

# Sodium content in major brands of US packaged foods, 2009<sup>1–4</sup>

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## ABSTRACT

**Background:** Most Americans consume more sodium than is recommended, the vast majority of which comes from commercially packaged and restaurant foods. In 2010 the Institute of Medicine recommended that manufacturers reduce the amount of sodium in their products.

**Objective:** The aim was to assess the sodium content in commercially packaged food products sold in US grocery stores in 2009.

**Design:** With the use of sales and nutrition data from commercial sources, we created a database with nearly 8000 packaged food products sold in major US grocery stores in 2009. We estimated the sales-weighted mean and distribution of sodium content (mg/serving, mg/100 g, and mg/kcal) of foods within food groups that contribute the most dietary sodium to the US diet. We estimated the proportion of products within each category that exceed 1) the Food and Drug Administration's (FDA's) limits for sodium in foods that use a "healthy" label claim and 2) 1150 mg/serving or 50% of the maximum daily intake recommended in the 2010 *Dietary Guidelines for Americans*.

**Results:** Products in the meat mixed dishes category had the highest mean and median sodium contents per serving (966 and 970 mg, respectively). Products in the salad dressing and vegetable oils category had the highest mean and median concentrations per 100 g (1072 and 1067 mg, respectively). Sodium density was highest in the soup category (18.4 mg/kcal). More than half of the products sold in 11 of the 20 food categories analyzed exceeded the FDA limits for products with a "healthy" label claim. In 4 categories, >10% of the products sold exceeded 1150 mg/serving.

**Conclusions:** The sodium content in packaged foods sold in major US grocery stores varied widely, and a large proportion of top-selling products exceeded limits, indicating the potential for reduction. Ongoing monitoring is necessary to evaluate the progress in sodium reduction. *Am J Clin Nutr* 2015;101:344–53.

**Keywords** nutrition, packaged foods, sodium, diet, food

## INTRODUCTION

High sodium intake is directly related to hypertension, one of the leading causes of cardiovascular disease, which accounted for nearly 800,000 deaths in the United States in 2010 (1–3). Most Americans consume more sodium than is recommended, on average, ~3300 mg/d, the vast majority of which is estimated to come from packaged and restaurant foods (>75%) (4, 5). The 2010 *Dietary Guidelines for Americans* (DGA)<sup>5</sup> recommends that all Americans should limit their sodium intake to <2300 mg/d, but those aged ≥51 y, African Americans, and those with

hypertension, diabetes, or chronic kidney disease should further reduce their intake to 1500 mg/d (6). A recent report suggested that sodium density, expressed in milligrams per kilocalorie, is a practical approach for expressing and monitoring adherence to these recommendations (7). The DASH (Dietary Approaches to Stop Hypertension) study diets consisted of incremental amounts of sodium based on caloric requirements; the sodium targets for the "intermediate" sodium level DASH diet range from 1.02 mg sodium/kcal to 1.15 mg/kcal (8). The US Food and Drug Administration (FDA) specifies general requirements for foods making health label claims, which restricts the amount of sodium in any foods that use a "healthy" label claim (9, 10). In 2010 the Institute of Medicine recommended that food manufacturers gradually reduce the amount of sodium in their products (2). Recent efforts by the New York City Department of Health and Mental Hygiene's National Salt Reduction Initiative (NSRI) encourage food manufacturers to meet specific targets for sodium across different food categories (11). In addition, many food manufacturers in the United States have voluntarily pledged to lower sodium in their products, including those who have partnered with the NSRI, Walmart, Kraft, and General Mills (12–14). Monitoring sodium in packaged foods is necessary to evaluate the impact of these efforts.

The USDA's National Nutrient Database for Standard Reference contains the nutritional composition of ~8000 foods and is the basis for the Food and Nutrient Database for Dietary Studies (FNDDS), which is used to assess dietary intakes of foods and nutrients for *What We Eat in America*, part of the NHANES (15–17). The USDA databases contain brand-level information for certain food categories, such as infant formula

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<sup>5</sup>Abbreviations used: DASH, Dietary Approaches to Stop Hypertension; DGA, *Dietary Guidelines for Americans*; FDA, Food and Drug Administration; NFP, Nutrition Facts Panel; NSRI, National Salt Reduction Initiative; RACC, Reference Amount Customarily Consumed; UPC, Universal Product Code.

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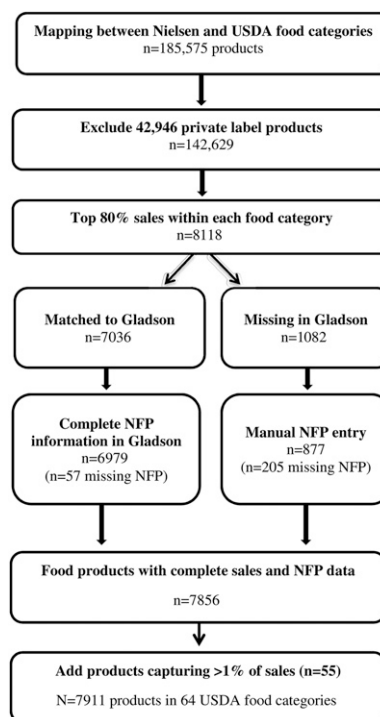
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and ready-to-eat cereals. However, currently, no comprehensive databases that combine nutrition and sales or consumption information are publicly or commercially available in the United States to monitor the sodium content in packaged or restaurant foods at the brand or product level (18). Although one such database was developed for New York's NSRI and others have been developed by independent researchers, understanding of the sodium content of packaged foods is limited. To address this gap, our objectives were as follows: to describe the baseline sodium content of top-selling branded packaged foods within food categories contributing the most to US sodium intake, to compare the sodium content to the FDA criteria for healthy foods in milligrams per serving, and to evaluate sodium content in relation to current recommendations for sodium intake (19).

## METHODS

We combined product-level, point-of-sales calendar-year 2009 data from Nielsen ScanTrack (20) with Nutrition Facts Panel (NFP) data from Gladson LLC (21) by Universal Product Code (UPC). The Nielsen ScanTrack database captures all products sold in the vast majority of US grocery stores with annual sales  $\geq$ \$2 million. On the basis of consultation between nutrition experts at the CDC and the USDA, we selected and purchased ~250 grocery modules that included packaged food products that 1) contained sodium added during processing and 2) were known to be commonly consumed in the US population. UPC-level data were obtained from Gladson's 2009 database, which includes all nutrition information as it appears on the NFP, as well as information such as package size, product description, brand, and parent company. Although both the Nielsen and Gladson databases contained information on private-label (generic) products, UPCs for these foods are unique to specific retailers. Because of the poor matching of UPCs for these private-label products between the 2 databases, they were deleted before merging. Once merged, the products were mapped to 63 of the 104 USDA's 2007–2008 FNDDS food categories, and an additional category of "salt and other seasonings" was created for a total of 64 categories with 142,629 products (Figure 1). Mapping of products in the database to USDA food categories was conducted by 2 independent researchers, and a third researcher resolved any differences. All product descriptions within all Nielsen modules were reviewed; and in some cases, an entire Nielsen module was directly mapped to a USDA food category, although for other modules the products had to be mapped individually. The remaining 41 USDA food categories that did not match to the database consisted of mainly fresh or frozen fruit and vegetables, dairy products, and beverages that contain minimal amounts of added sodium. Products in these 41 categories are not included in the database or in this analysis. Because the USDA food categories were developed for assessing dietary intakes and are broad in nature when compared with the variety of packaged food products available, we retained the Nielsen grocery module information. For USDA categories that contained an adequate number of products (UPCs) in different grocery modules ( $>10$ ), we created subcategories in an effort to better group more similar products together.

In an initial merge of the 142,629 products in Nielsen,  $>135,000$  products did not match or were missing nutrition information in the Gladson database. We limited our manual search



**FIGURE 1** 2009 Packaged foods database mapping flowchart. NFP, Nutrition Facts Panel.

for NFP data to those food products that comprised the top 80% of equalized unit sales (in ounces or pieces sold) within each USDA food category (Figure 1). Because the top 80% of sales within each food category comprised a relatively small number of products, this limited the database to a total of 8118 food products (e.g., a food category may have a total of 300 products but only 60 of those products comprise 80% of total unit sales within that category). Of these 8118 products, 7036 matched with the Gladson database. The NFP information for 877 of the remaining 1082 products was identified on the basis of a standardized Internet search protocol using, in order, the following: 1) manufacturers' websites, 2) retail websites (walmart.com, shopwell.com, shoprite.com, peapod.com, etc.), and 3) calorie/nutrition websites (livestrong.com, myfitnesspal.com, caloriecount.com, calorieking.com, foodfacts.com, fatsecret.com, coheso.com). For 205 products, NFP information was not found through the standardized Internet search, mainly because of product discontinuation or change. Fifty-seven of the products that matched with the Gladson database were missing serving size information or had serving sizes that were not conducive to analysis (e.g., 1 tablespoon) and were excluded, which left a total of 7856 products with complete sales and nutrient information. We further included any products from the Nielsen database that comprised  $>1\%$  of equalized unit sales within any category ( $n = 48$ ). Finally, we excluded 5 unpopped popcorn products and 1 dry soup mix product because of their extremely high sodium concentrations and densities (accounting for  $<0.5\%$  of unit sales), yielding an analytic database with 7898 packaged food products (Figure 1).

In this analysis, we examined the sodium content of packaged foods within the USDA food categories shown to contribute the most sodium to the US diet (19). We expanded the published list of 10 categories to include the top 20 food categories and

included the Nielsen module subgroups, where applicable (19, 22). We examined the mean and distribution (SD, quartiles, range) of the sodium content in packaged foods in milligrams per serving and in milligrams per 100 g and the sodium density in milligrams per kilocalorie. Preliminary analyses yielded very few significant differences between weighted and unweighted estimates; therefore, we included results weighted by equalized unit sales (in ounces or each sold). The serving size listed on the NFP was used to estimate the sodium content per serving. For the purpose of monitoring the sodium content of packaged foods as they are sold, we used the NFP label data for the food “as packaged” in this analysis, rather than incorporating the “as prepared” variations. We calculated the sales-weighted proportion of products within each food category for which a single serving exceeds the FDA sodium limits for foods, meals, or main dish products that use a “healthy” label claim. This limit is 600 mg/serving for main dishes and meals. For individual foods with a Reference Amount Customarily Consumed (RACC) of >30 g, the limit is 480 mg/serving. For individual foods with an RACC of ≤30 g, the limit is 480 mg sodium/50 g (10). To compare the sodium content of products to the US DGA sodium recommendations, we also estimated the sales-weighted proportion of products for which a single serving exceeds 50% of the DGA-recommended daily sodium intake of <2300 mg (1150 mg/serving) (6). We used SAS version 9.3 for all analyses.

## RESULTS

**Table 1** shows the number of products (UPCs), the number of unique brands, the millions of equivalent units sold (in ounces or each), and the sales-weighted means and ranges of serving sizes (in g) for packaged food products within the top 20 USDA food categories that contribute the most sodium to the average US diet, in descending rank of sodium intake contribution. We also included the FDA’s RACC within each food category for reference purposes (23). The bread and rolls category had the largest number of unique brands represented in our database ( $n = 114$ ). The frankfurters and sausages category contained 91 unique brands, followed by the savory snacks category, with 82 unique brands. The eggs and egg mixed dishes category had the smallest number of unique brands, with only 5 that comprised the top 80% of unit sales within that category. Products in the savory snacks category had the highest unit sales in our database, representing 2.5 billion ounces sold in 2009. Bread and rolls had the second highest unit sales, with just over 2 billion ounces sold. Serving sizes varied widely across categories, even for those with a specific RACC that applied to all products within a category. The sales-weighted mean serving size exceeded the RACC in the following several categories or sub-categories: frozen bread; fresh buns, rolls, bagels, etc.; frozen pasta mixed dishes; meat mixed dishes; fried rice, lo mein, stir-fry mixtures; and frozen/refrigerated biscuits, muffins, and quick breads.

Products in the meat mixed dishes category had the highest sales-weighted mean and median sodium contents in milligrams per serving at 966 and 970 mg, respectively; the IQR was 740–1100 mg/serving (**Table 2**). Among meat mixed dishes, the frozen products had a slightly lower sodium content in milligrams per serving than the canned products (mean = 935 mg/serving vs 1046 mg/serving). Products in the pasta mixed dishes

category had the second highest mean sodium content in milligrams per serving, at 805 mg, with a median of 810 mg and an IQR of 660–940 mg/serving. The sodium content in milligrams per serving in frozen pasta mixed dishes was also slightly lower than in the other products in the category (mean = 792 and 817 mg/serving, respectively). Products in the poultry mixed dishes, which was composed primarily of frozen foods, had a mean sodium content of 830 mg/serving, a median of 790 mg/serving, with an IQR of 560–1040 mg/serving. In the bread and rolls category, which contributes the most sodium to the average US diet, products had a mean and median of 216 and 200 mg sodium/serving, with an IQR of 150–250 mg/serving. Unlike products in the meat and pasta mixed dishes categories, in which the sodium content in the frozen products was slightly lower than others (canned, shelf-stable, etc.), in the bread and rolls category, frozen bread had a slightly higher mean and median sodium content per serving (245 and 240 mg/serving, respectively) compared with fresh bread (192 and 190 mg/serving, respectively). Compared with bread and rolls, only products in the savory snacks and ready-to-eat cereal categories had lower weighted-mean sodium contents in milligrams per serving at 202 and 172 mg, respectively (median: 180 mg/serving for both categories; IQR: 150–240 and 140–200 mg/serving, respectively). The highest variation in sodium in milligrams per serving within the 25th and 75th quartiles was observed in the poultry mixed dishes category, with an IQR of 480 mg/serving. The smallest IQR of 60 mg/serving was observed in the ready-to-eat cereal category.

Products in the processed-cheese subcategory had the highest mean sodium concentration in milligrams per 100 g, with a mean of 1326 mg/100 g, which was higher than in natural cheese products, with a mean of 647 mg/100 g (**Table 3**). Although formal statistical testing was not performed, the 10th percentile of processed cheese (1223 mg/100 g) was higher than the 90th percentile of natural cheese (786 mg/100 g). Products in the cold cuts and cured meats category had the second highest sodium concentration in milligrams per 100 g, with a mean of 1117, a median of 1093, and an IQR of 988–1214 (226 mg/100 g). Products in the salad dressings and the tomato-based condiments categories had mean sodium concentrations of 1072 and 974 mg/100 g, respectively. Products in the fried rice, lo mein, and stir-fry mixtures and the eggs and egg mixed dishes categories had the lowest concentrations, with means of 289 and 293 mg/100 g, respectively. The IQR of sodium concentrations in milligrams per 100 g ranged from 101 mg in bread and rolls (435–536 mg/100 g) to 688 mg in the cheese category (635–1323 mg/100 g).

**Table 4** shows the sales-weighted sodium density in milligrams per kilocalorie. Products in the soup and tomato-based condiments categories had the highest density, with means of 18.4 and 13.0 mg/kcal respectively, and medians of 7.3 and 12.7 mg/kcal, respectively. These categories were followed by cold cuts and cured meats, which had a mean density of 7.3 mg/kcal, a median of 6.8 mg/kcal, and an IQR of 3.7–10.2 mg/kcal. Ready-to-eat cereals and savory snacks had the lowest sodium density, with a mean of 1.4 mg/kcal in both categories (median: 1.5 and 1.2 mg/kcal, respectively). The IQR of sodium density varied the least (0.4 mg/kcal) in the macaroni and cheese and bread and rolls categories, with 25th–75th percentiles of 2.2–2.6 and 1.7–2.1 mg/kcal, respectively. The variation was greatest in the soup category, as indicated by the SD of 25.2 mg/kcal and the IQR of 9.5 mg/kcal (5.3–14.8 mg/kcal). The variation was

**TABLE 1**

Number of products, unique brands, equivalent units sold, RACC, and label serving size in branded packaged foods by the top food categories contributing to sodium consumption<sup>1</sup>

Rank <sup>2</sup>	Food category	Products, <i>n</i>	Unique brands, <i>n</i>	Equivalent units sold, <sup>3</sup> in millions	RACC <sup>4</sup>	Label serving size, <sup>5</sup> g	
						Range	Mean
1	Breads and rolls	705	114	2006	50 g	18–104	45
	Frozen	22	10	39		35–94	51
	Fresh bread	490	94	1444		18–76	40
	Fresh buns/rolls/bagels/etc.	193	48	523		26–104	63
2	Cold cuts and cured meats	294	46	840	55 g	28–85	45
	Canned	14	6	60		57–85	59
	Refrigerated	280	42	780		28–85	44
3	Pizza	157	19	752	140 g	68–284	138
4	Poultry	38	20	107	114 g	57–227	112
5	Soups	199	9	1529	245 g	64–305	201
6	Sandwiches	122	17	357	140 g	32–201	113
7	Cheese	506	59	1240	5–55 g	5–96	26
	Natural	257	37	487		16–85	27
	Processed	127	30	400		17–96	24
	Shredded/grated	122	13	352		5–28	26
8	Pasta mixed dishes	181	21	980	140–195 g or 1 cup	31–482	222
	Frozen	110	12	400		132–482	265
	Other	71	9	580		31–284	181
9	Meat mixed dishes	110	30	486	140–195 g or 1 cup	82–454	246
	Frozen	79	20	368		82–454	255
	Canned	31	11	118		213–298	225
10	Savory snacks	463	82	2450	30 g	18–71	29
	Potato chips	114	21	868		21–42	28
	Tortilla chips	118	26	758		27–44	28
	Other	231	49	824		18–71	30
11	Burritos, tacos, tamales	95	23	247	140–195 g	28–513	138
12	Frankfurters and sausages	417	91	1205	55–75 g	28–170	62
	Sausages	247	61	559		30–170	67
	Frankfurters/bratwursts	170	45	646		28–113	58
13	Salad dressings and vegetable oils	229	24	376	30 g	8–32	28
14	Ready-to-eat cereal	148	44	1,341	15–55 g	26–64	37
15	Tomato-based condiments	167	36	538	15–125 g	14–67	26
16	Eggs and egg mixed dishes	20	5	76	50–110 g	45–227	94
17	Fried rice, lo mein, stir-fry mixtures	72	19	150	140–195 g or 1 cup	85–425	263
18	Poultry mixed dishes	155	25	558	140–195 g or 1 cup	68–489	224
19	Biscuits, muffins, quick breads	97	18	562	55 g	27–113	54
	Frozen/refrigerated	46	4	197		28–113	60
	Fresh	26	6	180		32–92	57
	Mixes	25	9	185		27–47	38
20	Macaroni and cheese	22	7	318	1 cup	58–365	135

<sup>1</sup>RACC, Reference Amount Customarily Consumed (per eating occasion).

<sup>2</sup>Ranks are based on descending order of food group's contribution to total sodium consumption among all participants (aged  $\geq 2$  y) in NHANES 2007–2008 as published in reference 19 and expanded to include the top 20 food categories. Subgroups are based on Nielsen modules to group similar products.

<sup>3</sup>Units sold in ounces or each (1 ounce = 28.35 g).

<sup>4</sup>RACC as defined by the Food and Drug Administration general provision (23). For mixed dish-type foods that can be measured in cups (e.g., fried rice), the RACC is 1 cup. For mixed dish-type foods that cannot be measured in cups (e.g., lasagna), the RACC is given in grams.

<sup>5</sup>Ranges and mean serving sizes in grams from the products' Nutrition Facts Panel. Mean serving size is based on equalized sales-weighted estimates (weighted by the number of equivalent units sold in ounces or each).

second highest in the cold cuts and cured meats category, with an IQR that spanned 6.5 mg/kcal.

**Table 5** shows the sales-weighted proportion of products sold within each food category for which a single serving is greater than the following: 1) the FDA sodium limits for products using a "healthy" label claim and 2) 1150 mg/serving (one-half the DGA recommendation of <2300 mg/d). More than half of products sold in 11 out of the 20 food categories contain more

sodium per serving (or per 50 g) than the applicable FDA limits for "healthy" foods, including the following: meat mixed dishes (90.4%), particularly among canned products in this category (100%); pasta mixed dishes (83.2%); pizza (77%); cold cuts and cured meats (68%), particularly among canned products (92%); fried rice, lo mein, and stir-fry mixtures (68%); poultry mixed dishes (66.9%); soups (64.3%); macaroni and cheese (62.9%); frankfurters and sausages (62.6%); salad dressings and vegetable

**TABLE 2**Distribution of sodium content in milligrams per label serving in branded packaged foods by the top food categories contributing to sodium consumption<sup>1</sup>

Rank <sup>2</sup>	Food category	Range	Mean ± SD	Percentile				
				10th	25th	50th	75th	90th
1	Breads and rolls	0–620	216 ± 88	120	150	200	250	330
	Frozen	130–490	245 ± 81	130	210	240	280	350
	Fresh bread	0–480	192 ± 61	120	150	190	230	280
	Fresh buns/rolls/bagels/etc.	85–620	299 ± 116	190	210	250	400	470
2	Cold cuts and cured meats	210–1050	497 ± 177	280	350	490	620	740
	Canned	450–990	682 ± 137	490	580	790	790	790
	Refrigerated	210–1050	485 ± 173	280	320	470	620	720
3	Pizza	270–1460	765 ± 202	480	630	770	890	1000
4	Poultry	65–1040	374 ± 199	85	190	380	490	580
5	Soups	150–1200	700 ± 195	450	480	690	870	890
6	Sandwiches	125–1260	615 ± 179	420	540	620	740	800
7	Cheese	16–520	237 ± 93	150	180	210	270	410
	Natural	16–420	177 ± 57	125	170	180	200	220
	Processed	70–520	315 ± 75	250	270	270	410	420
8	Shredded/grated	45–430	190 ± 64	85	170	190	200	230
	Pasta mixed dishes	300–1470	805 ± 177	600	660	810	940	990
	Frozen	430–1470	792 ± 202	580	650	740	880	1040
Other	300–1300	817 ± 148	600	700	880	950	980	
9	Meat mixed dishes	80–1960	966 ± 301	610	740	970	1100	1270
	Frozen	80–1960	935 ± 339	590	710	890	1100	1390
	Canned	780–1270	1046 ± 135	870	970	1000	1200	1200
10	Savory snacks	0–610	202 ± 89	110	150	180	240	310
	Potato chips	5–380	186 ± 50	135	170	180	200	230
	Tortilla chips	0–290	149 ± 44	110	115	150	180	210
	Other	15–610	275 ± 105	160	200	260	320	410
11	Burritos, tacos, tamales	240–1570	508 ± 236	270	300	480	630	760
12	Frankfurters and sausages	190–1330	557 ± 163	400	470	520	640	740
	Sausages	190–1220	531 ± 178	350	440	490	600	710
	Frankfurters/bratwursts	230–1330	578 ± 147	450	480	550	680	760
13	Salad dressings and vegetable oils	10–620	304 ± 85	210	260	310	350	410
14	Ready-to-eat cereal	0–350	172 ± 80	50	140	180	200	290
15	Tomato-based condiments	30–970	244 ± 102	190	190	200	260	430
16	Eggs and egg mixed dishes	75–1490	356 ± 425	95	115	115	390	1200
17	Fried rice, lo mein, stir-fry mixtures	135–1390	724 ± 268	490	570	650	850	1200
18	Poultry mixed dishes	85–1810	830 ± 350	460	560	790	1040	1340
19	Biscuits, muffins, quick breads	115–840	369 ± 166	180	200	340	540	580
	Frozen/refrigerated	270–840	528 ± 97	360	510	550	580	580
	Fresh	130–540	210 ± 71	170	180	200	220	250
Mixes	115–400	290 ± 74	160	220	340	340	340	
20	Macaroni and cheese	550–990	759 ± 153	580	580	820	920	940

<sup>1</sup>Distribution is based on equalized sales-weighted estimates [weighted by the number of equivalent units sold in ounces or each (1 ounce = 28.35 g)].

<sup>2</sup>Ranks are based on descending order of food group's contribution to total sodium consumption among all participants (aged ≥2 y) in NHANES 2007–2008 as published in reference 19 and expanded to include the top 20 food categories. Subgroups are based on Nielsen modules to group similar products.

oils (60.8%); and sandwiches (53.2%). In addition, 91.3% of products in the processed-cheese subcategory exceeded the FDA limit, whereas only 1.4% of natural cheese products were above this cutoff. Among biscuits, muffins, and quick breads, 81.7% of frozen or refrigerated products exceeded the FDA limit for healthy label claims, whereas only 3.7% of fresh products in this category were above this level. In 3 categories (meat mixed dishes, pasta mixed dishes, and pizza) and in 3 subcategories (canned cold cuts and cured meats, processed cheese, and frozen or refrigerated biscuits, muffins, and quick breads) >75% of the products sold have more sodium per serving (or per 50 g) than

the FDA limit for “healthy” foods. In 4 categories, >10% of the products exceeded 1150 mg sodium/serving: meat mixed dishes (22.7%); poultry mixed dishes (15.8%); fried rice, lo mein, and stir-fry mixtures (13.2%); and eggs and egg mixed dishes (11.2%).

## DISCUSSION

In 2009, the sodium content of commercially processed packaged foods in the 20 categories contributing the most to US sodium intake was high and varied substantially within categories, as well as within subcategories. More than half of

**TABLE 3**Distribution of sodium content in milligrams per 100 g in branded packaged foods by the top food categories contributing to sodium consumption<sup>1</sup>

Rank <sup>2</sup>	Food category	Range	Mean ± SD	Percentile				
				10th	25th	50th	75th	90th
1	Breads and rolls	0–857	486 ± 90	370	435	494	536	577
	Frozen	320–698	470 ± 88	344	368	474	541	561
	Fresh bread	0–857	489 ± 93	370	441	494	540	588
	Fresh buns/rolls/bagels/etc.	300–808	477 ± 76	376	423	494	519	549
2	Cold cuts and cured meats	633–2257	1117 ± 234	864	988	1093	1214	1376
	Canned	794–1393	1159 ± 227	864	988	1041	1393	1393
	Refrigerated	633–2257	1114 ± 234	864	988	1093	1204	1340
3	Pizza	229–812	555 ± 94	439	494	548	630	688
4	Poultry	57–860	351 ± 191	76	179	339	515	631
5	Soups	66–1881	410 ± 262	182	255	338	457	714
6	Sandwiches	196–1025	554 ± 134	361	459	578	643	713
7	Cheese	56–1799	964 ± 390	600	635	776	1323	1481
	Natural	56–1376	647 ± 179	459	600	635	705	786
	Processed	304–1799	1326 ± 214	1223	1270	1323	1467	1481
	Shredded/grated	159–1786	815 ± 339	600	635	670	776	1517
8	Pasta mixed dishes	178–2463	460 ± 385	232	287	357	438	829
	Frozen	178–590	306 ± 73	215	245	311	342	404
	Other	242–2463	605 ± 491	287	359	438	466	1146
9	Meat mixed dishes	53–923	426 ± 135	275	335	408	536	564
	Frozen	53–923	408 ± 146	259	306	379	509	578
	Canned	323–597	472 ± 84	356	383	470	560	564
10	Savory snacks	0–2152	703 ± 307	397	516	635	847	1058
	Potato chips	18–1404	667 ± 190	464	598	635	739	850
	Tortilla chips	0–995	531 ± 159	388	406	529	635	741
	Other	53–2152	926 ± 375	516	647	907	1083	1359
11	Burritos, tacos, tamales	131–1368	420 ± 197	238	265	388	491	637
12	Frankfurters and sausages	310–1651	927 ± 216	634	811	926	1088	1199
	Sausages	310–1651	805 ± 215	556	634	811	911	1076
	Frankfurters/bratwursts	406–1481	1023 ± 161	826	917	1036	1158	1214
13	Salad dressings and vegetable oils	35–2187	1072 ± 298	741	917	1067	1199	1446
14	Ready-to-eat cereal	0–941	513 ± 219	136	448	559	670	705
15	Tomato-based condiments	106–1679	974 ± 274	661	772	1106	1117	1235
16	Eggs and egg mixed dishes	68–657	293 ± 158	168	168	203	379	534
17	Fried rice, lo mein, stir-fry mixtures	113–776	289 ± 122	156	208	267	323	469
18	Poultry mixed dishes	75–1235	426 ± 192	231	298	384	524	679
19	Biscuits, muffins, quick breads	250–1689	710 ± 295	344	383	847	952	1004
	Frozen/refrigerated	344–1689	928 ± 183	612	935	952	1004	1058
	Fresh	250–952	369 ± 121	289	317	353	383	423
	Mixes	364–1429	756 ± 201	458	613	847	847	847
20	Macaroni and cheese	201–1204	685 ± 241	353	427	829	847	902

<sup>1</sup>Distribution is based on equalized sales-weighted estimates [weighted by the number of equivalent units sold in ounces or each (1 ounce = 28.35 g)].

<sup>2</sup>Ranks are based on descending order of food group's contribution to total sodium consumption among all participants (aged ≥2 y) in NHANES 2007–2008 as published in reference 19 and expanded to include the top 20 food categories. Subgroups are based on Nielsen modules to group similar products.

products sold in 11 of the 20 food categories examined exceeded the FDA's limits for the "healthy" label claim per serving. Given the high average sodium per serving in these products, it does not require many servings to exceed the DGA recommendations for sodium intake. In 4 of these food categories, >10% of the products sold exceeded 1150 mg/serving, meaning it would require <2 servings of these foods to exceed the DGA recommendation of 2300 mg/d. Sodium serves several important purposes in food processing and manufacturing, and some of the food categories examined in this analysis are heterogeneous and capture a wide variety of products, particularly in the mixed

dishes categories. However, we observed a wide variation in sodium content in milligrams per serving, milligrams per 100g, and milligrams per kilocalorie in these foods, indicating the potential for choosing products to attain a "healthy" diet within all of the categories examined here. Although a large proportion of the products we examined exceeded the sodium targets for the "intermediate" sodium level DASH diet in terms of milligrams per kilocalorie (range: 1.02–1.15 mg/kcal), it is important to note that this particular measure should be interpreted with care, because foods that are high in fat or sugar and hence relatively low in sodium per kilocalorie may be misinterpreted as being

**TABLE 4**Distribution of sodium density in milligrams per kilocalorie in branded packaged foods by the top food categories contributing to sodium consumption<sup>1</sup>

Rank <sup>2</sup>	Food category	Range	Mean ± SD	Percentile				
				10th	25th	50th	75th	90th
1	Breads and rolls	0–6	1.9 ± 0.4	1.4	1.7	1.9	2.1	2.4
	Frozen	1–2	1.7 ± 0.3	1.3	1.4	1.7	1.8	2.1
	Fresh bread	0–6	1.9 ± 0.4	1.4	1.7	1.9	2.2	2.4
	Fresh buns/rolls/bagels/etc.	1–3	1.8 ± 0.3	1.4	1.6	1.8	1.9	2.2
2	Cold cuts and cured meats	1–15	7.2 ± 3.5	3.3	3.7	6.8	10.2	12.0
	Canned	3–5	4.3 ± 0.7	3.2	4.1	4.4	4.4	5.3
	Refrigerated	1–15	7.3 ± 3.5	3.3	3.7	7.3	10.2	12.4
3	Pizza	1–3	2.2 ± 0.4	1.8	2.0	2.2	2.6	2.8
4	Poultry	0–9	2.2 ± 1.5	0.3	1.6	1.9	2.4	3.9
5	Soups	3–194	18.4 ± 25.2	4.2	5.3	7.3	14.8	62.0
6	Sandwiches	1–3	2.2 ± 0.5	1.6	1.9	2.2	2.5	3.0
7	Cheese	0–10	3.2 ± 1.6	1.5	1.7	2.8	4.2	5.3
	Natural	0–7	2.0 ± 0.8	1.5	1.5	1.7	2.5	3.0
	Processed	1–10	4.6 ± 1.2	3.9	3.9	4.3	5.3	6.2
	Shredded/grated	0–6	2.4 ± 1.0	1.6	1.6	2.1	2.5	4.3
8	Pasta mixed dishes	1–7	3.0 ± 1.0	1.9	2.4	3.0	3.6	3.8
	Frozen	1–4	2.5 ± 0.5	1.8	2.0	2.4	2.8	3.1
	Other	2–7	3.6 ± 1.0	2.5	3.1	3.5	3.8	4.1
9	Meat mixed dishes	0–6	3.3 ± 1.1	2.2	2.6	3.1	4.2	4.6
	Frozen	0–6	3.1 ± 1.1	2.1	2.3	2.8	3.8	4.4
	Canned	2–5	3.8 ± 0.8	2.6	2.9	4.4	4.6	4.6
10	Savory snacks	0–13	1.4 ± 0.8	0.8	1.0	1.2	1.6	2.3
	Potato chips	0–3	1.3 ± 0.4	0.9	1.1	1.2	1.3	1.5
	Tortilla chips	0–2	1.0 ± 0.3	0.7	0.8	1.0	1.2	1.5
	Other	0–13	2.0 ± 1.1	1.1	1.4	1.8	2.3	3.2
11	Burritos, tacos, tamales	1–7	1.9 ± 0.8	1.0	1.2	1.9	2.2	2.6
12	Frankfurters and sausages	1–13	3.4 ± 1.3	2.3	2.7	3.1	4.0	4.7
	Sausages	1–10	3.0 ± 1.2	1.9	2.4	2.7	3.2	4.5
	Frankfurters/bratwursts	2–13	3.8 ± 1.3	2.7	3.0	3.8	4.0	4.8
13	Salad dressings and vegetable oils	0–32	4.0 ± 4.1	1.6	1.9	2.5	4.5	7.0
14	Ready-to-eat cereal	0–3	1.4 ± 0.6	0.4	1.2	1.5	1.8	1.9
15	Tomato-based condiments	3–40	13.0 ± 6.5	4.7	9.5	12.7	15.0	25.0
16	Eggs and egg mixed dishes	2–6	3.6 ± 0.9	2.6	3.0	3.2	3.8	3.8
17	Fried rice, lo mein, stir-fry mixtures	1–43	4.1 ± 6.0	1.3	1.9	2.5	3.7	10.0
18	Poultry mixed dishes	1–11	2.7 ± 1.5	1.5	1.7	2.5	3.0	4.3
19	Biscuits, muffins, quick breads	1–4	2.4 ± 0.8	1.3	1.7	2.3	3.1	3.5
	Frozen/refrigerated	2–4	3.2 ± 0.3	2.8	3.0	3.2	3.4	3.6
	Fresh	1–4	1.6 ± 0.6	0.9	1.7	1.7	1.8	1.8
	Mixes	1–4	2.0 ± 0.5	1.2	1.8	2.3	2.3	2.3
20	Macaroni and cheese	1–4	2.5 ± 0.4	2.2	2.2	2.4	2.6	2.8

<sup>1</sup>Distribution is based on equivalized sales-weighted estimates [weighted by the number of equivalent units sold in ounces or each (1 ounce = 28.35 g)].

<sup>2</sup>Ranks are based on descending order of food group's contribution to total sodium consumption among all participants (aged ≥2 y) in NHANES 2007–2008 as published in reference 19 and expanded to include the top 20 food categories. Subgroups are based on Nielsen modules to group similar products.

“healthy” (8). Given that 9 of 10 Americans exceed the daily recommended intake of sodium (4), our results emphasize the importance at the consumer level of reading product labels and selecting products that are lower in sodium. Although it is difficult to compare our findings with previous results because of differences in categorization of foods, databases and years examined, and definitions of “healthy” sodium content, our findings support those in the United States and in other developed countries that showed excess sodium content in commercially processed and packaged foods, as well as wide variation in the sodium content within food categories (24–28).

There are some acknowledged limitations to this database. First, because Gladson collects data from food manufacturers passively, the products in the 2009 database range from 2000 to 2010 in their dates of entry or update (with the exception of those products for which the NFP data had to be manually entered in 2012); 77% of products were entered or updated between 2008 and 2010; the remaining 23% were entered or updated before 2008. It is not known whether the older nutrition information for a particular product is valid because no changes were made to that product or whether the product indeed changed but the manufacturer did not send updated information to Gladson for entry

TABLE 5

Percentage of branded packaged food products that exceed specific levels of sodium by the top food categories contributing to sodium consumption<sup>1</sup>

Rank <sup>2</sup>	Food category	More than the FDA sodium limit for "healthy", <sup>3</sup> % (SE)	More than 1150 mg/serving, <sup>4</sup> % (SE)
1	Breads and rolls <sup>5</sup>	1.8 (1.3)	—
	Frozen	3.2 (3.3)	—
	Fresh bread		
2	Fresh buns/rolls/bagels/etc.	8.3 (6.0)	—
	Cold cuts and cured meats <sup>5</sup>	68.0 (4.2)	—
	Canned	92.0 (6.2)	—
3	Refrigerated	66.5 (4.3)	—
	Pizza <sup>6</sup>	77.0 (4.0)	2.8 (1.1)
	Poultry <sup>6</sup>	6.8 (4.2)	—
5	Soups <sup>6</sup>	64.3 (5.2)	1.3 (0.8)
6	Sandwiches <sup>6</sup>	53.2 (6.5)	0.7 (0.5)
7	Cheese <sup>5</sup>	42.2 (5.5)	—
	Natural	1.4 (0.6)	—
	Processed	91.3 (2.6)	—
	Shredded/grated	18.4 (4.8)	—
8	Pasta mixed dishes <sup>6</sup>	83.2 (3.5)	3.2 (1.1)
	Frozen	81.8 (3.8)	6.1 (2.1)
	Other	84.6 (5.8)	0.4 (0.4)
9	Meat mixed dishes <sup>6</sup>	90.4 (2.8)	22.7 (5.6)
	Frozen	86.7 (3.9)	18.4 (4.7)
	Canned	100.0 (0.0)	33.8 (14.5)
10	Savory snacks <sup>5</sup>	11.8 (2.2)	—
	Potato chips	4.8 (2.7)	—
	Tortilla chips	1.1 (0.8)	—
	Other	30.1 (4.9)	—
11	Burritos, tacos, tamales <sup>6</sup>	29.3 (5.9)	1.9 (1.6)
12	Frankfurters and sausages <sup>5</sup>	62.6 (4.5)	1.2 (0.5)
	Sausages	58.9 (4.8)	0.8 (0.5)
	Frankfurters/bratwursts	65.5 (7.0)	1.5 (0.9)
13	Salad dressings and vegetable oils <sup>5</sup>	60.8 (5.4)	—
14	Ready-to-eat cereal <sup>5</sup>	—	—
15	Tomato-based condiments <sup>5</sup>	47.5 (8.8)	—
16	Eggs and egg mixed dishes <sup>6</sup>	22.2 (9.8)	11.2 (7.2)
17	Fried rice, lo mein, stir-fry mixtures <sup>6</sup>	68.0 (6.5)	13.2 (6.2)
18	Poultry mixed dishes <sup>6</sup>	66.9 (4.7)	15.8 (3.9)
19	Biscuits, muffins, quick breads <sup>5</sup>	38.0 (8.6)	—
	Frozen/refrigerated	81.7 (6.0)	—
	Fresh	3.7 (3.9)	—
	Mixes	4.7 (3.8)	—
20	Macaroni and cheese <sup>6</sup>	62.9 (18.6)	—

<sup>1</sup>Distribution is based on equalized sales-weighted estimates [weighted by the number of equivalent units sold in ounces or each (1 ounce = 28.35 g)]. FDA, Food and Drug Administration; RACC, Reference Amount Customarily Consumed.

<sup>2</sup>Ranks are based on descending order of food group's contribution to total sodium consumption among all participants (aged  $\geq 2$  y) in NHANES 2007–2008 as published in reference 19 and expanded to include the top 20 food categories. Subgroups are based on Nielsen modules to group similar products.

<sup>3</sup>FDA sodium limit for products using a "healthy" label claim: 480 mg/serving for individual foods with an RACC  $>30$  g, 480 mg/50 g for individual foods with an RACC  $\leq 30$  g, 600 mg/serving for meals or main dishes (9).

<sup>4</sup>More than 1150 mg/serving = 50% of the *Dietary Guidelines for Americans* recommendation (2300 mg/d) (6).

<sup>5</sup>Defined as an individual food for FDA sodium limits (foods with an RACC  $>30$  g = 480 mg/serving, foods with an RACC  $\leq 30$  g = 480 mg/50 g) (23).

<sup>6</sup>Defined as a meal or main dish for FDA sodium limits (600 mg/serving) (23).

into its database. Second, all of the nutritional information is extracted directly from the NFP rather than from laboratory analysis of the foods. According to FDA regulatory standards, the label value on the NFP can exceed the actual sodium content by as much as 20% before the food is considered misbranded (29). However, we compared the sales-weighted average sodium values from the NFP for sliced white bread and hamburger and

hotdog buns with recent USDA laboratory results on these foods and found that the average NFP data closely aligned ( $\pm 4\%$ ) with the average values from the analysis for these foods (J Ahuja, unpublished results, 2013). The third limitation is that the 2009 Nielsen sales data did not capture warehouse-type retail sales (e.g., Costco, Sam's Club), Walmart grocery sales, or sales from independent or smaller grocery chains that gross  $< \$2$  million/y



in sales. Walmart has become the largest US food retailer, and discount supercenters and warehouse club stores currently account for ~30% of US grocery sales (30, 31). Although Walmart pledged in 2011 to reduce the sodium content in their private label products by 25% (32), no available evidence indicates that the sodium content of packaged foods available through this or other warehouse-type outlets differed substantially in 2009 from that of the major retailers included in the Nielsen data. Fourth, our database does not include private-label or generic food products, which were estimated to account for ~25% of calories sold in 2007 (33). However, we have no reason to believe that these products differ substantially in their nutritional composition from their branded counterparts. Also, our database is limited to those products that comprised the top 80% of sales or >1% of sales within each food category in the 2009 Nielsen ScanTrack database; and because identical products of a different size have a unique UPC, our database may contain some replicate products. Although several other sales and NFP databases exist and are publicly available for sale, we determined the Nielsen ScanTrack and Gladson databases to provide the most comprehensive information for the cost. Even taking into account these acknowledged limitations, we believe the database represents a valid cross-section of the nutritional composition of the most widely purchased packaged foods sold in US grocery stores in 2009.

The DGA emphasizes the importance of reducing the sodium content of foods in the marketplace to allow consumers to reduce their sodium intake. Targets for sodium reduction in packaged and processed foods have already been established in Canada and the United Kingdom and by New York's NSRI (11, 34, 35). Several food manufacturers have already committed to voluntarily reduce the sodium content of some of their products, some of which are listed as partners in the NSRI (11). Given the common consumption of packaged foods, a reduction in the sodium content of these products could greatly affect the overall sodium intake in the United States and thereby affect health outcomes.

With voluntary efforts already underway by some manufacturers to lower the sodium content in some of their products, it will be important to perform similar analyses in the future to examine progress over time in the US market. Tracking the sodium content and sales of packaged and processed foods over time will complement trends in dietary intakes already assessed in national surveys. Such analyses can determine potential shifts in the US market in response to voluntary efforts by manufacturers and consumer choice, as represented in the sales data.

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