aimed at lowering intakes. Researchers and policymakers will wish to compare newer estimates of sodium intake against intakes prior to the initiation of various strategies aimed at reducing sodium.

For any analysis using WWEIA, NHANES data to monitor sodium intake over time, it will be crucial to use baseline estimates that are calculated in a manner comparable to the new estimates, i.e., without the salt adjustment processing step. Failure to use comparable baseline estimates could result in spurious findings of a lack of effect of sodium reduction strategies. This report provides baseline estimates without salt adjustment for 2007-2008 in table 4 and appendixes 1 and 2. In addition, tables are provided on the FSRG website displaying similar adjusted and unadjusted WWEIA, NHANES 2007-2008 sodium intake estimates along with 2009-2010 estimates calculated in the new manner (i.e., without the salt adjustment procedure; 46).

For researchers who wish to conduct their own analyses of WWEIA, NHANES data for any survey cycle up to 2007-2008, sodium values provided in the version of FNDDS corresponding to the relevant survey data release can be used to recalculate total sodium intakes for the population(s) of interest. The 2001-2002 survey cycle is not included due to confidentiality issues regarding slight differences in methodology between the survey years; see table 2, footnote 3. Additionally, appendix 3 provides, by survey cycle, PDF files listing the food codes

that were eligible for salt adjustment in conjunction with the sodium values (per 100 grams) assigned to those foods during the adjustment procedure. As stated earlier in this report, the choice of which sodium value to employ depended upon the response to the question about salt use in cooking or preparing foods in the household – a reply of "very often" resulted in 100% of optional salt being included (this level corresponds to the FNDDS sodium value); "occasionally," 50% of optional salt included; and "never" or "rarely," 0% of optional salt included. These files of salt adjustment values, as well as this report, are being provided by FSRG to ensure that researchers have the tools needed to correctly interpret any observed change in sodium intakes.

In consideration of the need to continue providing accurate estimates of sodium intake to measure progress towards public health goals, a number of additional efforts are underway. FSRG and NDL have collaborated in identifying processed foods frequently reported in WWEIA, NHANES for analysis of their nutrient composition, including sodium. These foods have been sampled from across the country, from both retail stores and popular restaurants, so as to provide nutrient data that are more representative of the foods consumed. The new composition data will be disseminated, as usual, in successive SR and FNDDS releases. FSRG is also reviewing survey methodology to enhance dietary reporting of sodium. Each year, the AMPM is updated to assure that questions and response options elicit the necessary details about foods reported by survey respondents. Over the past few years, the AMPM updates have increasingly focused attention on sodium, as well as on food reformulations (including fortification and the incorporation of whole grains). The recipes that make up the foods in FNDDS also undergo continual review and updating to accurately reflect the most common current food preparation practices. All of these efforts support the ongoing assessment of sodium intake by the population.

Summary

The ability to estimate sodium intake accurately is of public health importance. The USDA 24HR method (the AMPM) and its database for coding dietary intake survey data and calculating nutrient intakes (the FNDDS) are strong tools used in estimating population intakes to monitor the nutritional health of the nation. Adjustment of salt levels in home-prepared foods consumed by individuals who said their households cooked with salt only occasionally or less often was once considered to be a useful way to produce sodium intake estimates more reflective of actual intakes. Although the addition of salt in food preparation is a factor in sodium intake, it is a very minor one compared to the use of processed food. Secular changes in food preparation practices (such as the fact that about two-thirds of U.S. adults frequently or occasionally obtain ready-to-eat meals from the store) call into question one of the assumptions on which the salt adjustment process was founded, namely, that individuals have control over the salt content of home-prepared food. Current survey respondents may or may not be knowledgeable about cooking practices within their homes. The AMPM produces sodium intake estimates that reflect 90 percent or more of sodium intake as estimated by the urinary sodium biomarker, and it does not appear as if application of salt adjustment, which has been shown to lower the AMPM-derived dietary sodium estimates by approximately 4%, would enhance the accuracy of those estimates. For those reasons, the process of adjusting optional salt in eligible foods is being discontinued in WWEIA, NHANES 2009-2010 and all subsequent surveys. Estimates of sodium intakes in 2007-2008 calculated without the data processing step of salt adjustment are included in this report and its appendixes in order to provide comparable baseline values for monitoring changes in sodium

intakes. Additionally, listings of salt adjustment values for eligible foods in WWEIA, NHANES 2003 through 2008 are included in an appendix. Among future efforts to enhance validity of sodium intake estimates, updating the food composition database will be a high priority.

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Appendix 1. Mean sodium intake from food with and without salt adjustment, by race/ethnicity and by income

Table A1-1. Sodium intakes from food: Comparison of mean daily amount (mg) with and without salt adjustment, by race/ethnicity and age, 2007-2008

Race/ethnicity and age (years)	Sample size	Mean daily sodium intake (mg)					
		With salt adjustment	SE	Without salt adjustment[1]	SE	Difference[2] (mg)	Relative difference[3] (percent)
Non-Hispanic white:							
2-5	295	2111	(58.5)	2166	(58.6)	54	2.6
6-11	336	2980	(111.4)	3063	(106.9)	83	2.8
12-19	360	3705	(151.5)	3799	(157.3)	95	2.6
20 and over	2548	3478	(67.3)	3631	(69.4)	153	4.4
2 and over	3539	3402	(65.8)	3539	(69.0)	137	4.0
Non-Hispanic black:							
2-5	182	2389	(114.7)	2452	(109.3)	64	2.7
6-11	295	3107	(98.7)	3173	(98.6)	66	2.1
12-19	311	3154	(101.6)	3224	(108.5)	70	2.2
20 and over	1136	3270	(92.0)	3389	(89.5)	119	3.6
2 and over	1924	3178	(58.4)	3281	(57.0)	103	3.2
Mexican American:							
2-5	217	2228	(165.8)	2331	(174.9)	103	4.6
6-11	291	2667	(114.7)	2731	(109.6)	64*	2.4
12-19	270	3247	(106.1)	3337	(102.6)	90	2.8
20 and over	930	3270	(70.3)	3370	(66.9)	100	3.1
2 and over	1708	3097	(49.8)	3192	(46.8)	95	3.1
All Hispanic:							
2-5	308	2260	(132.4)	2355	(137.2)	95	4.2
6-11	437	2715	(95.9)	2783	(95.4)	68	2.5
12-19	431	3239	(84.3)	3322	(87.3)	83	2.6
20 and over	1525	3269	(47.1)	3389	(47.1)	120	3.7
2 and over	2701	3114	(33.3)	3221	(32.4)	107	3.4

Source: What We Eat in America, NHANES 2007-2008, individuals age 2 years and older (excluding breastfed children), Day 1 dietary intake data, weighted.

[1]For each race/ethnicity/age group except non-Hispanic blacks age 6-11 years and Mexican Americans age 6-11 years, sodium mean without salt adjustment differs significantly from sodium mean with salt adjustment ($p<.001$).

[2]Calculated as sodium mean without salt adjustment - sodium mean with salt adjustment.

[3]Calculated as [(sodium mean without salt adjustment - sodium mean with salt adjustment) ÷ sodium mean with salt adjustment] x 100.

Table A1-2. Sodium intakes from food: Comparison of mean daily amount (mg) with and without salt adjustment, by family income (as % of Federal poverty threshold[1]) and age, 2007-2008

Family income as % of Federal poverty threshold and age (years)	Sample size	Mean daily sodium intake (mg)					
		With salt adjustment	SE	Without salt adjustment[2]	SE	Difference[3] (mg)	Relative difference[4] (percent)
Under 131% poverty:							
2-5	386	2425	(73.6)	2514	(75.9)	88	3.6
6-11	468	2931	(104.8)	3028	(105.3)	97	3.3
12-19	450	3262	(133.6)	3395	(147.5)	133	4.1
20 and over	1506	3152	(74.4)	3290	(80.9)	138	4.4
2 and over	2810	3086	(57.8)	3215	(64.8)	129	4.2
131-185% poverty:							
2-5	90	2140	(149.7)	2222	(143.2)	82	3.8
6-11	138	3598	(358.3)	3659	(355.1)	61	1.7
12-19	129	3792	(275.3)	3873	(269.3)	81*	2.1
20 and over	694	3273	(114.8)	3399	(111.1)	127	3.9
2 and over	1051	3289	(124.0)	3403	(120.1)	114	3.5
Over 185% poverty:							
2-5	298	2158	(55.6)	2208	(56.2)	50	2.3
6-11	446	2882	(74.4)	2943	(70.0)	61	2.1
12-19	473	3583	(175.0)	3654	(170.9)	71	2.0
20 and over	2735	3571	(54.8)	3724	(55.8)	153	4.3
2 and over	3952	3454	(46.5)	3587	(45.1)	133	3.8
All incomes:							
2-5	832	2230	(45.1)	2298	(47.2)	68	3.0
6-11	1121	2933	(71.4)	3010	(71.0)	78	2.6
12-19	1156	3505	(100.9)	3599	(101.5)	93	2.7
20 and over	5420	3430	(57.7)	3576	(59.8)	147	4.3
2 and over	8529	3330	(52.1)	3460	(54.1)	130	3.9

Source: What We Eat in America, NHANES 2007-2008, individuals age 2 years and older (excluding breastfed children), Day 1 dietary intake data, weighted.

[1]Percent of Federal poverty threshold is based on family income, family size, and composition using U.S. Census Bureau poverty thresholds. The poverty threshold categories are related to Federal Nutrition Assistance Programs, www.fns.usda.gov.

[2]For each income/age group except the 131-185% poverty group age 12-19 years, sodium mean without salt adjustment differs significantly from sodium mean with salt adjustment ($p<.001$).

[3]Calculated as sodium mean without salt adjustment - sodium mean with salt adjustment.

[4]Calculated as [(sodium mean without salt adjustment - sodium mean with salt adjustment) ÷ sodium mean with salt adjustment] x 100.

*Indicates an estimate with a relative standard error greater than 30% and/or small sample size.

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Appendix 2. Usual intakes of sodium with and without salt adjustment, 2007-2008

Table A2-1: Sodium (mg)[+]: Usual intakes[#] from food and water, 2007-2008, compared to Adequate Intakes (AI)[†] and Tolerable Upper Intake Levels (UL)[†], with salt adjustment

	Day 1			Percentiles of usual intakes													
Age (years)	N	Mean[*]	SE	5th	10th	25th	50th	75th	90th	95th	AI[**]	% above AI	SE	UL[**]	% above UL	SE
Males:																
1-3	383	1955	(88.3)	1109	1255	1535	1887	2296	2715	2970	1000	>97		1500	77	(5.8)
4-8	502	2628	(57.1)	1604	1780	2125	2568	3089	3645	4025	1200	>97		1900	86	(3.1)
9-13	412	3572	(172.9)	2345	2555	2947	3438	3991	4552	4929	1500	>97		2200	>97	
14-18	380	4047	(154.3)	2248	2546	3129	3876	4761	5682	6281	1500	>97		2300	94	(2.6)
19-30	518	4333	(166.7)	2511	2834	3448	4207	5057	5917	6459	1500	>97		2300	>97	
31-50	890	4328	(99.1)	2608	2929	3520	4249	5064	5880	6385	1500	>97		2300	>97	
19-50	1408	4330	(105.0)	2586	2900	3506	4245	5073	5902	6423	1500	>97		2300	>97	
51-70	869	3759	(112.8)	2171	2461	2999	3669	4419	5177	5650	1300	>97		2300	93	(2.0)
71 and over	466	3004	(121.1)	1867	2070	2462	2940	3483	4029	4380	1200	>97		2300	82	(4.5)
51 and over	1335	3570	(111.2)	2038	2324	2843	3499	4220	4953	5416	--	>97		2300	91	(1.9)
19 and over	2743	4049	(79.8)	2311	2625	3217	3955	4775	5599	6119	--	>97		2300	95	(0.6)
Females:																
1-3	349	1926	(52.0)	1078	1230	1527	1879	2275	2672	2913	1000	97	(2.4)	1500	76	(4.5)
4-8	435	2443	(60.2)	1534	1697	1996	2382	2822	3276	3557	1200	>97		1900	80	(3.8)
9-13	418	2918	(125.7)	2010	2180	2498	2871	3278	3685	3929	1500	>97		2200	89	(5.2)
14-18	339	2935	(160.8)	1659	1867	2286	2801	3404	4049	4473	1500	>97		2300	74	(6.8)
19-30	456	3059	(116.1)	1858	2074	2477	2978	3556	4144	4508	1500	>97		2300	82	(6.2)
31-50	914	3045	(84.6)	1642	1882	2342	2929	3610	4309	4753	1500	97	(1.2)	2300	77	(2.9)
19-50	1370	3050	(61.6)	1714	1944	2392	2949	3591	4250	4669	1500	>97		2300	79	(2.9)
51-70	872	2802	(64.4)	1754	1941	2302	2754	3265	3794	4136	1300	>97		2300	75	(2.8)
71 and over	484	2357	(61.8)	1570	1717	1993	2329	2701	3072	3308	1200	>97		2300	52	(4.4)
51 and over	1356	2673	(48.7)	1653	1844	2195	2637	3127	3631	3941	--	>97		2300	69	(2.5)
19 and over	2726	2891	(42.0)	1675	1891	2299	2812	3394	3987	4374	--	>97		2300	75	(2.3)
Males and females:																
1 and over	8687	3311	(50.9)	1718	1983	2490	3166	3974	4807	5348	--	>97		--	84	(1.4)

Source: What We Eat in America, NHANES 2007-2008. Excludes breastfed children and pregnant or lactating females.
[+][#][†][*][**] >97 See table notes.

Table A2-2: Sodium (mg)[+]: Usual intakes[#] from food and water, 2007-2008, compared to Adequate Intakes (AI)[†] and Tolerable Upper Intake Levels (UL)[†], without salt adjustment

	Day 1			Percentiles of usual intakes													
Age (years)	N	Mean[*]	SE	5th	10th	25th	50th	75th	90th	95th	AI[**]	% above AI	SE	UL[**]	% above UL	SE
Males:																
1-3	383	2035	(86.8)	1173	1323	1611	1971	2387	2812	3070	1000	>97		1500	82	(5.2)
4-8	502	2685	(62.0)	1627	1809	2164	2620	3156	3725	4114	1200	>97		1900	87	(2.9)
9-13	412	3667	(179.5)	2416	2631	3032	3532	4092	4658	5036	1500	>97		2200	>97	
14-18	380	4141	(146.5)	2317	2619	3207	3963	4858	5792	6401	1500	>97		2300	95	(2.6)
19-30	518	4539	(169.2)	2660	2994	3629	4416	5297	6192	6756	1500	>97		2300	>97	
31-50	890	4501	(107.3)	2733	3063	3668	4415	5250	6084	6602	1500	>97		2300	>97	
19-50	1408	4515	(107.9)	2724	3046	3669	4427	5279	6128	6666	1500	>97		2300	>97	
51-70	869	3924	(117.4)	2343	2632	3168	3834	4580	5335	5807	1300	>97		2300	96	(1.5)
71 and over	466	3206	(121.0)	2072	2276	2670	3148	3691	4237	4587	1200	>97		2300	89	(2.9)
51 and over	1335	3745	(115.2)	2223	2509	3025	3676	4392	5120	5579	--	>97		2300	94	(1.4)
19 and over	2743	4230	(80.7)	2471	2789	3388	4136	4966	5799	6327	--	>97		2300	97	(0.5)
Females:																
1-3	349	1994	(49.9)	1142	1298	1598	1952	2347	2740	2978	1000	>97		1500	80	(4.5)
4-8	435	2506	(58.7)	1590	1753	2054	2444	2890	3353	3641	1200	>97		1900	83	(3.7)
9-13	418	3045	(123.0)	2114	2289	2617	3001	3420	3839	4090	1500	>97		2200	93	(4.3)
14-18	339	2997	(147.1)	1690	1903	2333	2860	3478	4140	4576	1500	>97		2300	76	(6.1)
19-30	456	3147	(119.0)	1924	2145	2556	3065	3647	4238	4603	1500	>97		2300	85	(6.3)
31-50	914	3160	(91.8)	1745	1989	2456	3047	3730	4428	4869	1500	>97		2300	80	(3.5)
19-50	1370	3155	(65.4)	1805	2041	2495	3056	3700	4358	4777	1500	>97		2300	82	(3.1)
51-70	872	2905	(65.0)	1901	2082	2430	2863	3349	3850	4172	1300	>97		2300	81	(2.8)
71 and over	484	2536	(66.1)	1706	1862	2152	2504	2891	3273	3516	1200	>97		2300	65	(4.3)
51 and over	1356	2799	(47.3)	1806	1995	2338	2766	3238	3722	4017	--	>97		2300	77	(2.4)
19 and over	2726	3005	(44.5)	1793	2010	2419	2928	3502	4086	4465	--	>97		2300	80	(2.5)
Males and females:																
1 and over	8687	3440	(53.0)	1810	2083	2602	3292	4119	4969	5516	--	>97		--	88	(1.4)

Source: What We Eat in America, NHANES 2007-2008. Excludes breastfed children and pregnant or lactating females.

[+] [#] [†] [*] [**] >97 See table notes.

Table A2-3: Sodium[+] (mg): Usual intakes[#] from food and water, 2007-2008, percentiles and standard errors, with salt adjustment

	Percentiles of usual intakes (SE)													
Age (years)	5th		10th		25th		50th		75th		90th		95th	
Males:														
1-3	1109	(98.7)	1255	(99.6)	1535	(97.2)	1887	(98.6)	2296	(95.1)	2715	(98.2)	2970	(108.7)
4-8	1604	(83.8)	1780	(81.3)	2125	(66.8)	2568	(58.5)	3089	(62.4)	3645	(87.3)	4025	(126.2)
9-13	2345	(177.3)	2555	(151.9)	2947	(112.8)	3438	(130.5)	3991	(232.5)	4552	(380.2)	4929	(497.4)
14-18	2248	(169.8)	2546	(175.6)	3129	(172.8)	3876	(174.2)	4761	(183.5)	5682	(205.5)	6281	(234.5)
19-30	2511	(174.7)	2834	(163.7)	3448	(154.4)	4207	(164.7)	5057	(209.1)	5917	(274.2)	6459	(318.7)
31-50	2608	(86.7)	2929	(80.1)	3520	(72.1)	4249	(88.1)	5064	(127.3)	5880	(182.1)	6385	(221.4)
19-50	2586	(96.7)	2900	(89.2)	3506	(83.0)	4245	(98.2)	5073	(137.1)	5902	(189.8)	6423	(222.7)
51-70	2171	(118.2)	2461	(112.0)	2999	(110.7)	3669	(114.8)	4419	(142.5)	5177	(190.6)	5650	(231.0)
71 and over	1867	(115.0)	2070	(114.2)	2462	(109.5)	2940	(116.3)	3483	(144.1)	4029	(187.2)	4380	(218.3)
51 and over	2038	(87.9)	2324	(88.8)	2843	(93.3)	3499	(108.9)	4220	(138.1)	4953	(178.6)	5416	(211.3)
19 and over	2311	(53.2)	2625	(51.1)	3217	(55.7)	3955	(72.4)	4775	(103.9)	5599	(142.6)	6119	(169.1)
Females:														
1-3	1078	(121.4)	1230	(105.7)	1527	(75.0)	1879	(51.7)	2275	(69.5)	2672	(117.4)	2913	(150.5)
4-8	1534	(73.9)	1697	(74.0)	1996	(70.3)	2382	(61.5)	2822	(64.5)	3276	(91.7)	3557	(111.8)
9-13	2010	(161.6)	2180	(149.3)	2498	(127.6)	2871	(123.9)	3278	(146.1)	3685	(193.8)	3929	(229.5)
14-18	1659	(190.2)	1867	(179.7)	2286	(152.3)	2801	(128.9)	3404	(132.0)	4049	(180.1)	4473	(228.3)
19-30	1858	(187.7)	2074	(173.4)	2477	(149.3)	2978	(121.0)	3556	(116.5)	4144	(150.0)	4508	(185.4)
31-50	1642	(106.4)	1882	(97.7)	2342	(78.7)	2929	(71.1)	3610	(109.1)	4309	(177.8)	4753	(232.8)
19-50	1714	(99.1)	1944	(91.5)	2392	(73.2)	2949	(54.7)	3591	(67.3)	4250	(113.9)	4669	(148.4)
51-70	1754	(91.4)	1941	(78.4)	2302	(54.5)	2754	(49.0)	3265	(88.0)	3794	(151.7)	4136	(196.9)
71 and over	1570	(92.8)	1717	(82.8)	1993	(61.8)	2329	(57.7)	2701	(88.1)	3072	(139.2)	3308	(175.5)
51 and over	1653	(82.7)	1844	(70.2)	2195	(47.8)	2637	(40.1)	3127	(76.8)	3631	(135.1)	3941	(175.4)
19 and over	1675	(76.5)	1891	(67.7)	2299	(50.6)	2812	(35.8)	3394	(54.9)	3987	(96.4)	4374	(127.8)
Males and females:														
1 and over	1718	(45.0)	1983	(42.9)	2490	(40.2)	3166	(44.6)	3974	(66.8)	4807	(102.6)	5348	(128.6)

Source: What We Eat in America, NHANES 2007-2008. Excludes breastfed children and pregnant or lactating females.
[+#] See table notes.

Table A2-4: Sodium[+] (mg): Usual intakes[#] from food and water, 2007-2008, percentiles and standard errors, without salt adjustment

	Percentiles of usual intakes (SE)													
Age (years)	5th		10th		25th		50th		75th		90th		95th	
Males:														
1-3	1173	(98.9)	1323	(100.0)	1611	(96.7)	1971	(97.2)	2387	(93.4)	2812	(99.1)	3070	(111.9)
4-8	1627	(82.5)	1809	(81.4)	2164	(70.5)	2620	(65.2)	3156	(66.9)	3725	(83.6)	4114	(118.7)
9-13	2416	(167.9)	2631	(144.5)	3032	(112.9)	3532	(137.0)	4092	(234.9)	4658	(373.7)	5036	(484.5)
14-18	2317	(198.5)	2619	(200.0)	3207	(187.1)	3963	(172.8)	4858	(162.7)	5792	(176.9)	6401	(209.6)
19-30	2660	(185.2)	2994	(175.2)	3629	(164.1)	4416	(166.9)	5297	(201.8)	6192	(261.4)	6756	(303.3)
31-50	2733	(87.4)	3063	(78.2)	3668	(71.0)	4415	(93.6)	5250	(139.7)	6084	(198.2)	6602	(239.1)
19-50	2724	(99.0)	3046	(91.4)	3669	(84.8)	4427	(101.0)	5279	(140.0)	6128	(193.1)	6666	(225.3)
51-70	2343	(113.1)	2632	(109.7)	3168	(112.7)	3834	(119.8)	4580	(146.5)	5335	(191.2)	5807	(228.0)
71 and over	2072	(101.2)	2276	(99.9)	2670	(97.2)	3148	(116.1)	3691	(161.2)	4237	(219.7)	4587	(259.1)
51 and over	2223	(88.7)	2509	(89.9)	3025	(95.4)	3676	(113.4)	4392	(144.5)	5120	(185.4)	5579	(215.6)
19 and over	2471	(57.3)	2789	(55.0)	3388	(58.5)	4136	(74.8)	4966	(105.9)	5799	(143.9)	6327	(169.6)
Females:														
1-3	1142	(122.4)	1298	(104.2)	1598	(71.2)	1952	(48.9)	2347	(72.6)	2740	(122.6)	2978	(155.7)
4-8	1590	(77.0)	1753	(75.8)	2054	(69.9)	2444	(59.2)	2890	(65.6)	3353	(98.8)	3641	(122.0)
9-13	2114	(161.1)	2289	(147.5)	2617	(124.6)	3001	(121.5)	3420	(147.4)	3839	(201.1)	4090	(240.1)
14-18	1690	(182.1)	1903	(171.5)	2333	(142.8)	2860	(118.6)	3478	(121.3)	4140	(170.3)	4576	(219.3)
19-30	1924	(209.5)	2145	(192.4)	2556	(162.8)	3065	(127.4)	3647	(117.3)	4238	(153.3)	4603	(193.7)
31-50	1745	(127.1)	1989	(116.3)	2456	(93.8)	3047	(80.4)	3730	(116.7)	4428	(189.3)	4869	(247.3)
19-50	1805	(110.6)	2041	(101.3)	2495	(81.0)	3056	(59.9)	3700	(72.3)	4358	(120.6)	4777	(158.0)
51-70	1901	(90.1)	2082	(75.3)	2430	(51.1)	2863	(50.3)	3349	(92.3)	3850	(154.1)	4172	(196.4)
71 and over	1706	(93.4)	1862	(83.2)	2152	(63.0)	2504	(61.0)	2891	(93.1)	3273	(144.1)	3516	(180.3)
51 and over	1806	(77.2)	1995	(64.1)	2338	(41.8)	2766	(37.6)	3238	(75.2)	3722	(128.3)	4017	(166.0)
19 and over	1793	(86.0)	2010	(75.5)	2419	(55.5)	2928	(38.6)	3502	(57.4)	4086	(100.2)	4465	(131.5)
Males and females:														
1 and over	1810	(49.4)	2083	(47.1)	2602	(43.6)	3292	(47.1)	4119	(68.5)	4969	(105.1)	5516	(132.2)

Source: What We Eat in America, NHANES 2007-2008. Excludes breastfed children and pregnant or lactating females.
[+#] See table notes.

Table Notes

+ Sodium intake estimates include sodium that occurs naturally in food and beverages (including drinking water) and salt added during food processing and cooking or food preparation. Excluded are salt added at the table and sodium contributed by dietary supplements and medications.

The method used to estimate the usual nutrient intake distributions presented in this table was developed by the National Cancer Institute (NCI). An overview of the general method and the procedure for usual intake estimation is available from reference 47 (see appendix C, "Procedure for Usual Intake Estimation").

† For definitions, see reference 3.

* Daily mean and standard error of the mean for sodium are estimated directly from day 1 intake data and do not reflect the NCI usual intake estimation approach used to estimate the distribution statistics. The conventional mean estimates are provided to be comparable to other tables produced by the Food Surveys Research Group. While the NCI method and the conventional method are both estimating the mean, the actual results may differ slightly.

** Percentile of usual intake, as well as the estimates of the percentages less than or greater than the DRI and the standard error of the percentage, are the direct result of an estimation of the usual nutrient intake distribution for that specific gender/age/lifestage group. Exceptions were necessary for composite groups where the DRI value differs across the component groups including 19 and over, 51 and over, and 71 and over by gender, and for males and females 1 and over. For these composite groups, the estimated percentage less than or greater than the DRI value was computed as an average of the percentages for the gender/age/lifestage subgroups comprising the composite group weighted proportionally by population size. Because a single DRI value for these composite groups does not exist, a hyphen is displayed.

>97 Percentages greater than 97 percent are represented by >97. Standard errors are not displayed in these cases.

Appendix 3. PDF files containing sodium values (per 100 grams) assigned for foods eligible for salt adjustment

Each file name listed below is linked to a PDF file containing sodium values per 100 grams edible portion for those food codes that had salt as an optional component in previous surveys. These values were used to calculate the amount of total sodium in these foods as consumed in their respective WWEIA, NHANES survey cycles. File names together with their applicable survey cycles and the number of food codes eligible for adjustment are presented below.

File name	WWEIA, NHANES survey cycle	Number of eligible food codes
FNDDS2 – Foods Eligible For Sodium Adjustment	2003-2004	1,709
FNDDS3 – Foods Eligible For Sodium Adjustment	2005-2006	1,708
FNDDS4.1 – Foods Eligible For Sodium Adjustment	2007-2008	1,797

Included in each file is a listing of food codes with main food descriptions. Each food code has three different sodium values and start and end dates. These are defined as:

- **SodiumDefault:** This is the sodium value in the FNDDS version used in that survey cycle. For example, in FNDDS4.1-FoodsEligibleForSodiumAdjustment, the default is the sodium value included in FNDDS 4.1, which was used in coding the WWEIA, NHANES 2007-2008 data. This default sodium value represents the amount of sodium in the food with **all optional salt included**. This value was applied when survey respondents reported that salt was used **"very often"** in cooking or preparing food in their household or when they reported that they didn't know how often salt was used. It was also used when the respondent reported the food or beverage was obtained from a place other than the store.
- **SodiumNosalt:** This sodium value represents the amount in the food with **all optional salt excluded**. This value was applied when survey respondents reported the food was obtained from the store and that salt was **"never"** or **"rarely"** used in cooking or preparing food in their household.
- **SodiumComb:** This sodium value represents the amount in the food with **one-half of the optional salt included**. This value was applied when survey respondents reported the food was obtained from the store and salt was **"occasionally"** in cooking or preparing food in their household.
- **Start Date and End Date:** These are the main food description start dates and end dates corresponding to the beginning and end of that survey cycle's data collection.