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Sodium monitoring in commercially processed and restaurant foods

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Abstract

Background—Most sodium in the US diet comes from commercially processed and restaurant foods. Sodium reduction in these foods is key to several recent public health efforts.

Objective—The objective was to provide an overview of a program led by the USDA, in partnership with other government agencies, to monitor sodium contents in commercially processed and restaurant foods in the United States. We also present comparisons of nutrients generated under the program to older data.

Design—We track ∼125 commercially processed and restaurant food items ("sentinel foods") annually using information from food manufacturers and periodically by nationwide sampling and laboratory analyses. In addition, we monitor >1100 other commercially processed and restaurant food items, termed "priority-2 foods" (P2Fs) biennially by using information from food manufacturers. These foods serve as indicators for assessing changes in the sodium content of commercially processed and restaurant foods in the United States. We sampled all sentinel foods nationwide and reviewed all P2Fs in 2010–2013 to determine baseline sodium concentrations.

Results—We updated sodium values for 73 sentinel foods and 551 P2Fs in the USDA's National Nutrient Database for Standard Reference (releases 23–26). Sodium values changed by at least 10% for 43 of the sentinel foods, which, for 31 foods, including commonly consumed foods such as bread, tomato catsup, and potato chips, the newer sodium values were lower. Changes in the concentrations of related nutrients (total and saturated fat, total sugar, potassium, or dietary fiber) that were recommended by the 2010 *Dietary Guidelines for Americans* for reduced or increased

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the CDC.

Supplemental Tables 1–6 are available from the "Supplemental data" link in the online posting of the article and from the same link in the online table of contents at http://ajcn.nutrition.org.

The authors' responsibilities were as follows—JKCA, PRP, DBH, AM, CG, JG, RM, and MC: designed the research; JKCA, PRP, DBH, SW-K, MN, BS, RT, JR, JW, MK, QN, KH, CM, DR, and AM: conducted the research; JKCA: wrote the manuscript; and JKCA and SW-K: had primary responsibility for the final content. All of the authors read and approved the final manuscript. None of the authors declared a conflict of interest.

consumption accompanied sodium reduction. The results of sodium reduction efforts, based on resampling of the sentinel foods or re-review of P2Fs, will become available beginning in 2015.

Conclusion—This monitoring program tracks sodium reduction efforts, improves food composition databases, and strengthens national nutrition monitoring.

Keywords

USDA National Nutrient Database for Standard Reference (SR); United States; monitoring; sodium; sodium reduction; commercially processed foods; restaurant foods

INTRODUCTION

In 2013 the Institute of Medicine and the WHO concluded that high dietary sodium intake is positively related to cardiovascular disease risk, consistent with current efforts to lower excessive dietary sodium intakes (1, 2). Most sodium in the US diet comes from commercially processed and restaurant foods (3, 4). The CDC reported that 10 food categories contribute >40% of the sodium consumed in United States: bread and rolls, cold cuts/cured meats, pizza, poultry, soups, sandwiches, cheese, pasta mixed dishes, meat mixed dishes, and savory snacks. Most food items in these categories are commercially processed or restaurant items (4).

Recent public health efforts in the United States have focused on working with food manufacturers and restaurants in reducing the sodium in their products. Several regional and national programs are targeting sodium reduction in these foods (5–7). For example, the New York National Salt Reduction Initiative set specific targets for sodium concentrations in 87 packaged and restaurant food categories. The food industry has plans to reduce sodium in its products over the next several years (8–11). For example, ConAgra and McDonald's have committed to reducing salt by 20% and 15%, respectively, by 2015 (10, 11). However, Jacobson et al. (12) reported no significant changes in sodium content when they compared identical processed and fast-food restaurant foods in the United States over 6 y (2005–2011).

A key recommendation of the 2010 Institute of Medicine report *Strategies to Reduce Sodium Intake in the United States* was to enhance monitoring and surveillance relative to sodium intake measurement and sodium content of foods (13) to track and evaluate reduction efforts and plan future strategies. Monitoring sodium in the United States is complex because of the diversity of the food supply and its rapid pace of change. The United States has >85,000 uniquely formulated foods (14) and ∼ 1 million restaurants and other food service outlets (15).The marketplace is dynamic; manufacturers continuously reformulate, introduce, or take foods off the market. Food composition databases need to be continuously updated to keep pace with these changes and serve as mechanisms for tracking changes (16). The USDA's National Nutrient Database for Standard Reference (SR)[6] and Food and Nutrient Database for Dietary Studies are the major sources of food composition data in the United States and are used for national nutrition monitoring (16).

[6]Abbreviations used: NDL, Nutrient Data Laboratory; NFNAP, National Food and Nutrient Analysis Program; NFP, Nutrition Facts Panel; P2F, Priority 2 Foods; SR, National Nutrient Database for Standard Reference; WWEIA, What We Eat in America.

This article's objective was to provide an overview of a USDA-led program, in partnership with other US government agencies, to monitor the sodium content of commercially processed and restaurant foods, which began in 2010. The article details the procedures used and provides the program's status and comparison of nutrient data generated since 2010 to older data in the SR.

METHODS

Overview of the monitoring program

Figure 1 provides a schematic overview of the monitoring program. As part of the monitoring plan, ∼ 125 selected food items, termed "sentinel foods," are tracked annually by using information from food manufacturers and at periodic intervals by nationwide sampling and laboratory analyses. We conduct nationwide sampling and laboratory analysis of sentinel foods using the protocols established by the National Food and Nutrient Analysis Program (NFNAP). This program, which the Nutrient Data Laboratory (NDL) of the USDA administers in collaboration with other US government agencies, generates original analytic data on foods. The highlights of the program include the use of statistically valid nationwide sampling plans; the selection of brands to sample using consumer sales data; an analysis of foods using valid, approved methods by prequalified laboratories; comprehensive quality control; and NDL oversight to generate high-quality, new, and updated analytic nutrient data that are representative of the US marketplace (17). We monitor other commercially processed and restaurant foods, termed "priority-2 foods" (P2Fs), every 2 y using information from food manufacturers. This includes information obtained directly from manufacturers or restaurant chains, their websites, or the Nutrition Facts Panel (NFP) of their products. The NDL uses these data sources to conserve resources because nationwide sampling and analysis are expensive. A review of information obtained from manufacturers provides early indications of possible changes in the sodium content of foods, and the NDL may follow it up with laboratory analysis. Currently, there are >1100 P2Fs. The sentinel foods and P2Fs serve as indicators for assessing changes over time in the sodium content of commercially processed and restaurant foods in the United States. They are not intended to be representative of all sodium-contributing foods.

Most commercially processed sentinel foods and P2Fs include several major brands. The NDL's goal is to sample and analyze brands that represent 70–80% of units sold in the United States. We sample major fast-food and family-style restaurant chains for most restaurant sentinel foods. Similarly, we use major brands and fast-food and family-style restaurant chains to represent P2Fs. Details on the selection of these brands and restaurant chains are available in the following sections. In addition to sodium, we monitor related nutrients (total and saturated fat, total sugar, potassium, and total dietary fiber) for sentinel foods and P2Fs because their values may change when manufacturers reformulate foods to reduce their sodium concentrations (13) and the 2010 *Dietary Guidelines for Americans* (18) recommends increased (potassium and total dietary fiber) or decreased (total and saturated fat and total sugar) consumption of these nutrients.

The major advantage of using laboratory analyses to monitor nutrient content is the ability to examine changes in potassium and other nutrients that are not currently required to be listed

on NFPs. In addition, changes in the sodium content of many products may be gradual (sometimes called “stealth” reductions), and NFPs might not reflect recently lowered sodium values (9). A food label complies with US regulations as long as the product’s nutrient content is no more than 20% higher than the value declared on the label (19).

Updated nutrient values are released annually through the SR (20) and biennially through the Food and Nutrient Database for Dietary Studies (21). Beginning in 2015, the NDL will release changes in sodium concentrations in a new “sodium monitoring” section of its website.

Sentinel foods

Selection of sentinel foods—We reviewed dietary intake data from 9255 respondents who completed an in-person 24-h dietary recall as part of What We Eat in America (WWEIA), NHANES 2007–2008 (22). WWEIA, NHANES is an ongoing dietary intake survey of the nationally representative, noninstitutionalized US population of all ages. Sodium density (mg/100 g of food), frequency of consumption by respondents in the survey, and percentage of contribution to sodium intake of commercially processed and restaurant foods were carefully evaluated to determine the list of 125 sentinel foods. Table 1 shows examples of the sentinel foods, by food type [adapted from the WWEIA food categories (23)]. Supplemental Table 1 lists all of the foods. Approximately half of the sentinel foods are in the 10 food categories that contribute the most sodium to the US diet according to the CDC (4). Other sentinel foods, such as catsup (“condiments and sauces”) and French fries (“potato products”), are foods with high sodium density and/or that are very popular.

Approximately three-fourths of the sentinel foods are commercially processed (92 of 125), and the rest come from fast-food or restaurant chains (33 sentinel foods). Sentinel foods account for approximately one-third of the total sodium intake of all individuals, excluding breastfed infants, in WWEIA 2007–2008. The USDA validated the accuracy of mean dietary sodium intake estimates in the survey by comparing these data to the results of 24-h urinary sodium excretion tests (24).

Sampling and analysis of sentinel foods—The NDL developed a sampling plan for each food item that it used to represent a given sentinel food. The sampling design used a hierarchical, 3-stage, probability-proportional-to-size sample selection process to ensure the selection of a nationally representative sample of food products that were geographically dispersed across the United States. The 3 stages of this selection process were as follows (25): 1) county and/or city (based on population density from US Census data), 2) retail locations (e.g., supermarkets and restaurants) within the counties and cities (based on annual sales from Nielsen data and Trade Dimensions data), and 3) food brands based on market shares of units sold (derived by the NDL from Nielsen data).

The NDL selected 12 counties across the United States during stage 1 on the basis of the most recent US Census data available. The sampling frame for foods sampled before summer 2013 was based on data from the 2000 Census, which was subsequently updated with data from the 2010 US Census (25, 26). At stage 2, for commercially processed foods, the NDL selected 1 retail outlet and 2 alternates in each of these 12 counties and cities. The

retail outlets that we used to purchase sentinel foods included Walmart and grocery stores with gross sales >$2 million. In stage 3, we determined the market shares of food brands using product-level point-of-sales Nielsen data (27). These data captured unit sales from the vast majority of US grocery stores that have annual sales of at least $2.0 million. However, they did not include sales from warehouse-type stores (e.g., Costco), Walmart, and stores with gross sales of <$2 million. We assumed that consumer shopping behavior for types of brands purchased was similar across store types for these analyses. We used 2009 Nielsen sales data for foods sampled before summer 2013, which we subsequently updated with Nielsen sales data from 2012.

The NDL identified major national and private brands of sentinel foods on the basis of units sold in a calendar year for these foods. When the market share of the private brands collectively was high (i.e., the brand was among the top 3 or 4 brands), we purchased the private brands of the retail location that it had identified for sampling because the Nielsen data do not identify stores associated with private brands. We sampled private brands for two-thirds of the commercially processed sentinel foods.

The number of brands sampled varied by food item, but most foods had a market leader or a few prominent brands that were selected. For example, for the sentinel food “meat and poultry hot dog,” there are 274 universal product codes and 74 brands in the Nielsen data. However, only 5 national and private brands account for >80% of sales (see Figure 2). Some foods had no prominent brands. For example, for “cheese pizza, thin crust, frozen,” 20 brands represented 70% of the market. In such cases, the brands sampled were limited to the top 2 or 3 because of cost constraints of nationwide sampling and laboratory analysis.

We reviewed the labels for the universal product codes with the highest market share within each brand, when available. In most cases, we selected the universal product codes with the highest sales within the brand for purchase on the basis of the assumption that different package sizes within a brand have similar nutrient values per serving.

Limited analysis of the Nielsen data shows that, for many food categories, a small number of products represent a major proportion of that market. For example, among ready-to-eat cereals, there are ∼ 3000 unique universal product codes and 1300 unique cereals. Of these, only 127 cereals account for 88% of total sales of all cereals. Hence, it is cost-effective to focus on the items with the highest sales (28).

For fast-food and restaurant items, we primarily used *QSR* magazine’s list of top 50 restaurants and their menus to select samples of the relevant sentinel food (29). We also used information on the most common fast-food restaurants reported by WWEIA 2007–2008 respondents (obtained from WWEIA 2007–2008 nonpublic internal files) to purchase relevant sentinel foods. We sampled local, independent restaurants for Asian mixed dishes and a few other selected ethnic foods. We used industry publications and/or contracted data analyses to identify prominent brands before 2011 (i.e., before NDL purchased Nielsen data).

An NDL-directed professional product-purchasing company purchased sample units of each of the major brands and shipped it under optimum conditions (30) to the Food Analysis

Laboratory Control Center at Virginia Tech (Blacksburg, VA) or the Texas Tech Department of Animal and Food Sciences (Lubbock, TX). The scientists at these universities processed and prepared the samples for chemical analyses. They randomly mixed the 12 sample units for each brand to yield 6 composites for cost-efficiency. Sometimes, low-sales regional or national brands were composited with private brands to reduce laboratory costs. The composites were then shipped to prequalified commercial and university laboratories for chemical analyses. Figure 2 shows the steps in the sampling and analysis of the sentinel food "meat and poultry hot dog."

The laboratories analyzed most foods to develop a full nutrient profile of up to 133 nutrients comprising macronutrients, minerals, vitamins, fatty acids, and amino acids. The laboratories analyzed sodium by inductively coupled plasma atomic emission spectroscopy by using the Association of Analytic Chemists method 985.01 (3.2.06) + 984.27 (50.1.15) (20). Details on the methods used for other nutrients are available in the SR documentation (20). We used a rigorous quality-control program that included analysis of in-house control materials and standard reference materials, blinded with food samples to monitor the accuracy of the chemical analyses. A panel of food specialists and chemists reviewed the nutrient data obtained from the laboratories to verify the accuracy and precision of the analytic results (31). We weighted the analytic nutrient values by the market share of the selected brands of commercially processed foods to generate nationally representative values for the SR. For fast-food restaurant items, we weighted nutrient values by the market share of the restaurant on the basis of total US dollar sales data from *QSR* magazine (29). For family-style restaurant foods, we equally weighted all brands because market share data on brands were not available. For some foods, when the new analytic values for sodium and related nutrients were not much different from old analytic data, we combined the new analytic data with the old.

Resampling and analysis of sentinel foods—We will resample and analyze the sentinel foods every 4–8 y using the same methods as discussed above. To determine how frequently to resample the foods, we divided the foods into 4 groups on the basis of these criteria:

- Frequency of consumption of the sentinel food based on WWEIA 2009–2010 dietary intake data (32).
- Potential for sodium content reduction based on the difference between the baseline and target sodium concentrations proposed for 2014 by the New York National Salt Reduction Initiative for packaged and restaurant foods (33). Supplemental Table 2 identifies the sentinel foods associated with the initiative's food categories.
- History of change in the marketplace. The number of times the sodium values for the sentinel food changed in the SR since the release of SR 16 in 2003, which served as a proxy for this criterion.

We created a summated scale using the shared variance contributions of the 3 variables based on the principal axis factoring (factor analysis) method. On the basis of the scale, we divided the sentinel foods into 4 groups that provide a framework for the frequency with which we will resample sentinel foods. Foods that WWEIA respondents reported consuming

most frequently have the greatest percentage difference between the baseline and proposed targets from the New York National Salt Reduction Initiative, and whose values have changed most frequently in the SR, represent group 1. Supplemental Table 3 gives examples of sentinel foods categorized into the 4 groups, along with the values for the 3 criteria above. We will resample foods in group 1, such as “American cheese” and “white bread,” every 4 y and foods in group 4, such as “canned tuna, in water” and “tomato juice,” every 8 y. However, we may adjust the sampling frequency for logistical reasons, such as to equally distribute food sampling over the years for resource allocation, to analyze foods using similar quality-control materials, and to sample foods from similar locations at the same time for costefficiency. For example, we are likely to sample pizza items in groups 2 and 3 in the same pick-up to ensure efficient resource use. We will use the newest market share data available at that time to select brands to sample and then to weight the analytic nutrient values.

Tracking changes in sodium content—We will track changes in sodium content by comparing baseline analytic values (2010–2013) with sodium content from resampling (2014 onward). We will statistically analyze changes of ≥10% for significance. We deem 10% to be an appropriate change in nutrient values to justify further review. The CV is ∼ 6% for the sodium analyses of duplicate samples of matrixmatched food materials from the different laboratories that the NFNAP uses. This value has been no higher than 6% for most control materials over the past several years (K Patterson, NDL, personal communication, December 2013).

In this report, we compare the new analytic data that the NDL has generated since 2010 with older SR values to identify changes in values of sodium of at least 10%. For these foods, we identified changes in one or more related nutrients of at least ±10%. We did not statistically analyze differences in sodium and related nutrients for this report, because some of the older SR values were based on label data, analytic data from literature, or not based on nationally representative sampling plans.

P2Fs

Selection of P2Fs—We selected the P2Fs on the basis of careful examination of dietary intake data from the WWEIA 2009–2010. Food descriptions, frequency of consumption, sodium density (mg/100 g of food), and source of sodium values were reviewed to identify ∼ 1200 commercially processed and restaurant foods other than sentinel foods that contained added sodium and, hence, their sodium content had the potential to be modified. The P2Fs exclude foods with naturally present sodium: milk, yogurt, natural spices and herbs, fruit, infant formulas, most beverages, legumes, unprocessed vegetables, fresh meats and poultry, cereal grains, nuts, seeds, and fish. Foods with sodium values < 50 mg/100 g were also excluded for resource efficiency, resulting in ∼ 1100 foods in the list of P2Fs. The list includes brand-name items, such as Kellogg’s Froot Loops, and generically described items, such as sour cream. We will update the P2F list subsequent to the release of dietary intake data from WWEIA 2011–2012 and so on.

Monitoring of sodium values—We use the following procedures to monitor sodium values for the P2Fs:

1. Identification of brands. For generically described P2Fs, such as sour cream or ranch dressing, we identified brands with the highest market share. We used the same procedures as described above for sentinel foods to identify brands for sampling.
2. Review of sodium values. We obtained information on sodium content for the designated brands using the following sources and in the following order of priority: *a*) data that the manufacturer submitted to the NDL, *b*) data from manufacturer and restaurant websites, *c*) NFP values on packages at retail markets, and *d*) manufacturers' responses to NDL inquiries.
3. Sodium estimates and comparison. We weighted the sodium values obtained from these sources according to Nielsen market share data and compared the weighted values to the SR values. If the values differed by at least 10%, we reviewed the basis for the SR sodium values and made changes as appropriate. If the SR values were based on recent analytic data obtained with the use of nationwide sampling, we changed the sodium values only if the sodium value on the NFP had changed since the nationwide sampling. When data for related nutrients (potassium, total and saturated fat, total sugar, and total dietary fiber) were available from the above-mentioned sources, we reviewed those values and made changes in the SR if the differences were ≥10%.

After the SR release in 2013, we reviewed changes in sodium values to determine their potential priority for laboratory analysis. We selected foods for possible analysis that WWEIA respondents frequently reported, that had changes in sodium content >10%, and that we had not analyzed for the longest periods.

We sampled all sentinel foods and disseminated updated data for 73 foods in SR releases 23–26 (2010–2013). Similarly, we reviewed all P2Fs in 2010–2013.

Ongoing sodium-related studies

In addition to the monitoring activities described above, USDA scientists are conducting research that will improve the estimates of sodium content of the food supply in the SR. Reviews of dietary intake data on sources of foods that WWEIA survey respondents reported eating and of Nielsen market sales data are ongoing to identify high-consumption, commercially processed foods. The NDL then prioritizes these foods for NFNAP sampling and laboratory analyses in addition to analyses of sentinel foods and P2Fs. We added >250 sodium-contributing, commercially processed and restaurant foods to the SR for determining nutrient intakes of survey respondents in WWEIA 2009–2010 and 2011–2012. We analyzed many of these foods, such as fast-food sandwiches, ethnic breads, commercial cakes and pies, and restaurant (Chinese, Latino, and family-style) entreés, using the procedures described above. Furthermore, the NDL is analyzing selected meat items—including whole turkey, fresh chicken and turkey retail parts, fresh pork cuts, and selected seafood items—

because current processing methods for these products can substantially increase their sodium concentrations.

The common practice of injecting brine solution or ”enhancing” meat and poultry to improve moisture and flavor may increase the sodium concentration by 2–3 times compared with similar unprocessed items. According to industry estimates, enhancement is used for many retail meat and poultry items, including 30% of chicken and 40% of fresh pork cuts (34). Similarly, according to the National Fisheries Institute, during commercial processing of raw fish and seafood eventually sold in the retail market, sodium compounds may come into contact with fish (J Exler, NDL, personal communication, August 2013). NDL scientists have conducted analytic studies of frequently consumed seafood samples obtained from retail locations. The analytic results for these samples were compared with those from untreated samples (freshly caught seafood not subjected to typical storage practices on fishing boats) (35).

RESULTS

Comparison of updated sodium content of sentinel foods and P2Fs to older SR data

Sodium values were updated on the basis of new analytic data from SR 23 to SR 26 for 73 sentinel foods and from reviews for 551 P2Fs.

Sentinel foods—Sodium values changed by at least ±10% for 43 of the 73 sentinel foods on the basis of a comparison of the new analytic data in SR 23 (2010) to SR 26 (2013) with older SR data. Table 2 lists the sodium values for the 43 foods, along with the sources of these data (analytic, label, or manufacturer), data points, and the year of the most recent and previous nutrient values in the SR. The content of one or more related nutrients (potassium, total and saturated fat, total sugar, or total dietary fiber) changed by at least ±10% for most sentinel foods. Supplemental Table 4 shows the changes in the related nutrients for these 43 sentinel foods. For ∼70% of the sentinel foods (31 of 43 foods with a ±10% change), the newer sodium values were lower than previous SR values. These foods include commonly consumed foods, such as bread, tomato catsup, French fries and chicken tenders from fast-food restaurants, packaged macaroni and cheese, and potato chips. The updated sodium values were >10% higher than the previous SR values for the remaining 12 sentinel foods, including commonly consumed foods, such as salsa, ham, mayonnaise, and fast-food cheese pizza.

P2Fs—Sodium values changed by at least ±10% for 328 P2Fs, as listed in Supplemental Table 5, from SR 23 (2010) to SR 26 (2013). Sodium values were lower in the SR from previous values for ∼60% of the 328 P2Fs, including frequently consumed foods such as sour cream, butter, frankfurters, selected cheeses, salad dressings, nuts, and selected sweet bakery products. The updated sodium values were >10% higher than previous values for the remaining 40% of P2Fs, including shrimp, selected ready-to-eat cereals, and baked products. One or more related nutrients (potassium, total and saturated fat, total sugar, or total dietary fiber) changed in the SR by at least ±10% for approximately one-quarter of the P2Fs (identified in Supplemental Table 5). We may not have updated data on some of these nutrients in the SR because of the lack of reliable data.

We have scheduled many P2Fs for laboratory analysis on the basis of reviews of changes in their sodium values between SR 23 (2010) and SR 26 (2013). Supplemental Table 6 lists the P2Fs that the NDL analyzed in fiscal year 2014. This table lists the percentage of change in sodium values, frequency of reported intakes of foods based on WWEIA, NHANES 2009–2010, and the year the food was last analyzed. The results of sodium reduction efforts, based on resampling of the sentinel foods or re-review of P2Fs, will become available beginning in 2015 in a separate “Sodium Monitoring” section on the NDL website.

Progress in other sodium-related studies

We have completed several sodium-related studies for pork, turkey, and chicken. The NDL has added or updated nutrient values for enhanced and nonenhanced forms of pork (40 items), turkey (50 items), and chicken (32 items) in the SR. Sodium values for 3 highly consumed fresh pork loin cuts were 7–24% higher in 2010–2013 than in 1992 (36). Mean sodium concentrations in enhanced forms of meat (pork, turkey, chicken breast, and dark meat chicken; 231, 181, 172, and 154 mg/100 g, respectively) were significantly (P , 0.001) higher than their nonenhanced counterparts (49, 113, 45, and 106 mg/100 g, respectively) (37). Similarly, sodium values for 4 very popular types of fish and seafood (cod, pollock, salmon, and shrimp) that we purchased at nationwide retail locations were 2–3 times higher (303, 333, 112, and 566 mg/100 g, respectively) than samples that had not been subjected to typical storage practices (109, 159, 71, and 119 mg/100 g, respectively) (35).

DISCUSSION

The current USDA-led sodium monitoring plan provides a pragmatic approach that focuses on selected sentinel foods for laboratory analysis and monitors P2Fs by using less expensive methods. The strength of the monitoring plan is the use of standardized procedures for nationwide sampling and laboratory analyses of sentinel foods along with the use of dietary intake data from WWEIA to select sentinel foods and P2Fs. This effort targets major national and private brands representing these foods on the basis of market share data to maximize cost-effectiveness. Although sodium is the focus of the monitoring plan, we are also analyzing or reviewing related nutrients.

The implementation of this program has improved the analytic basis of the SR and the currency of the USDA databases and, consequently, strengthened national nutrition monitoring. We are also using these data to plan further examinations of other foods and nutrients, including future nationwide sampling and analyses. This effort complements another collaborative effort that the CDC is leading to develop a database of the ∼ 8000 packaged foods that contribute the most sodium to the US diet. In the CDC database, the sodium values are primarily based on proprietary databases, namely Gladson, and the choice of brands for these packaged foods is based on market share data from Nielsen (5, 38).

The current monitoring plan has several limitations. Only foods that are reported or used for determining nutrient intakes in WWEIA are included. The sentinel foods do not represent all sodium-contributing foods in the US food supply. Furthermore, we do not sample several important sources of sentinel foods such as local pizzerias, small and medium stores, cafeterias, and schools. According to Drewnowski and Rehm (39), school meals account for

up to 10.4% of sodium in the diets of children and 6% in the diets of adolescents in the United States. Sodium values in the SR may not be nationally representative because of limitations in the selection and number of samples and in market share data. We monitor the sodium content of most sentinel foods and P2Fs through NFPs and information from manufacturer and restaurant websites. Manufacturers might not update these labels and websites regularly, so these information sources might not reflect the current sodium values of these foods. However, for most foods, these sources can serve as early indicators of changes in sodium content that we can follow up with laboratory analysis.

Comparisons of the 2010–2013 nutrient data to data in older versions of the SR show that sodium content has decreased by at least 10% in more products than it has increased. We cannot make definitive conclusions yet because these changes in nutrient values may reflect real changes because of product reformulations, changes in the market share of the brands, or improvements in data. Many sentinel foods whose sodium contents were previously estimated by using label values have now undergone laboratory analysis, and estimates that were previously not weighted by market share have now been updated. Similarly, many of the changes in P2F sodium values since 2010 reflect the use of more current data. Hence, as the monitoring continues, the sensitivity and specificity of the program's findings will continue to improve. We need to investigate the impact of sodium reductions on related nutrients when the results from the resampling become available, because the picture is complex since changes in the concentrations of related nutrients that the 2010 *Dietary Guidelines for Americans* recommended for reduced or increased consumption accompany sodium reduction. It is too early to report on the impact of changes in the sodium content of these foods on consumption in the United States, because the results from resampling and analysis of the sentinel foods or re-review of P2Fs will not become available until 2015.

In conclusion, the implementation of this interagency collaborative effort will enhance the monitoring of changes in sodium intakes and sodium reduction efforts in the US food supply. This effort will also provide an early indication of how concentrations of sodium and related nutrients are changing in the US food supply, help public health officials target their sodium reduction efforts where they will be most effective, and serve as a model for similar monitoring efforts in the future. Finally, this effort has improved food composition databases and strengthened national nutrition monitoring in the United States, especially through increased laboratory analysis of many very popular foods.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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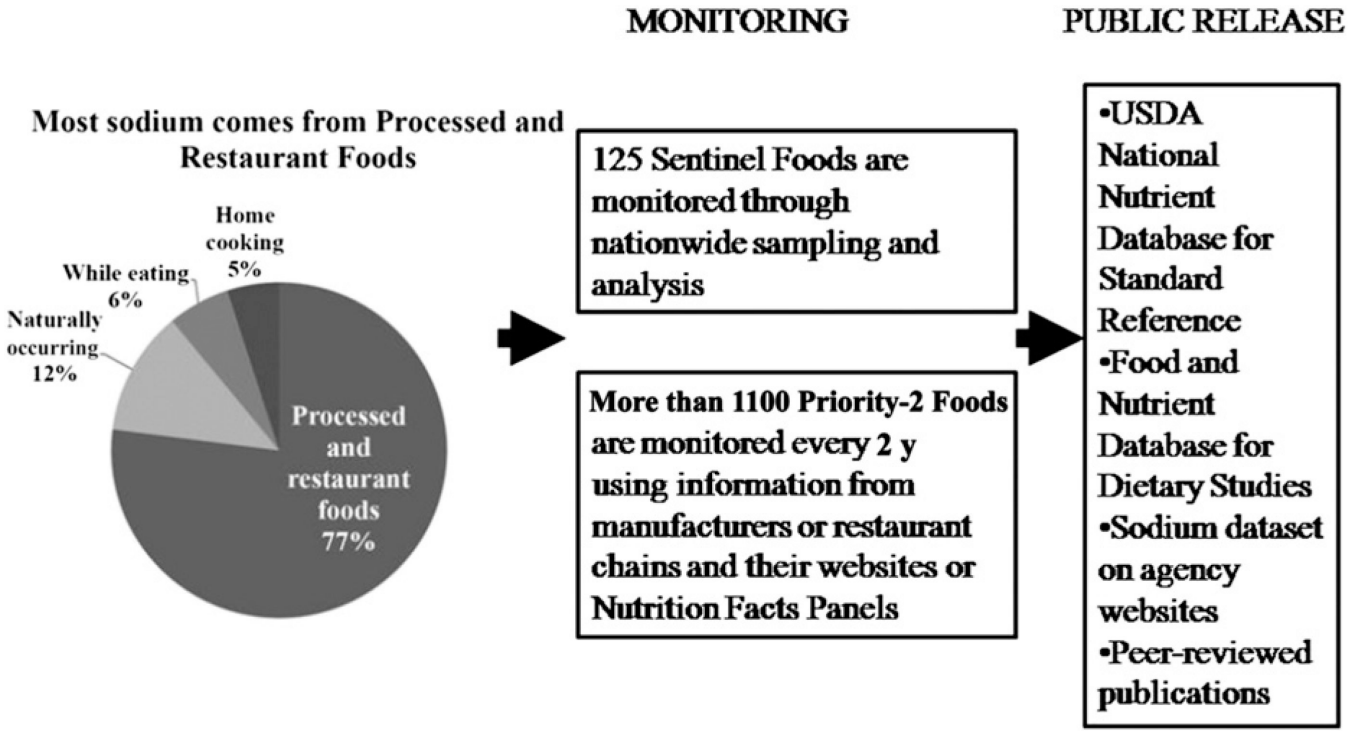

FIGURE 1.
Framework of sodium monitoring plan. Adapted from reference 3 with permission.

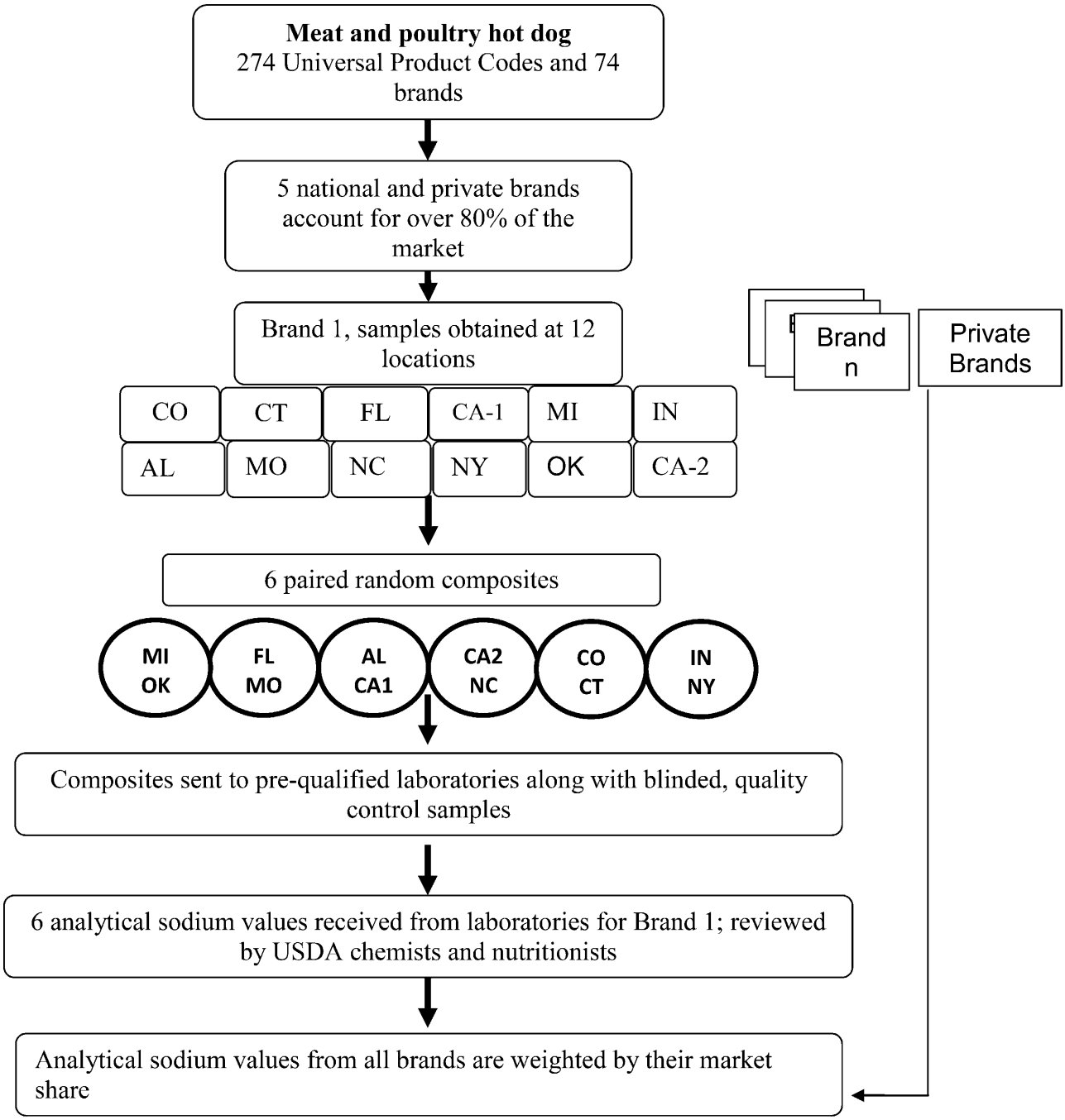

FIGURE 2.
Sampling and analysis of the sentinel food "meat and poultry hot dog." CA-1, sample 1 (California); CA-2, sample 2 (California).

TABLE 1

Sentinel foods by food type[1]

Food type	No. of sentinel foods	Examples
Asian mixed dishes	3	Chicken and vegetables, Chinese restaurant; orange chicken, Chinese restaurant
Breads, rolls, tortillas	6	Flour tortilla, wheat bread
Breakfast cereals	4	Instant oatmeal, flavored; raisin bran
Cheese	6	American cheese, cheddar cheese
Condiments and sauces	10	Catsup, salsa
Cured meats/poultry	9	Pork bacon, salami
Grain-based mixed dishes	9	Spanish rice, prepared from packaged; Spanish rice, fast food or restaurant
Meat and poultry mixed dishes	3	Chili with meat and beans, canned; chili with meat and beans, fast food or restaurant
Meats	1	Pork chop
Mexican mixed dishes	4	Bean burrito, fast food; beef soft taco, fast food
Pizza	5	Pepperoni pizza, thick crust, fast food or restaurant; pepperoni pizza, regular crust, fast food or restaurant
Plant-based protein foods	5	Refried beans, canned; refried beans, fast food or restaurant
Potato products	6	French fries, frozen; French fries, fast food or restaurant
Poultry products	8	Chicken tenders, frozen; chicken tenders, fast food or restaurant
Quick bread products	5	Biscuit, fast food; cornbread, prepared from mix
Salad dressings and mayonnaise	4	Mayonnaise; ranch dressing
Sandwiches	6	Breaded chicken sandwich, fast food; hamburger, fast food
Savory snacks and crackers	9	Hard pretzel; potato chips, flavored
Seafood products	4	Fried shrimp, fast food or restaurant; fish sticks, frozen
Soups	6	Chicken noodle soup, prepared from canned, condensed; tomato soup, prepared from canned, condensed
Sweet bakery products	6	Chocolate cake with icing, chocolate chip cookie
Vegetable products	6	Tomato juice; green beans, canned

[1] Data adapted from reference 23.

TABLE 2

Sentinel foods with changes in sodium content of at least ±10%: comparison of new analytic sodium values (2010–2013) to previous values in the USDA National Nutrient Database for Standard Reference

	Previous sodium value[1]				New analytic sodium value[2]			
Sentinel food description	**Value, mg/100 g**	***n***	**Year**	**Basis[4]**	**Value, mg/100 g**	***n***	**Year**	**Change,[3] %**
Breads, rolls, tortillas								
Taco shell, corn	389 ± 81.736[5]	3	2006	Analytic	243 ± 28.266	16	2012	−38
White bread	681 ± 8.561	8	1998	Analytic	491 ± 10.378	19	2011	−28
Breakfast cereals								
Instant oatmeal, flavored	535	0	2001	Calculated by manufacturer	434 ± 16.947	6	2012	−19
Condiments and sauces								
Barbecue sauce	847	9	2010	Label calculation	1027 ± 192.075	27	2012	21
Catsup	1114 ± 12.744	54	2006	Aggregated analytic	907 ± 6.715	18	2012	−19
Salsa	600 ± 16.684	6	2004	Analytic	705 ± 9.963	12	2012	18
Cured meats/poultry								
Beef hot dog	1140	5	1998	Analytic	992 ± 9.677	18	2013	−13
Ham, packaged and deli	1130 ± 92.685	11	2012	Analytic	1314 ± 150.122	5	2013	16
Pork bacon	2428 ± 35.911	4	2003	Analytic	1717 ± 27.131	18	2012	−29
Salami	2010	2	2004	Analytic	1654 ± 5.476	12	2012	−18
Turkey, packaged and deli	1042 ± 113.42	3	2007	Analytic	928 ± 114.081	12	2011	−11
Grain-based mixed dishes								
Lasagna with meat, frozen	280 ± 11.721	6	2004	Analytic	354 ± 3.052	12	2012	26
Macaroni and cheese, prepared from package[6]	761	2	1998	Analytic	682 ± 22.406	12	2011	−10
Spaghetti with meatballs,	406 ± 15.063	6	2004	Analytic	315 ± 5.144	18	2012	−22
Mexican mixed dishes								
Bean burrito, fast food	627 ± 40.154	15	1988	Analytic	563 ± 6.204	6	2011	−10
Beef hard taco, fast food	469 ± 21.369	50	2004	Analytic	397 ± 10.512	6	2011	−15
Pizza								
Cheese pizza, thick crust, fast food or restaurant	533 ± 52.354	19	2005	Analytic	597 ± 10.189	12	2011	12

	Previous sodium value[1]				New analytic sodium value[2]			
Sentinel food description	**Value, mg/100 g**	***n***	**Year**	**Basis[4]**	**Value, mg/100 g**	***n***	**Year**	**Change,[3] %**
Cheese pizza, thin crust, fast food or restaurant	581 ± 70.647	14	2005	Analytic	742 ± 34.993	12	2011	28
Pepperoni pizza, thick crust, fast food or restaurant	617 ± 63.043	19	2005	Analytic	684 ± 5.936	12	2011	11
Potato products								
French fries, fast food or restaurant	290	0	2010	Label calculation	210 ± 14.037	18	2012	−28
Mashed potatoes, fast food or restaurant	227 ± 54.694	7	1988	Analytic	306 ± 13.143	6	2011	35
Poultry products								
Chicken tenders, fast food or restaurant	857	5	2009	Analytic	748	11	2012	−13
Quick bread products								
Cornbread, prepared from mix	778	0	1992	Analytic	599 ± 7.627	12	2012	−23
Salad dressings and mayonnaise								
Italian dressing	1654 ± 47.394	6	1998	Analytic	993 ± 6.054	12	2012	−40
Mayonnaise	568 ± 2.408	411	2007	Aggregated analytic from varied sources	635 ± 7.927	12	2012	12
Ranch dressing	1094	0	2010	Imputed	901 ± 6.873	18	2013	−18
Sandwiches								
Double cheeseburger, fast food	507	0	2011	Aggregated analytic from varied sources	617 ± 67.1	18	2012	22
Egg, cheese, and ham on muffin; fast food	556 ± 18.268	4	2006	Analytic	617 ± 10.886	6	2012	11
Fish sandwich with cheese, fast food	513 ± 33.259	19	1988	Analytic	434 ± 6.627	6	2012	−15
Savory snacks and crackers								
Cracker, Ritz[7]-like	865 ± 24.159	8	2008	Analytic	705 ± 23.07	6	2013	−18
Cracker, saltine	1116 ± 45.268	8	2008	Analytic	943 ± 17.732	12	2013	−16
Hard pretzels	1357 ± 135.688	3	2005	Analytic	1150 ± 39.767	22	2013	−15
Potato chips, flavored	750 ± 61.222	13	2011	Analytic	591 ± 40.99	13	2013	−21
Potato chips, unflavored	525 ± 26.695	6	2000	Analytic	450 ± 94	5	2013	−14
Tortilla chips, unflavored	421 ± 18.336	5	2004	Analytic	325 ± 21.835	12	2013	−23
Seafood products								

	Previous sodium value[1]				New analytic sodium value[2]			
Sentinel food description	**Value, mg/100 g**	***n***	**Year**	**Basis[4]**	**Value, mg/100 g**	***n***	**Year**	**Change,[3] %**
Canned tuna, in water	338 ± 19.913	32	1987	Analytic	247 ± 10.616	24	2012	−27
Soups								
Chicken broth, canned, ready to serve	158	0		Imputed	371 ± 6.054	15	2013	135
Tomato soup, prepared from canned, condensed[6]	551 ± 5.484	8	1997	Analytic	377 ± 3.483	6	2011	−32
Vegetable soup, canned, ready to serve	359	1	2006	Label calculation	267 ± 2.357	14	2013	−26
Sweet bakery products								
Chocolate chip cookie	344	0	2010	Label calculation	307 ± 5.515	12	2013	−11
Chocolate sandwich cookie	460	0	2012	Label calculation	388 ± 9.253	12	2013	−16
Vegetable products								
Corn, canned	298	2	2006	Analytic	186 ± 9.939	3	2011	−38
Tomato and vegetable juice	198	0	2010	Imputed	169 ± 4.398	11	2013	−15

[1] The sentinel food's sodium value in the USDA National Nutrient Database for Standard Reference before its update with data from nationwide sampling and analysis in 2010–2013. Current and previous releases of the USDA National Nutrient Database for Standard Reference are available at https://www.ars.usda.gov/Services/docs.htm?docid=8964

[2] The sentinel food's analytic sodium value from the nationwide sampling and analysis in 2010–2013.

[3] The changes in nutrient values may reflect real changes because of reformulations, changes in the market share of the brands, or general improvements in data. Examples of improved data include use of analytic data, market share data, nationally representative sample, etc.

[4] Data source for the sodium value. The different data sources are described in the Standard Reference documentation (20).

[5] Mean ± SE (all such values).

[6] Dried or condensed forms were sampled and analyzed for these products. The sodium values represent the samples analyzed.

[7] Mondelez International, Inc.