



Sodium Intake among US School-Aged Children: National Health and Nutrition Examination Survey, 2011-2012



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ABSTRACT

Background Identifying current major dietary sources of sodium can enhance strategies to reduce excess sodium intake, which occurs among 90% of US school-aged children.

Objective To describe major food sources, places obtained, and eating occasions contributing to sodium intake among US school-aged children.

Design Cross-sectional analysis of data from the 2011-2012 National Health and Nutrition Examination Survey.

Participants/setting A nationally representative sample of 2,142 US children aged 6 to 18 years who completed a 24-hour dietary recall.

Main outcome measures Population proportions of sodium intake from major food categories, places, and eating occasions.

Statistical analyses performed Statistical analyses accounted for the complex survey design and sampling. Wald *F* tests and *t* tests were used to examine differences between subgroups.

Results Average daily sodium intake was highest among adolescents aged 14 to 18 years (3,565±120 mg), lowest among girls (2,919±74 mg). Little variation was seen in average intakes or the top five sodium contributors by sociodemographic characteristics or weight status. Ten food categories contributed to almost half (48%) of US school-aged children's sodium intake, and included pizza, Mexican-mixed dishes, sandwiches, breads, cold cuts, soups, savory snacks, cheese, plain milk, and poultry. More than 80 food categories contributed to the other half of children's sodium intake. Foods obtained from stores contributed 58% of sodium intake, fast-food/pizza restaurants contributed 16%, and school cafeterias contributed 10%. Thirty-nine percent of sodium intake was consumed at dinner, 31% at lunch, 16% from snacks, and 14% at breakfast.

Conclusions With the exception of plain milk, which naturally contains sodium, the top 10 food categories contributing to US schoolchildren's sodium intake during 2011-2012 comprised foods in which sodium is added during processing or preparation. Sodium is consumed throughout the day from multiple foods and locations, highlighting the importance of sodium reduction across the US food supply.

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ABOUT 90% OF US CHILDREN AGED 6 TO 18 YEARS consume excess dietary sodium¹ and one in nine children ages 8 to 17 years have blood pressure above the normal range for their age, sex, and

height,² which increases their risk of high blood pressure as adults.^{3,4} Reducing sodium intake can reduce blood pressure in children and adults.^{5,6} It is especially important to reduce sodium intake among children because taste preferences formed in childhood can influence food preferences as adults.⁷ The 2015-2020 Dietary Guidelines for Americans recommend Americans consume <2,300 mg sodium per day and suggest that specific subgroups further limit sodium intake.⁸ The Institute of Medicine's Tolerable Upper Intake Level for sodium is 1,900 mg/day for children aged 4 to 8 years, 2,200 mg/day for children aged 9 to 13 years, and 2,300 mg/day for those aged 14 years and older.⁹ A variety of governmental and nongovernmental organizations encourage Americans to select nutrient-dense foods and to limit intakes

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of solid fats, added sugars, and sodium.^{8,10-12} Sodium reduction strategies such as industry efforts to reduce sodium in food products, as well as strategies implemented during the 2014-2015 school year as part of the Healthy Hunger Free Kids Act¹³ to gradually reduce sodium in school foods, complement a total diet approach for adherence to the Dietary Guidelines.⁸ Current data help establish a baseline for monitoring the influence of sodium reduction strategies.

Previously, data were unavailable for Asian Americans, a growing segment of the US population.¹⁴ Sources of sodium intake may differ between Asian Americans and other race/ethnic groups. In the 2011-2012 National Health and Nutrition Examination Survey (NHANES), non-Hispanic Asian participants were oversampled to allow separate estimates for this group.¹⁵ As in previous years,¹ identifying major food categories, places obtained, and eating occasions (meals or snacks) contributing to sodium intake can help develop more effective strategies for sodium reduction and provide the most current data about specific race/ethnic groups, now including Asian-American children. Most of the sodium Americans eat is not naturally inherent in the food, or added by the consumer at the table, but from sodium added during commercial processing or preparation.¹⁶

Determining the food types, places, and times contributing most to sodium intake can help determine whether a targeted approach would be effective. In addition, examining the amount of sodium consumed per calorie (sodium density) can help researchers and policy makers understand whether differences in sodium intake between population race/ethnic groups, or other subgroups, or across places or eating occasions are due to differences in consumption of energy, a sodium-dense diet, or both.

The current analyses are also important given several recent changes made to the US Department of Agriculture's Food and Nutrient Database for Dietary Studies (FNDDS) in 2011-2012, which is used to code dietary intake data in this analysis,¹⁷ and improvements to the categorization of foods. The addition of new codes for commercial and restaurant foods, enhanced and fortified foods, and changes in coding and categorization to reflect the current marketplace allow for an up-to-date representation of top food sources contributing to sodium intake. This analysis describes sodium intake, sodium density (milligrams of sodium per 1,000 kcal), and the food categories, places obtained, and eating occasions contributing to sodium intake among US children aged 6 to 18 years during 2011-2012, before the implementation of the sodium targets for school foods authorized under the Healthy Hunger Free Kids Act.¹³

METHODS

For these analyses we used data from the 2011-2012 NHANES, a nationally representative, ongoing survey of the US noninstitutionalized population. The National Center for Health Statistics Research Ethics Review Board reviewed and approved all NHANES protocol and content, and written consent was obtained from all participants. Parental consent was obtained for all children younger than age 18 years, and child assent was also obtained for children aged 7 to 17 years. To select participants, a complex, multistage probability sampling design was used with oversampling of selected populations, including, for the first time in

2011-2012, non-Hispanic Asians.¹⁵ Of the 2,336 children aged 6 to 18 years selected for participation, 2,142 completed an initial, in-person, 24-hour dietary recall as part of What We Eat in America (WWEIA), the dietary intake portion of NHANES.¹⁸

During the 24-hour dietary recall, information collected includes food descriptions, additions, amounts consumed, and any foods or beverages eaten in combination, for all foods and beverages consumed during the previous 24-hour period. Information is self-reported by the participant (aged 12 to 18 years) or the participant assisted by a proxy (aged 6 to 11 years), the person responsible for preparing the participant's meals. Each food is assigned a food code from the FNDDS and the corresponding nutrient intake for each food and beverage is estimated from the reported amount consumed. Each FNDDS food code is placed in one of 152 independent WWEIA food categories by grouping similar foods and beverages together on the basis of use and nutrient content.¹⁹ Thirty-two food categories that were similar were consolidated into fewer groups (eg, whole, low-fat, reduced-fat, and nonfat plain milk combined into one category for plain milk), resulting in 131 categories for the present analysis (available in the Figure [available online at www.andjrnl.org]).

The top 10 food categories that contribute the most to population sodium consumption were identified and ranked based on their percent contribution to the total sodium intake among US children aged 6 to 18 years (calculated as the sum of the sodium from foods consumed from a category, divided by the sum of sodium consumed from all foods from all children aged 6 to 18 years, and multiplied by 100), excluding salt added at the table.²⁰ In addition, the top 10 food categories contributing the most to sodium intake among US children aged 6 to 18 years were examined by age groups, sex, race/ethnicity, family income, and weight status, and the population proportion of total sodium intake was examined by place obtained (ie, store, fast-food/pizza restaurant, restaurant with a waiter/waitress, school cafeteria, and other) and by eating occasion (ie, breakfast, lunch, dinner, and snack) overall and by age group. The code for "store" included, but was not limited to grocery stores, supermarkets, warehouse stores, farmers markets, and convenience-type stores. Restaurants were distinguished by service from a waiter or waitress (eg, coffee shops or food courts without a waiter/waitress are considered fast-food restaurants).

Additional calculations determined the population proportion of sodium consumed at lunch from each place obtained (proportion of sodium obtained from each source at lunch, divided by proportion from all sources at lunch, multiplied by 100).²⁰ Average sodium intake (milligrams per day) and average sodium density were examined overall and by socio-demographic characteristics and weight status, by eating occasion, and by place obtained. Estimates of average sodium intake excluded sodium from salt added at the table due to the difficulty in quantifying the amount of salt added at the table. Average sodium density was defined as milligrams of sodium per 1,000 kcal consumed. Wald *F* tests were used to examine overall differences between subgroups. Univariate *t* tests were used to examine differences between all subgroups; for example, children aged 6 to 10 years were compared with children aged 11 to 13 years, and 14 to 18 years, and children aged 11 to 13 years were compared with children aged 14 to 18

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