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Prevalence of Excess Sodium Intake in the United States — NHANES, 2009–2012

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Hypertension, a major risk factor for cardiovascular diseases, occurs among 29% of U.S. adults, and lowering excess sodium intake can reduce blood pressure (*1–3*). The *2015–2020 Dietary Guidelines for Americans* recommend consuming less than 2,300 mg dietary sodium per day for persons aged ≥14 years and less for persons aged 2–13 years.* To examine the current prevalence of excess sodium intake among Americans overall, and among hypertensive adults, CDC analyzed data from 14,728 participants aged ≥2 years in the 2009–2012 National Health and Nutrition Examination Survey (NHANES). Eighty-nine percent of adults and over 90% of children exceeded recommendations for sodium intake. Among hypertensive adults, 86% exceeded 2,300 mg dietary sodium per day. To address the high prevalence of excess sodium consumption in the U.S. population, the Institute of Medicine (IOM) recommended reducing sodium in the food supply, as excess sodium added to foods during commercial processing and preparation represents the main source of sodium intake in U.S. diets (*4*).

NHANES is a nationally representative, multistage survey of noninstitutionalized persons in the United States. The survey includes an in-person examination with a 24-hour dietary recall, and a second 24-hour dietary recall administered by telephone 3–10 days later. This cross-sectional study used data from NHANES years 2009–2012 (N = 20,293). For children aged 2–5 years, dietary intake was reported by a proxy, and for children aged 6–11 years, by the participant assisted by a proxy. The unweighted response rate of the examined sample was 77.3% in 2009–2010 and 69.5% in 2011–2012. This study included participants aged ≥2 years who completed two 24-hour dietary recalls (n = 14,900), but excluded pregnant women and women whose pregnancy status was unknown (n = 161), as well as respondents with unreliable dietary recalls (n = 11), yielding 14,728 respondents eligible for analysis.

Normal blood pressure was defined as a mean systolic blood pressure <120 mm Hg and mean diastolic blood pressure <80 mm Hg. Hypertension was defined as mean systolic blood pressure ≥140 mm Hg, mean diastolic blood pressure ≥90 mm Hg, or self-reported use of antihypertensive medication. Among persons who did not meet this definition of hypertension, prehypertension was defined as a mean systolic blood pressure of 120–139 mm Hg or a mean diastolic blood pressure of 80–89 mm Hg. An average of up to three brachial systolic and diastolic blood pressure readings was used for determination of blood pressure values. The majority of study participants had at least two complete blood pressure measurements, but for participants with only one, the single measurement was used. Race/ethnicity was categorized as non-Hispanic white (white), non-Hispanic black (black), and Hispanic. In sensitivity analyses, respondents who self-identified as Mexican-Americans were analyzed separately, and

*Additional information available at http://health.gov/dietaryguidelines.

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little difference was observed between Mexican-Americans and "other Hispanic" groups.

Estimated mean usual daily sodium intake and caloric intake (continuous variables) were calculated, as well as sodium density (mg of sodium per 1,000 kilocalories consumed). The proportion of persons with excess sodium intake was estimated by sex, age group, and racial/ethnic subpopulation, and among adults (aged ≥19 years), by hypertension status. Recommendations for sodium intake among persons aged <14 years are adjusted downward for age-specific calorie intake (Table 1). Statistical software was used to account for day-to-day variation in sodium intake to estimate usual intake from two 24-hour dietary recalls.[†] All analyses used survey sample weights (Dietary two-day sample) in statistical software for complex surveys.

The majority of persons in the United States in 2009–2012 exceeded recommendations for dietary sodium (Table 1). Among adults aged ≥19 years, 89% consumed excess sodium. A larger proportion of adult men (98%) than women (80%) consumed more than 2,300 mg of dietary sodium per day (p<0.001), as did a larger proportion of adult whites (90%) than blacks (85%) (p = 0.02). Among children aged 2–18 years, 92%–94% consumed excess sodium.

Sodium intake was typically higher among persons consuming more kilocalories (kcal), and estimated sodium consumed was highest among persons aged 19–50 years (Table 2). Sodium density, which captures milligrams of sodium per 1000 kcal consumed, was highest among adults aged 19–50 years (mean = 1,730 mg/1,000 kcal) and lowest among children aged 2–3 years (mean = 1,466 mg/1,000 kcal). Total sodium intake was higher among males than females (p<0.001), but sodium density did not differ significantly between sexes (p = 0.50).

Among adults with hypertension, 86% consumed dietary sodium in excess of 2,300 mg, which is statistically significantly less than the prevalence for adults with prehypertension (91%, p<0.001) and adults without hypertension (90%, p = 0.01) (Figure). Adults with hypertension had the lowest mean sodium intake (Table 2).

Discussion

Most adults and children in the United States exceed the *2015–2020 Dietary Guidelines for Americans* recommendation for dietary sodium. Even among groups at higher risk for cardiovascular disease, including adults aged ≥51 years, blacks, and adults with prehypertension and hypertension, at least three out of four consumed more than 2,300 mg daily, increasing their potential risk of stroke and coronary heart disease mortality (*2*).

The high prevalence of excess sodium intake and the amount of sodium consumed per calorie in this report are generally consistent with previous reports including one that examined trends in sodium consumption during 2003–2010 in relation to the IOM Dietary Reference Intakes (DRIs) (*5–7*). This

[†]Additional information available at http://epi.grants.cancer.gov/diet/usualintakes/method.html.

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TABLE 1. Prevalence of U.S. population aged ≥2 years with usual sodium intake in excess of *2015–2020 Dietary Guidelines for Americans* limits, by sex, age group, and racial/ethnic subpopulation* — National Health and Nutrition Examination Survey, 2009–2012

Subpopulation (limit)	No. in sample (unweighted)	% with intake ≥limit (95% CI)
Age 2–3 yrs (1,500 mg)	**793**	**93.5 (87.4–99.6)**
Male	403	95.4 (90.0–100)
Female	390	91.4 (84.1–98.8)
White, non-Hispanic	219	93.9 (87.6–100)
Black, non-Hispanic	190	96.1 (91.0–100)
Hispanic	273	92.0 (83.2–100)
Age 4–8 yrs (1,900 mg)	**1,639**	**92.2 (88.6–95.7)**
Male	861	95.1 (92.4–97.8)
Female	778	89.0 (83.4–94.5)
White, non-Hispanic	470	91.8 (86.9–96.6)
Black, non-Hispanic	367	94.3 (90.3–98.4)
Hispanic	595	91.6 (87.2–95.9)
Age 9–13 yrs (2,200 mg)	**1,526**	**93.7 (89.9–97.6)**
Male	742	97.0 (93.6–100)
Female	784	90.7 (85.8–95.7)
White, non-Hispanic	443	93.4 (89.1–97.7)
Black, non-Hispanic	364	92.0 (85.5–98.4)
Hispanic	536	94.5 (89.5–99.6)
Age 14–18 yrs (2,300 mg)	**1,330**	**92.8 (86.8–98.8)**
Male	682	99.0 (97.1–100)
Female	648	87.1 (76.8–97.4)
White, non-Hispanic	378	94.6 (89.0–100)
Black, non-Hispanic	345	86.6 (76.2–97.0)
Hispanic	438	91.9 (83.2–100)
Age ≥19 yrs (2,300 mg)	**9,440**	**89.0 (87.0–90.9)**
Male†	4,613	98.4 (97.6–99.2)
Female	4,827	79.9 (76.7–83.0)
White, non-Hispanic§	4,210	89.8 (87.9–91.8)
Black, non-Hispanic	2,061	84.6 (80.9–88.3)
Hispanic	2,266	88.6 (84.5–92.8)
Age 19–50 yrs (2,300 mg)	**5,025**	**92.1 (89.4–94.7)**
Male	2,459	99.3 (98.5–100)
Female	2,566	84.5 (79.8–89.2)
White, non-Hispanic	2,037	93.1 (90.7–95.5)
Black, non-Hispanic	1,049	88.1 (82.6–93.5)
Hispanic	1,338	91.3 (86.8–95.8)
Age ≥51 yrs (2,300 mg)	**4,415**	**85.0 (82.2–87.9)**
Male	2,154	96.6 (95.0–98.2)
Female	2,261	74.8 (70.2–79.4)
White, non-Hispanic	2,173	86.2 (83.1–89.3)
Black, non-Hispanic	1,012	78.3 (72.8–83.8)
Hispanic	928	80.5 (73.8–87.3)

Abbreviation: CI = confidence interval.

* The proportion of persons with excess sodium intake was estimated by sex, age group, and racial/ethnic subpopulation. Statistical software was used to account for day-to-day variation in sodium intake to estimate usual intake from two 24-hour dietary recalls. All other analyses used survey sample weights (Dietary two-day sample) in statistical software for complex surveys. Respondents with "other" race/ethnicity are not shown. Age categories were defined according to Institute of Medicine Dietary Reference Intake age categories. Age-specific tolerable upper intake levels (UL) for sodium were defined as the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects. Age-appropriate ULs for sodium were 1,500 mg/day for children aged 2–3 years, 1,900 mg/day for children aged 4–8 years, 2,200 mg/day for children and adolescents aged 9–13 years, and 2,300 mg/day for persons aged ≥14 years.

† Prevalence of excess sodium among adult men versus women ($p<0.001$).

§ Prevalence of excess sodium among adult non-Hispanic whites versus non-Hispanic blacks ($p = 0.02$); non-Hispanic whites versus Hispanics ($p = 0.61$); non-Hispanic blacks versus Hispanics ($p = 0.16$).

TABLE 2. Mean usual daily sodium intake, calorie intake, and sodium density for persons aged ≥2 years* — National Health and Nutrition Examination Survey, 2009–2012

Subpopulation	Mean sodium intake, mg/day (SE)	Mean calorie intake, kcal (SE)	Mean usual sodium density, mg/1,000 kcal (SE)
Age 2–3 yrs	**2,154 (31.4)**	**1,481 (21.6)**	**1,466 (22.5)**
Male	2,227 (47.2)	1,536 (28.8)	1,465 (30.4)
Female	2,074 (63.8)	1,421 (45.2)	1,471 (28.8)
White, non-Hispanic	2,160 (46.6)	1,507 (33.1)	1,441 (27.0)
Black, non-Hispanic	2,270 (88.7)	1,491 (43.8)	1,554 (71.4)
Hispanic	2,099 (66.4)	1,450 (40.1)	1,457 (28.2)
Age 4–8 yrs	**2,754 (61.7)**	**1,785 (26.8)**	**1,555 (23.1)**
Male	2,883 (73.3)	1,856 (35.1)	1,570 (27.1)
Female	2,617 (68.1)	1,709 (32.2)	1,542 (29.8)
White, non-Hispanic	2,734 (89.6)	1,803 (43.9)	1,525 (32.7)
Black, non-Hispanic	2,858 (78.6)	1,812 (44.1)	1,592 (29.3)
Hispanic	2,728 (70.7)	1,746 (34.4)	1,577 (26.5)
Age 9–13 yrs	**3,126 (84.5)**	**1,926 (41.8)**	**1,657 (20.8)**
Male	3,312 (112.5)	2,053 (69.9)	1,645 (28.2)
Female	2,961 (98.4)	1,812 (46.8)	1,668 (29.5)
White, non-Hispanic	3,111 (115.8)	1,925 (54.0)	1,650 (36.3
Black, non-Hispanic	3,037 (123.2)	1,859 (71.4)	1,678 (36.7)
Hispanic	3,176 (97.6)	1,961 (55.2)	1,652 (28.4)
Age 14–18 yrs	**3,538 (108.8)**	**2,099 (50.9)**	**1,722 (36.0)**
Male	4,018 (150.3)	2,367 (79.7)	1,735 (46.1)
Female	3,084 (109.1)	1,844 (61.5)	1,709 (38.0)
White, non-Hispanic	3,634 (130.4)	2,143 (71.6)	1,738 (51.5)
Black, non-Hispanic	3,205 (158.2)	1,987 (94.2)	1,639 (37.2)
Hispanic	3,463 (171.7)	2,057 (81.3)	1,715 (42.7)
Age ≥19 yrs	**3,552 (32.2)**	**2,114 (20.2)**	**1,727 (9.9)**
Male	4,143 (46.3)	2,458 (30.2)	1,735 (12.2)
Female	2,978 (29.2)	1,779 (17.4)	1,719 (13.8)
White, non-Hispanic	3,594 (37.9)	2,149 (25.0)	1,719 (10.1)
Black, non-Hispanic	3,325 (65.4)	2,032 (40.3)	1,683 (20.9)
Hispanic	3,524 (94.4)	2,074 (57.5)	1,745 (28.1)
Hypertensive	3,379 (46.0)	2,110 (24.8)	1,722 (9.3)
Prehypertensive	3,705 (34.8)	2,189 (22.8)	1,729 (9.7)
Normotensive	3,581 (39.3)	2,069 (22.3)	1,729 (10.8)

See table footnotes on page 1396.

suggests that overall sodium consumption and the concentration of sodium in foods consumed have not changed over the past decade. The top sources of sodium in the U.S. diet include breads and rolls, deli meats, pizza, poultry, soups, sandwiches, cheese, pasta dishes, meat mixed dishes, such as meatloaf with tomato sauce, and savory snacks.§

During 2009–2012, despite some differences by age, sex, race/ethnicity, and hypertension status, the vast majority of Americans across all subpopulations exceeded recommendations for sodium intake. Compared with adults without hypertension, adults with hypertension consumed slightly less dietary sodium, which might indicate efforts to reduce sodium consumption among this group. However, 86% of adults with hypertension still consumed too much sodium. Compared

§ Additional information available at http://www.cdc.gov/vitalsigns/sodium/index.html.

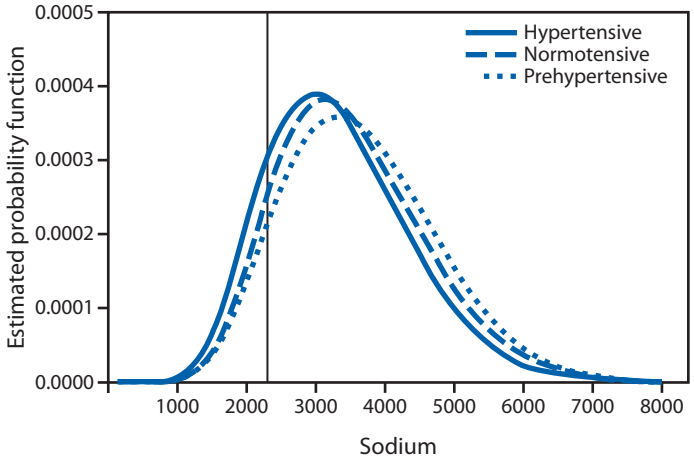
TABLE 2. (*Continued*) Mean usual daily sodium intake, calorie intake, and sodium density for persons aged ≥2 years* — National Health and Nutrition Examination Survey, 2009–2012

Subpopulation	Mean sodium intake, mg/day (SE)	Mean calorie intake, kcal (SE)	Mean usual sodium density, mg/1,000 kcal (SE)
Age 19–50 yrs	**3,744 (35.8)**	**2,227 (22.8)**	**1,730 (11.2)**
Male	4,374 (67.1)	2,595 (41.7)	1,736 (14.9)
Female	3,090 (37.9)	1,846 (18.9)	1,723 (14.9)
White, non-Hispanic	3,816 (47.5)	2,274 (28.5)	1,728 (12.1)
Black, non-Hispanic	3,480 (91.7)	2,161 (56.1)	1,653 (27.1)
Hispanic	3,674 (98.1)	2,173 (64.1)	1,736 (30.4)
Hypertensive	3,793 (87.7)	2,265 (52.3)	1,719 (9.5)
Prehypertensive	3,932 (40.6)	2,340 (24.1)	1,731 (10.9)
Normotensive	3,628 (39.4)	2,159 (23.4)	1,730 (12.0)
Age ≥51 yrs	**3,293 (48.3)**	**1,960 (26.3)**	**1,724 (14.2)**
Male	3,812 (76.6)	2,262 (40.2)	1,733 (19.5)
Female	2,837 (46.4)	1,695 (26.5)	1,716 (18.1)
White, non-Hispanic	3,346 (61.5)	2,005 (31.5)	1,710 (17.6)
Black, non-Hispanic	3,057 (79.8)	1,818 (43.5)	1,730 (24.3)
Hispanic	3,129 (117.5)	1,817 (66.1)	1,771 (34.9)
Hypertensive	3,228 (52.5)	1,921 (26.3)	1,724 (14.2)
Prehypertensive	3,411 (71.1)	2,029 (40.0)	1,726 (15.9)
Normotensive	3,350 (67.5)	2,002 (38.9)	1,717 (17.3)

Abbreviation: SE = standard error.

* Mean usual daily sodium intake (continuous variable) was calculated, as well as sodium density (mg of sodium per calorie consumed). Statistical software was used to account for day-to-day variation in sodium intake to estimate usual intake from two 24-hour dietary recalls. All other analyses used survey sample weights (Dietary Day 2 sample) in statistical software for complex surveys. Overall mean sodium intake was higher for males compared to females ($p<0.001$). Overall mean sodium density did not differ significantly for males versus females ($p = 0.50$). Overall mean sodium intake was higher for non-Hispanic whites compared to non-Hispanic blacks ($p<0.001$), and did not differ for non-Hispanic whites versus Hispanics ($p = 0.06$) or non-Hispanic blacks versus Hispanics ($p = 0.07$). Overall mean sodium density did not differ for non-Hispanic whites versus non-Hispanic blacks ($p = 0.06$), non-Hispanic whites versus Hispanics ($p = 0.71$), or non-Hispanic blacks versus Hispanics ($p = 0.12$). Mean sodium intake was lower for adults with hypertension (hypertensive) compared to adults with prehypertension (prehypertensive) ($p<0.001$) or adults without hypertension (normotensive) ($p<0.001$), and was higher for adults with prehypertension compared to adults without hypertension ($p = 0.02$).

FIGURE. Distribution of estimated usual intake of sodium (mg/day) among U.S. adults, by hypertension status* — National Health and Nutrition Examination Survey, 2009–2012



* The vertical line indicates the *2015–2020 Dietary Guidelines for Americans* recommendation for sodium intake (2,300 mg per day for adults). Overall, 86% of adults with hypertension (hypertensive), 90% of adults without hypertension (normotensive), and 91% of adults with prehypertension (prehypertensive) exceeded 2,300 mg per day sodium intake.

with persons without hypertension, persons with hypertension can benefit even more from reduced sodium consumption (*2*). Physicians and other health care professionals can counsel their patients to lower sodium intake through following a healthy dietary pattern. One example is the Dietary Approaches to Stop Hypertension eating plan,[¶] which emphasizes fruits, vegetables, and low-fat dairy products.

The findings in this report are subject to at least three limitations. First, NHANES data are subject to response bias, although the data are weighted for some nonresponse. Second, dietary data are subject to both recall bias and bias because of underreporting of foods or portion sizes. Finally, sodium intake estimates excluded salt added at the table and from dietary supplements and antacids, which account for about 5%–6% of sodium intake (*4*).

Given that the majority of the population consumes excess dietary sodium and one third of adults have hypertension (*8*), sodium reduction is an integral part of initiatives to prevent cardiovascular diseases, such as Million Hearts, which aims to prevent a million heart attacks and strokes by 2017,[**] CDC's Sodium Reduction in Communities Program,[††] and the National Sodium Reduction Initiative, coordinated by New York City, in which some corporations have pledged to reduce sodium content to meet targets for specific food categories.[§§] Other initiatives to help consumers lower sodium intake include the U.S. Department of Agriculture Nutrition Standards for school meals and competitive foods, and the Department of Health and Human Services Health and Sustainability Guidelines for Federal Concessions and Vending Operations. Reducing sodium added to foods by food manufacturers and restaurants is a fundamental public health strategy for reducing the intake of sodium to levels consistent with the *2015–2020 Dietary Guidelines for Americans* (*4*). Globally, 36 countries have engaged industry to lower sodium intake through the setting of voluntary sodium targets for foods and meals (*9*). In the United Kingdom, reduction in sodium intake with this approach was associated with substantial

[¶] Additional information available at https://www.nhlbi.nih.gov/health/health-topics/topics/dash.

[**] Additional information available at http://millionhearts.hhs.gov.

[††] Additional information available at http://www.cdc.gov/dhdsp/programs/sodium_reduction.htm.

[§§] Additional information available at http://www.nyc.gov/html/doh/html/diseases/salt.shtml.

Summary

What is already known about this topic?

Excess sodium intake is a modifiable risk factor for hypertension and cardiovascular disease. However, according to data from the National Health and Nutrition Examination Survey 2005–2008, 88%–99% of Americans consumed dietary sodium in excess of *2010 Dietary Guidelines for Americans*.

What is added by this report?

During 2009–2012, most Americans, including 89% of adults and over 90% of children, consumed dietary sodium in excess of *2015–2020 Dietary Guidelines for Americans* recommendations. Adults with hypertension consumed slightly less sodium than other adults, but 86% still exceeded 2,300 mg per day.

What are the implications for public health practice?

To address the continued widespread overconsumption of sodium, a multifaceted strategy is needed, including changes in individual lifestyles and how foods are produced. Reducing sodium added to foods by food manufacturers and restaurants is a key strategy for lowering population-wide dietary sodium intake.

reductions in hypertension and cardiovascular disease deaths (*10*). Cardiovascular diseases remain the number one killer in the United States (*8*), and a multifaceted strategy, including changes in individual lifestyles and how foods are produced, might contribute to the reduction of sodium consumption by Americans of all ages.

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