

**Sodium in School Lunches Before and After Implementation of the Healthy, Hunger Free  
Kids Act of 2010**

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**Abstract**

Sodium in School Lunches Before and After Implementation of the Healthy, Hunger Free Kids Act of 2010

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*Background:* Good nutrition is essential for child health and development. Effective school lunch standards can contribute to the well-being and academic achievement of students. The Healthy, Hunger Free Kids Act of 2010 (HHFKA) mandated implementation of nutrition standards for the National School Lunch Program. The HHFKA standards required increased servings of fruits, vegetables, and whole-grain rich foods and set upper calorie, saturated fat, and sodium limits starting in 2012. Sodium standards were to be phased in over time, starting in July 2014.

*Objective:* This longitudinal study assessed sodium content of school lunches selected by students before and after implementation of the HHFKA.

*Methods:* The sodium content of 1,741,630 school lunches selected between January 2011 and January 2014 in three middle schools and three high schools in an urban school district in Washington State was analyzed. Mean daily sodium content of foods selected by students per month was compared before and after HHFKA implementation using time series analysis.

*Results:* After HHFKA implementation, there was a significant decrease in the sodium content of school lunches selected by students. Mean daily sodium in selected school lunches decreased from 1,149 mg (range 1,087-1,231 mg) to 947 mg (range 899-1,001 mg) in middle schools and from 1,414 mg (range 1,366-1,426 mg) to 1,127 mg (range 995-1,189 mg) in high schools. By July 2012, all six schools met the first HHFKA sodium goal of <1,360 mg per meal in middle schools and <1,420 mg per meal in high schools, two years before the deadline. The three middle schools met the second sodium goal of <1,035 mg per meal, five years before the deadline.

*Conclusion:* Just implementing nutrition standards for types and amounts of foods served was effective by itself in reducing the sodium content of school lunches selected by students. It is feasible to meet sodium targets established in the HHFKA.

## Introduction

During the 1930's, the risk for child malnutrition grew as many children could not pay for school lunch, and families had limited resources to provide home meals (1). Initial federal aid for school lunches was granted through year-to-year appropriations, and in 1946 The National School Lunch Program (NSLP) was given permanent status (1). The purpose of the NSLP is to “safeguard the health and well-being of the nation’s children” in recognition of the “relationship between food and good nutrition and the capacity of children to develop and learn” (2).

NSLP has grown dramatically since its inception, serving more than 5 billion lunches to more than 30 million students during the 2014-15 school year (3). A nationwide assessment of NSLP in 2009-10 found that only 7% of schools met *all* current school meal nutrition standards; the Healthy Hunger Free Kids Act of 2010 (HHFKA) included provisions to improve the nutritional quality of school meals (4, 5).

HHFKA required the United States Department of Agriculture (USDA) to update meal and nutrition standards so NSLP would align with the 2010 USDA Dietary Guidelines for Americans (6). The new nutrition standards were implemented at the beginning of the 2012-13 school year; standards required increased servings of fruits, vegetables and whole-grain rich foods, set upper calorie, saturated fat, and sodium limits, and eliminated trans fats (5).

One controversial component of the HHFKA was the upper limit of sodium in school meals. Sodium upper limits were recommended by the Institute of Medicine in an effort to lower the risk of chronic disease (5). Previous NSLP standards *encouraged* reduced sodium but did not specify a sodium target (4). In 2010, the mean sodium content of school lunches offered and served exceeded the 2010 Dietary Guidelines recommendations for sodium by more than 50% (4). Furthermore, less than 10% of schools served lunches with an average sodium content that

was within 200 mg of the recommended maximum (4). The new standards set upper limits for average sodium content of school meals for each grade group (K-5, 6-8, 9-12) (5). Sodium targets reflected a 20-50% reduction in sodium in school lunches that was to be implemented gradually over the span of eight years (Table 1)(5).

**Table 1.** Sodium reduction timeline and mean daily sodium limits established in the HHFKA standards (5)

	Sodium Reduction Timeline and Limit per Meal		
Grade Group	Target 1 (July 1, 2014)	Target 2 (July 1, 2017)	Target 3 (July 1, 2022)
K-5	<1,230 mg	< 935 mg	< 640 mg
6-8	< 1,360 mg	< 1,035 mg	< 710 mg
9-12	< 1,420 mg	< 1,080 mg	< 740 mg

Many HHFKA standards were implemented on July 1, 2012. However, the first sodium target was delayed until July 2014, and the second sodium target was to be met five years later in July 2017. The final sodium target of less than 710 mg per meal for middle school and less than 740 mg per meal for high school was set for July 2022. (5)

### **Prior Research**

Prior studies examining changes in school meals after implementation of the new standards have primarily focused on fruit and vegetable consumption and variety, student participation, and food waste (7-11). Few studies have looked at how sodium levels have changed in school meals following the implementation of HHFKA (12, 13). After the implementation of the HHFKA Bergman et al. found a decrease in sodium content of foods selected and consumed in four elementary schools that fulfilled the HealthierUS School Challenge requirements (12). A study conducted by Shemesh found a decrease in average weekly sodium in school meals following the implementation of the HHFKA (13); the study did not review which foods contributed to the sodium content in school meals (13).

The current study is unique because it evaluates changes in sodium content of 1,741,630 school lunches selected by students in six schools over three years that included the HHFKA implementation on July 1, 2012. The study provides insight into the feasibility of meeting the HHFKA sodium targets and illustrates what factors affect sodium content in school meals.

## **Methods**

School lunch student food selection data were collected from January 2011 to January 2014 in the 16 school-year months prior to and the 15 school-year months after implementation of the HHFKA. Food production records were used to collect these data. These records are normally kept by the school district and contain no student information, therefore, informed consent was not necessary. Study procedures were approved by the University of Washington institutional review board.

This study took place in three middle schools and three high schools in a large, urban US school district. At the time of the study, in this school district, 28% of students were non-Hispanic white, and 54% were eligible for free and reduced-price meals. The total enrollment of the six study schools was approximately 7,200.

## **Student Food Selection**

School food service managers provided researchers with daily food production records based on standardized menus and recipes developed by the district's Nutrition Services Department. Food service managers used order guides for specific foods and recipe ingredients and projected amounts needed based on the anticipated number of servings of each menu item. Foods were distributed to schools from a central facility, and each school had a finishing kitchen where final steps of food preparation took place. Individual school production records documented the number of food items produced (including entrées and side dishes) and the

number of servings of each individual food item selected by students at lunch.

Individual items served at the daily salad bars were ordered in bulk and were not included in the production records. Thus, the nutritional contribution of the self-serve salad bars was estimated through school-level purchase records of the most common specific fruit and vegetable items selected from a common food order guide exclusively for use in the salad bars. This estimate did not account for condiments that were only occasionally on the salad bar (olives, jalapenos, pickles, peppers).

Nutritional information for all items served as part of the school lunch program was provided by the district's Nutrition Services Department, using NUTRIKIDS nutrition analysis software (Heartland Payment Systems Inc.). Nutritional information for salad bar items was determined using the Food Processor SQL, version 10.9.0 nutrition analysis software (ESHA Research). Spreadsheets with information about individual student food selections from the daily production records and the nutrient content of foods were matched forming a single data set.

***Dependent Variables:*** Mean daily sodium per student for each month, mean daily sodium density for each month, and mean monthly sodium dosage per item:

- Mean daily sodium was calculated as the total sodium content in all lunch items selected each day, divided by the total number of students served. Daily means were averaged over each month.
- Mean daily sodium density was computed as mean daily sodium per 1,000 kcal. To calculate mean daily sodium density, mean daily calories were calculated as the total calories in all lunch items selected each day divided by the number of students who participated in school lunch. Mean daily calories were standardized by dividing by 1,000 kcal. Finally, mean daily sodium was divided by the standardized caloric value to

determine mean daily sodium density; daily means were averaged over each month. *Because sodium tends to decrease as calories decrease, sodium density can be used to measure specific changes in sodium content regardless of caloric changes. This allows for identification of true changes in sodium content of foods regardless of the decrease in calories. Reducing calories may lead to a decrease in sodium content and high sodium density foods, but a reduction in calories may not be the goal (14).*

- Mean monthly sodium dosage was calculated for each food item served. The total servings of each item per period (prior to or following HHFKA implementation) was multiplied by the sodium content of the item, divided by the number of months per period.

Univariate time series are values of a single measure collected over time. In this study, two univariate time series analyzed average sodium content of food selected - one in the three middle schools and one in three high schools. Each series was composed of values averaged over each month when school was in session for a total of 31 months. A policy coefficient was included in the analysis to reflect the time of HHFKA implementation. All analyses were performed using SAS/STAT software, version 9.3 (SAS Institute Inc.).

Nutrition data for all items served prior to and following implementation of HHFKA was aggregated and sorted from highest to lowest mean monthly sodium dosage. This allowed for the identification of the top sodium contributors prior to and following implementation of the new standards.

## **Results**

Figure 1 shows mean daily sodium per student in foods selected during the 31-month study period. The univariate time series analysis indicated that the policy coefficient was

negative and statistically significant for middle schools (estimated coefficient =  $-157.32$ ,  $p < 0.001$ ) and high schools ( $-314.44$ ,  $p < 0.001$ ) suggesting a decrease in mean sodium following implementation of the new standards. This decrease occurred in the beginning of the 2012-13 school year when HHFKA grain and vegetable standards were required even though the target date for sodium reduction was not until July 2014.

Following HHFKA implementation, there was a decrease in mean daily sodium content per student of foods selected from 1,149 mg (range 1,087-1,231 mg) to 947 mg (range 899-1,001 mg) in middle schools and from 1,414 (range 1,366-1,426 mg) to 1,127 (range 995-1,189 mg) in high schools. This coincided with a decrease in mean sodium density of food selected by students.

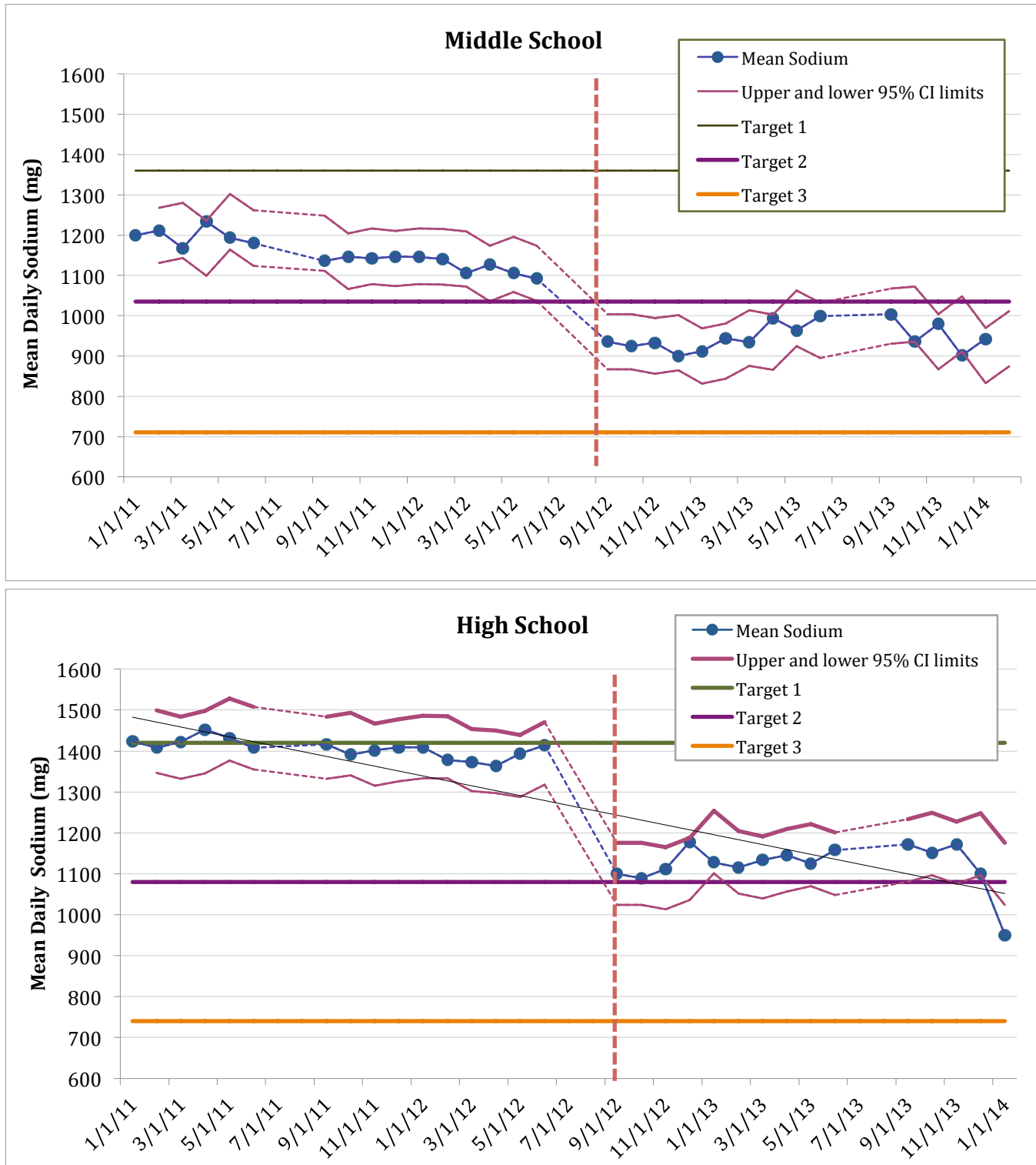
Mean daily sodium density of selected foods decreased from 1,963 mg/1,000 kcal (range 1,887-2,049 mg/1,000 kcal) to 1,798 mg/1,000kcal (range 1,742-1,875 mg/1,000 kcal) in middle schools and from 2,047 mg/1,000 kcal (range 1,852-1,971 mg/1,000 kcal) to 1,916 (range 1,852 – 1,971) in high schools.

#### *Mean Monthly Sodium Dosage Per Item*

Tables 2 and 3 show the food items that contributed the most sodium prior to and following implementation of the HHFKA. French fries were the major, single item contributor of sodium in middle schools (5,153,879 mg per month) and high schools (6,329,359 mg per month) before the implementation of the new standards. In this school district, French fries were removed as individual sides following implementation of the HHFKA. However, as seen in Tables 3 and 4, fries were added to some entrees (chicken tenders, chicken nuggets, and corn dogs) following HHFKA implementation. Following HHFKA implementation corn dogs, a top contributor of sodium in selected middle school lunches, were removed from middle school

lunches and mini corn dogs with fries were added. As seen in Table 2, despite having added fries, the mini corn dogs had lower sodium content and sodium density than the corn dogs. Table 3 shows that the sodium content and sodium density of chicken Caesar salad and Asian chicken salad, top contributors of sodium in selected high school lunches, decreased following HHFKA implementation. Egg rolls were removed from rice bowl entrees following HHFKA implementation, and this coincided with a decrease in sodium content and sodium density of beef teriyaki bowls, chicken lo mein bowls, and Szechuan chicken bowls.

**Figure 1.** Estimated mean daily sodium per student in school lunches selected by students before and after implementation of new meal standards



The vertical dashed line indicates the implementation of the Healthy Hunger-Free Kids Act. The dashed horizontal lines between markers represent summer months when no data were collected.

## **Discussion**

This longitudinal study compared sodium content in school lunches before and after implementation of several new HHFKA standards in three middle schools and three high schools in a large, urban US school district in Washington State. Although sodium reductions were not required in 2012-13, significant reductions in sodium occurred at the beginning of the 2012-13 school year when other new standards were implemented. With the implementation of the new standards in 2012, the mean daily sodium content of school lunches that were selected by students decreased below the first sodium target that was not mandated until 2014-15. In middle schools, the mean daily sodium in school lunches selected decreased even below the second sodium target that was initially planned for implementation in 2017-18.

The school district food service director was interviewed and reported that specific sourcing of low sodium items or reformulation of recipes did not drive the decrease in sodium in school meals - recipes were not reformulated and new low-sodium products were not actively pursued during this time. During product selection, if a choice arose between two similar food items, selection was based on sodium content; the sodium content of foods was otherwise not a main factor in food selection. The decrease in sodium was secondary to changes made to comply with new grain, calorie and vegetable requirements.

Complying with vegetable, calorie, and grain HHFKA standards resulted in significant sodium reduction earlier than scheduled. It is noteworthy that implementation of the HHFKA standards required that an increased variety of vegetables be served. This resulted in the removal of fries served as individual sides and reduced pairing of fries with entrees. An HHFKA limit on the maximum caloric content of meals also contributed to the decision to reduce the frequency and serving size of fries.

In addition, new HHFKA standards reduced the serving size, quantity and type of grain allowed per meal. In complying with this rule, sodium reduction was a secondary outcome. For example, larger hoagie rolls were replaced with whole wheat bread; egg rolls were removed or replaced by spring rolls; garlic bread was replaced by whole wheat rolls. Because the new standards also specified that salad croutons, chow mein noodles and breaded patties now count toward grain servings - these items were reduced or removed from lunches following implementation of HHFKA so that serving sizes of rolls, breads and other grains could be maximized. This explains the reduction in density and amount of sodium in Asian Chicken and Caesar Salad. Furthermore, portion sizes of rice and noodles were reduced to comply with grain serving size specifications set by HHFKA standards. The replacement, removal and reduction of grain products in compliance with HHFKA standards, contributed to the decrease in mean sodium content of school lunches selected by students. Although USDA changed requirements later in the school year, this district made few alterations after the initial changes in 2012 beyond bringing back some breaded items.

The findings of this study are consistent with studies that indicate that revised school nutrition standards is associated with reduced sodium content of foods selected by students (12, 13). This study is unique in that it provides sodium data for more than 1.7 million school lunches selected over 31 months and provides insight into *why* sodium decreased in school lunches. Unlike previous studies that only measured overall sodium content of lunches selected or consumed, this study recognized and analyzed differences in foods served in school lunches prior to and following implementation of HHFKA.

Limitations of this study include involvement of only one urban school district and the inclusion of only middle schools and high schools. The generalizability of these findings could

be enhanced if more schools, grade levels, and geographic regions were included. In addition, the data reflect foods selected by students, not food consumed. Furthermore, condiments and items occasionally offered on the salad bar (e.g. olives, jalapenos, pickles, peppers) were not included in sodium calculations. These items tend to be sodium dense, and, although attempts were made to improve the nutritional quality of condiments, these measures were not included in our data. As a result sodium, content of selected school lunches is likely underestimated.

## **Conclusion**

This study provides evidence that the HHFKA standards for sodium in school lunches are attainable. Sodium levels were significantly reduced without using low sodium items or reformulating recipes. If sodium levels decreased without conscious efforts to reduce sodium, further reductions are likely possible if low-sodium food items are used and if recipes are reformulated. A previous study that analyzed school lunch participation rates at the six schools over the same 31 months found no effect of HHFKA on student lunch participation (7). These findings support the continuation of HHFKA standards that require schools to offer a variety of vegetables and limit the calories in school meals as these requirements have secondary effects that support additional HHFKA meal standards. This study provides evidence to support ongoing sodium reduction efforts in school meals and the feasibility of achieving HHFKA sodium reduction goals.

**Table 2.** Top 15 sodium-contributing items in three middle schools.

Pre-Implementation (January 2011 – June 2012)					
Recipe Description	Mean # Served per Month	Calories	Sodium (mg)	Sodium Density (mg Na/1,000 kcal)	Mean Monthly Sodium Dosage (mg)
French Fries/Jojos	15,158	160	340	2,125	5,153,879
Assorted Pizzas	4,986	385	672	1,768	3,350,993
Chocolate Milk	22,234	148	144	973	3,201,761
Corn Dog	1,498	540	1,560	2,889	2,336,880
Beefy Nachos	1,388	474	1,553	3,276	2,155,279
Chicken Sandwich	1,887	325	806	2,480	1,520,569
Mini Twin Cheeseburgers	2,028	451	737	1,634	1,494,314
Spicy Chicken Sandwich	1,812	312	775	2,484	1,404,058
Chicken Tenders	1,327	265	875	3,302	1,161,398
Chicken Nuggets	1,771	219	648	2,959	1,147,527
White Milk	8,085	103	107	1,039	865,093
Fiesta Bean Burrito	818	439	1,057	2,408	864,560
Chicken Burger	1,079	303	731	2,413	788,429
Hash Browns	3,243	90	199	2,211	645,323
Hoagie Sandwiches	512	293	1,177	4,017	602,036
Post-Implementation (September 2012 – January 2014)					
Recipe Description	Mean # Served per Month	Calories	Sodium (mg)	Sodium Density (mg Na/1,000 kcal)	Mean Monthly Sodium Dosage (mg)
Grilled Chicken Sandwich	4,026	240	790	3,292	3,180,435
Chocolate Milk	21,770	148	144	973	3,134,846
Assorted Pizzas	4,728	342	627	1,842	2,966,220
Mini Corn Dogs w/Fries	2,386	475	1,075	2,263	2,565,022
Chicken Nuggets w/Fries	2,548	380	840	2,211	2,140,600
Beefy Nachos	1,181	373	1,412	3,786	1,667,478
Mini Twin Burgers	1,958	390	590	1,513	1,155,141
Chicken Tenders w/Garlic Toast	1,207	425	953	2,242	1,149,890
Spicy Chicken Rings	776	420	1,160	2,762	899,851
Mozzarella Pizza Stick	1,142	280	700	2,500	799,680
White Milk	7,206	103	107	1,039	771,023
Deli Sandwich	658	351	1,089	3,103	716,998
Mini Twin BBQ Beef Rib Sliders	1,007	410	680	1,659	685,032
Peanut Butter & Jelly Sandwich	1,032	430	580	1,349	598,328
Beef Teriyaki Rice Bowl	417	410	1,407	3,432	586,813

**Table 3.** Top 15 sodium-contributing items in three high schools.

Pre-Implementation (January 2011 – June 2012)					
Recipe Description	Mean # Served per Month	Calories	Sodium (mg)	Sodium Density (mg Na/1,000 kcal)	Mean Monthly Sodium Dosage (mg)
French fries/Jojos	18,616	160	340	2,125	6,329,359
Assorted Pizzas	6,485	411	691	1,681	4,478,356
Hoagie Sandwiches	2,546	297	1,324	4,455	3,366,642
Chocolate Milk	15,119	148	144	973	2,177,165
Chicken Caesar Salad	1,256	387	1,550	4,005	1,946,122
Spicy Chicken Sandwich	1,149	312	775	2,484	890,378
Asian Chicken Salad	393	587	1,647	2,806	647,477
Mini Twin Cheeseburgers	874	451	737	1,634	644,414
Chicken Tenders	726	265	875	3,302	635,633
Milk White 1%	5,837	103	107	1,039	624,566
Beefy Nachos	363	474	1,549	3,268	562,614
Chicken Burger	758	303	731	2,413	554,098
Chicken Sandwich	666	325	806	2,480	537,149
Corn Dog	305	540	1,560	2,889	476,288
Beef Teriyaki Bowl w/Egg Roll	283	668	1,665	2,493	470,363
Post-Implementation (September 2012 – January 2014)					
Recipe Description	Mean # Served per Month	Calories	Sodium (mg)	Sodium Density (mg Na/1,000 kcal)	Mean Monthly Sodium Dosage (mg)
Assorted Pizzas	5,243	371	749	2,019	3,927,252
Deli Sandwich	2,608	395	1,366	3,458	3,562,164
Chocolate Milk	14,800	148	144	973	2,131,181
Chicken Tenders W/Bread & Fries	939	585	1,293	2,210	1,213,634
Grilled Chicken Sandwich	1,419	240	790	3,292	1,121,054
Chicken Caesar Salad	1,072	361	1,036	2,870	1,110,385
Beefy Nachos	670	515	1,533	2,977	1,027,825
Chicken Nuggets W/Bread & Fries	901	470	1,010	2,149	910,246
Spicy Chicken Tender W/Bread & Fries	549	600	1,490	2,483	818,407
Beef Teriyaki Rice Bowl	452	547	1,572	2,874	710,544
White Milk	5,654	103	107	1,039	604,935
Asian Chicken Salad	660	363	900	2,479	594,000
Spicy Chicken Sandwich	719	310	770	2,484	553,322
Cheeseburger	682	330	805	2,439	548,795
Peanut Butter & Jelly Sandwich	880	430	580	1,349	510,284

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