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Interrelationships of added sugars intake, socioeconomic status, and race/ethnicity in adults in the United States: National Health Interview Survey 2005 (ADAJ-D-08-00562R1)

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Abstract

Background—The consumption of added sugars (e.g., white sugar, brown sugar, high-fructose corn syrup) displaces nutrient-dense foods in the diet. The intake of added sugars in the United States (US) is excessive. Little is known about the predictors of added sugars intake.

Objective—To examine the independent relationships of socioeconomic status and race/ethnicity with added sugars intake, and to evaluate the consistency of relationships using a short instrument to those from a different survey using more precise dietary assessment.

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Design—Cross-sectional, nationally representative, interviewer-administered survey

Subjects/setting—Adults (≥ 18 years) participating in the 2005 US National Health Interview Survey (NHIS) Cancer Control Supplement responding to 4 added sugars questions ($n=28,948$)

Statistical analyses performed—The intake of added sugars was estimated using validated scoring algorithms. Multivariate analysis incorporating sample weights and design effects was conducted. Least squares means and confidence intervals, and significance tests using Wald F statistics are presented. Analyses were stratified by gender and controlled for potential confounders.

Results—The intake of added sugars was higher among males than females and inversely related to age, educational status, and family income. Asian-Americans had the lowest intake and Hispanics the next lowest intake. Among men, blacks had the highest intake, although whites and American Indians/Alaskan Natives (AI/ANs) also had high intakes. Among women, blacks and AI/ANs had the highest intakes. Intake of added sugars was inversely related to educational attainment in whites, blacks, Hispanic men, and AI/AN men, but was unrelated in Asian-Americans. These findings were generally consistent with relationships in NHANES 2003–04 (using one or two 24-hour dietary recalls).

Conclusions—Race/ethnicity, family income and educational status are independently associated with intake of added sugars. Groups with low income and education are particularly vulnerable to diets with high added sugars. Differences among race/ethnicity groups suggest that interventions to reduce intake of added sugars should be tailored. The NHIS added sugars questions with accompanying scoring algorithms appear to provide an affordable and useful means of assessing relationships between various factors and added sugars intake.

INTRODUCTION

The class of foods known as added sugars has been defined by the United States Department of Agriculture (USDA) as sugars and syrups that are added to foods during processing or preparation. They include white sugar, brown sugar, raw sugar, corn syrup, corn-syrup solids, high-fructose corn syrup, malt syrup, maple syrup, pancake syrup, and fructose sweetener; they do not include naturally occurring sugars such as lactose in milk or fructose in fruits (1). The consumption of added sugars in the United States (US) has increased dramatically since 1985 (2), and there has been increasing concern and research about their role in disease. Direct etiologic relationships between added sugars and disease have been shown for dental caries (3,4) and are hypothesized to contribute to weight gain (5). A separate set of concerns relates to the effects of added sugars on overall dietary patterns, specifically displacement of nutrient-dense foods. Some research has found that higher intakes of added sugars are associated with diets lower in many essential micronutrients (6) and lower in healthy eating scores (7). By definition, diets with amounts of added sugars which exceed the discretionary calorie allowance contain lower than recommended amounts of other food groups.

A 2003 World Health Organization report (8) recommended that sugars be limited to less than 10% of total energy. The 2005 Dietary Guidelines for Americans recommends a decrease in the consumption of foods with added sugars (9) and limiting all discretionary calories (solid fats, alcohol and added sugars combined) to 8–20 percent of energy, depending on overall energy needs---the higher levels only for those with very high calorie expenditures. The Institute of Medicine's Dietary Reference Intakes states that: "to develop food patterns that follow the 2005 Dietary Guidelines and meet nutrient needs and energy, most of one's energy must be obtained from the food groups, and very few calories are available to use in the form of added sugars" (10).

Cook and Friday reported that the US diet (aged 2 and above) from 1999–2002 included an average of 22.9 teaspoons per day (about 359 kcal or 16.6% of caloric intake) of added sugars

(11). It is important to understand which factors are related to added sugars intake in order to formulate effective nutrition intervention programs. No studies have published such information. The objective of these analyses was to examine the potential interrelationships of added sugars intake and various predictors using multivariate analyses in a nationally representative sample. In particular, whether interrelationships of added sugars and other factors differed in five race/ethnicity groups was examined. Data from the 2005 National Health Interview Survey (NHIS), a nationally representative sample of the US, were used. Thus, results are generalizable to the US population.

METHODS

Study Sample and Design

The NHIS is a cross-sectional study conducted annually by the National Center for Health Statistics (NCHS) to ascertain a variety of self-reported health behaviors and conditions. Periodically, a Cancer Control Module (CCM) is included to obtain information pertinent to cancer researchers. The 2005 CCM (12) consisted of questions about diet, physical activity, tobacco use, sun exposure, cancer screening, genetic testing, and family history of cancer. Because the 2005 CCM was constrained to take no longer than 20 minutes, only a limited number of questions about diet were included. The goal of the diet questions was to allow characterization of the diets of subgroups of the population in terms of cup equivalents of fruits and vegetables, teaspoons of added sugar, grams of fiber, dairy servings, and calcium intake.

The NHIS consists of a clustered, randomized sample of households in the US. If multiple families resided in the same household, all were included in the sampling frame. The 2005 survey was administered in the home by computer-assisted personal interviewing. In 2005, information for the NHIS was collected from 38,509 households, 86.5% of those eligible for interview. Of the participating households, 99.5% of families participated, yielding an 86.1% (86.5×99.5) overall family response rate. Of these, 31,428 adults 80.1% were interviewed, yielding a final 69.0% (86.1×80.1) response rate for the sample adults (12). The 2005 CCM supplement was to be administered to one adult per family selected randomly from men and women age 18 and older living in the households participating in the NHIS (12); 623 provided no answers on the supplement, leaving 30,805.

Data collection procedures for the 2005 NHIS were approved by the Research Ethics Review Board at the National Center for Health Statistics. No approval is necessary for these analyses of de-identified data.

Five-Factor Screener

The Five-Factor Screener used in the 2005 NHIS is described elsewhere (<http://appliedresearch.cancer.gov/surveys/nhis/5factor/>). Briefly, it asked frequency of use information for 18 food groupings and one additional question about type of cereals consumed; portion size information was not asked. There were ten frequency categories ranging from never to 5 or more times a day. These responses were coupled with external information (described below) to estimate daily intakes of fruits and vegetables, added sugar, fiber, calcium, and dairy servings. The added sugars component of the five factor screener consisted of frequency of use questions for 4 food groupings: soda; fruit drinks; doughnuts, sweet rolls, muffins; and cake/cookies/pie. These were chosen because they were found in earlier analyses of USDA's Continuing Survey of Food Intakes by Individuals (CSFII) 1994–96 to be most predictive of added sugars intake, accounting for 51% of the variability (13), and were also those which contributed most to overall intake (6). Analyses of National Health and Nutrition Examination Survey (NHANES) 2001–02 data indicate that the largest sources of added sugars

intake continue to be sodas, grain-based desserts, and fruit drinks, accounting for 60% of the added sugars intake in the U.S. population (14).

Data Processing and Analyses

To estimate daily intake of added sugars, first, the reported frequency category for each of the four added sugars items was converted into mean daily number of times consumed. Second, external information about portion size from CSFII 1994–96 data from 2 non-consecutive 24-hour dietary recalls was applied. Median portion size estimates for each were computed for sex and 10-year age-specific subgroups. For added sugars, portion size units were in teaspoons (13). For each food, the portion-size estimates for the sex and age group of each individual were multiplied by the individual's reported daily frequency of intake. Finally, linear regression models were used to predict added sugars intake for each individual based on his or her portion-size adjusted responses on the Five Factor Screener. The regression coefficients in the prediction formula were estimated from the CSFII 1994–96 data, after cube-root transformation of added sugars, to better approximate normal distributions. The resulting estimate in transformed terms was used in the analyses presented in this paper. For ease of interpretation, all results are back-transformed.

Of the 30,805 respondents who answered at least one survey question, 1,590 did not respond to all 4 added sugars questions and were excluded from the current analyses. In addition, individuals with extreme values for added sugars (defined as higher than the 75th percentile value + 2 times the interquartile range, on the transformed variable, by gender; n=13) were excluded from analyses.

Linear regression models were used to explore the relationships between added sugars intake and numerous demographic variables, including age, race/ethnicity, family income, education, and number of employed adults in the household. Cube-root transformed added sugars intake was the dependent variable in the regression model, while the other variables were independent variables. Age was modeled both as a continuous variable and as a categorical variable. Consistent with the Bureau of Census methodology, NHIS 2005 allowed respondents to choose multiple races, which 1.1% of the full NHIS sample of 31,428 did. When asked about primary race, only 52 did not respond. In addition, primary race was unavailable for 59, because of privacy concerns. Thus, primary race was chosen for analysis and combined with ethnicity information from the following race/ethnicity categorization: Non-Hispanic white; non-Hispanic black, non-Hispanic Asian, American Indian/Alaskan Native (AI/AN) regardless of ethnicity; and Hispanic regardless of race (except AI/AN). Percentage of poverty level (imputed) (15) was formed from reported family income, imputed when necessary, and family size and composition (12), and was used as the indicator of family income. Education attained was categorized into four levels: less than high school; high school graduate; some post high school education, including vocational; and college degree or greater. In addition, the possibility of interactions in education, family income, and race/ethnicity was explored. Statistical significance was evaluated at the $p < 0.05$ level. Variables that were not statistically significant (e.g. number of employed adults in the household) were not included in the final models. The relationships with age were linear; thus age was modeled as a continuous variable rather than a categorical variable. The final models included the following variables: age, race/ethnicity, family income, education, and race/ethnicity*education. Least squares means and their 95% confidence intervals were estimated on the transformed scale for the various demographic sub-groupings; results were back-transformed for presentation. All analyses were conducted separately for males and for females. The final model results presented in Table 3 are based on data from 12,647 males and 16,301 females.

The consistency of NHIS estimates of added sugars intake with those from the NHANES 2003–2004 (16), which obtained up to two 24-hour dietary recalls from each respondent, was

assessed. NHANES estimates were derived from all respondents providing the first recall; for those who provided two days of recall, the mean of the two days was used. Because mean added sugars intake is lower on the second day than on the first day of report, the mean difference, by gender, was calculated and then added to each person's reported intake on the second day so that the first and second days would have the same mean. This manipulation preserves the integrity of the sample responding on the first day of report and corrects for the downward bias in second reports. In these comparisons, a multivariate model that was defined similarly for the two surveys was used. For NHIS, those with imputed rather than reported income were not included, so as to more nearly match NHANES which does not impute income. In NHANES, only non-Hispanic whites, non-Hispanic blacks, and Hispanics comprised large enough sample sizes for these analyses. Those classifying themselves as Hispanics, regardless of race, were included in the Hispanic category in both surveys. Respondents reporting a single race other than white or black, and multi-racial respondents who did not select white or black as their main race, were excluded from analyses for both surveys. NHANES educational categories were used. Added sugars outliers were excluded (n=2 men in NHANES).

Because of the complex sample design, sample weights and design effects were incorporated into all analyses. All analyses were performed using SAS (version 8.2, 2001; SAS Institute, Cary, NC) and SAS-callable SUDAAN (version 9.0.1, 2005; Research Triangle Institute, Research Triangle Park, NC). Wald p statistics were used to test heterogeneity of added sugars intake by age, race/ethnicity, education level, or income level. In the tests, the interaction of education and race/ethnicity was estimated by averaging mean intake in each education category over the race categories, and vice versa. Variables that were ordinal in nature were also tested for linear trend using Wald F statistics.

RESULTS

Table 1 presents selected demographic characteristics of the NHIS population by gender and race/ethnicity. There was variation in the distributions of age, education, family income, and participation in a poverty assistance program by race/ethnicity, but little variation by gender. Blacks were more likely to be younger, have completed less education, have lower family income, and were more likely to participate in poverty assistance programs compared to Non-Hispanic whites. Hispanics were younger, had lower levels of education, and had the highest poverty rates compared to other race/ethnicity groups. Asians reported high levels of education and family income. AI/ANs were similar to Hispanics and blacks as they were proportionally younger, had lower education attainment, had higher levels of poverty rates, and were more likely to participate in poverty assistance program compared to the other race/ethnicity groups.

Table 2 presents estimates of mean daily intake of added sugars from the NHANES 2003–04, and the NHIS 2005. NHANES estimates are derived from the 24-hour dietary recall method (16), while the NHIS estimates are derived from the four relevant items on the screener. In general, estimates from the two surveys and instruments were similar with parallel relationships. Expected relationships in added sugars intake by gender and by age were found in both surveys; added sugars intake was higher among men than women, and was highest among the youngest adults, decreasing with each successive age group. Looking at intake by race/ethnicity, statistically significant differences were seen among men in NHIS but not NHANES, while significant differences were seen among women in both surveys. Among men in NHIS and women in both surveys, blacks had the highest intake of added sugars. Intake differed by education level among men in both surveys, while intake differed by education among women in NHIS but not NHANES. Where differences were statistically significant, people in the highest education level had the lowest intake. For both genders in both surveys, family income was inversely related to added sugars intake. The interaction of race/ethnicity and educational status was not statistically significant in either survey.

Table 3 displays the estimated mean intake of added sugars in NHIS across several demographic categories while controlling for age, race/ethnicity, education, family income as a percentage of poverty level, and the interaction between race/ethnicity and education. For both men and women, added sugars intake was inversely related to both education and family income ($p < 0.001$). There were significant differences in added sugars intake across race/ethnicity groups with Asian-Americans having the lowest intake and Hispanics with the next lowest intake according to racial/ethnic categories. Black men had the highest intake among men, although white and AI/AN men were also high. Black women and AI/AN women had the highest intake among women.

When examining the educational categories stratified by race/ethnicity, added sugars intake was inversely related to increased educational attainment in whites, blacks, Hispanic men, and AI/AN men. For Hispanic and AI/AN women, the inverse relationship was not as clearly delineated, although in both groups women with college degrees had lower added sugars intake than those with less education. In contrast, educational status generally was unrelated to added sugars intake among Asian-Americans.

DISCUSSION

The relationships between added sugars intake and a variety of chronic diseases (e.g. cancer, coronary heart disease, diabetes) and conditions (e.g. blood lipid levels), are research areas of great interest. Given the “obesity epidemic,” the potential role of added sugars in obesity, especially among children and adolescents, is of particular interest. However, studies directly linking added sugars and obesity have been inconsistent (10,17,18). So, while etiologic relationships between added sugars and disease have been shown for dental caries (3,19), there remains much uncertainty as to the precise role of added sugars in other diseases and conditions. A second area of concern is the displacement of nutrient dense food groups with increasing added sugars intake. Current dietary guidance emphasizes balancing dietary intake and expenditure. In order to obtain needed nutrients within an overall energy “budget,” there is very little room for “discretionary calories” (including solid fats, added sugars, and alcohol), which provide little or no nutritional value. Dietary plans developed by USDA to meet nutrient requirements at different calorie levels, when constructed to divide calories equally between discretionary fats and added sugars and provide no calories from alcohol, allow 6 tsp of added sugars at a 1600 calorie level, rising to 18 tsp at a 2800 calorie level (10). Based on NHANES 2003–04, added sugars intakes among adults averaged 14 tsp in women (mean energy intake of 1769 calories;) and 20 tsp in men (mean energy intake of 2516 calories), indicating excessive added sugars intake for the U.S. adult population as a whole.

A major strength of the 2005 NHIS is its large and diverse sample, allowing examination of the independent effects of factors related to added sugars intake in a multivariate setting---the first such analysis with US national data. In addition, it was possible to examine factors within subpopulations defined by race/ethnicity. The five subpopulations analyzed differ from each other in many respects, several of which are related to added sugars intake. Thus, the ability to disentangle independent effects allows for a fuller understanding of differences across race/ethnicity.

There is little published work examining relationships between added sugars intake and family income or social class in the U.S. One study, using individual survey data from USDA’s 1994–96 and 1998 Continuing Surveys of Food Intakes by Individuals, found an increase in added sugars intake up to a certain level of income, and then a decrease (20). However, other determinants of added sugars intake were not controlled for in these analyses. It has been established that foods high in added sugars are less costly than foods with high nutrient density, and that added sugars intake is directly related to the amount of food dollars available (21).

Energy dense foods---those with substantial amounts of added sugars and/or discretionary fats---are cheaper than nutrient dense foods (22,23). A preponderance of studies in developed countries has found relative body size to be greater among those with lower income, particularly among women (24). Some suggest that the low cost of added sugars and fats, along with their high palatability, may explain why low income families have higher rates of overweight and obesity (22,25,26).

Dietary information in several race/ethnicity groups is limited. Although two large studies were conducted among American Indians in 1988–1991 (27) and 1991–1992 (28), there is little recent information about the diets of AI/ANs. No study has reported total added sugars intake for this group as a whole, nor for specific tribes. Harnack et al reported frequent consumption of soda and Kool-Aid among American Indian women in Minneapolis; consumption frequency was greater among younger and less educated women (29). Findings here are consistent, indicating that the AI/AN subpopulation had high added sugars intake, and that intake of added sugars was inversely related to education.

Asian-Americans as a group had the lowest intakes of added sugars. This is consistent with other smaller studies of particular national origins. For example, Lv et al. studied newly arrived Chinese-Americans in Pennsylvania, and found that, even after acculturation, sodas were consumed on average only weekly (30). Recent analyses of food frequency data from Korean American women in the Multiethnic Cohort Study, collected in 1993–96, estimated daily intake of added sugars at 7.8 tsp for Korean-born and 8.9 tsp for US-born (31). A study of dietary intake patterns among Korean Americans in Michigan indicated infrequent consumption of “sweets and fats”, and no change as a result of acculturation (32).

Multivariate analyses of the diets of young adults from the Bogalusa Heart Study found a greater intake of sweetened beverages and a smaller intake of snacks and desserts in European-Americans than in blacks (33). A study of urban southern college students examining self-reported sugar-sweetened beverage intake also found a significant increased intake in black students compared to white students (34).

In this paper, dietary assessment of added sugars was based on a short instrument, and thus is prone to error in its estimate of usual intake. If the error were related to race/ethnicity, the results of these analyses could be biased. However, added sugars intake estimates from the screener in NHIS and the more precise 24HR measures in NHANES across race/ethnicity are comparable, indicating that the potential for substantial bias is minimal. Much of the literature on added sugars intake focuses on the percentage of energy from added sugars, rather than absolute amounts. It was not possible to estimate that percentage, since overall energy intake cannot be assessed accurately with a short dietary assessment instrument. Strong independent relationships between various demographic factors and added sugars intake were found; however, other factors not measured in the NHIS might also be related. For example, many environmental factors, such as increased availability of vending machines, greater advertising, and greater portion size in restaurants than at home (35), have been associated with greater consumption of foods high in added sugars. These environmental factors may vary in their impact on added sugars intake among particular race/ethnicity groups.

CONCLUSIONS

Reducing or limiting added sugars intake is an important objective within overall dietary guidance as intake in the US has been estimated at nearly 17% of calories a day (11). Many factors, including race/ethnicity, family income and educational status, are independently associated with added sugars intake. Groups with low income and education are particularly vulnerable to diets with high added sugars. However, there are differences within race/ethnicity

groups that suggest that interventions aimed at reducing the intake of added sugars should be tailored to each group. The four added sugars questions used in NHIS 2005 with their accompanying scoring algorithms appear to provide an affordable and useful means of measuring added sugars intake across populations.

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Table 1
Demographic characteristics of NHIS adult men and women by race/ethnicity: NHIS 2005

Demographic Characteristic	Men (Unw. N = 12,711)				Women (Unw. N = 16,406)					
	Non-Hispanic White (Unw. N = 8439)	Non-Hispanic Black (Unw. N = 1508)	Hispanic (Unw. N = 2234)	Asian (Unw. N = 420)	AI/AN (Unw. N = 110)	Non-Hispanic White (Unw. N = 10592)	Non-Hispanic Black (Unw. N = 2418)	Hispanic (Unw. N = 2790)	Asian (Unw. N = 458)	AI/AN (Unw. N = 148)
	Percentage Distribution (using Wt. N)									
Age (y)										
18–39	36.5	47.7	61.2	49.8	56.9	35.1	44.0	54.9	45.9	47.4
49–59	39.8	36.5	29.1	36.8	31.6	38.0	37.7	32.9	34.7	42.1
≥60	23.6	15.8	9.7	13.4	11.5	26.9	18.3	12.3	19.4	10.5
p-value	0.0000						0.0000			
Education completed										
< HS	11.3	21.6	43.2	7.8	32.2	10.5	21.5	43.5	15.1	22.4
HS	29.7	36.1	25.5	17.2	33.6	30.2	30.3	24.7	20.0	37.7
Some college	28.2	27.4	20.5	24.6	25.4	31.2	31.9	21.8	21.7	23.1
College graduate	30.8	14.9	10.7	50.4	8.7	28.0	16.3	10.0	43.2	16.8
p-value	0.0000						0.0000			
Family Income (as percentage of poverty)										
< 200%	21.0	41.5	49.0	24.2	46.7	26.2	50.1	55.0	28.1	49.5
200–299%	16.2	16.9	19.2	14.8	10.2	16.8	17.8	17.7	14.4	14.6
300–399%	15.1	13.5	12.3	12.3	14.5	15.1	12.0	10.4	15.1	13.2
400–499%	11.8	9.9	7.3	11.2	12.1	10.5	7.0	6.1	8.6	6.1
≥500%	35.9	18.2	12.2	37.4	16.6	31.4	13.0	10.7	33.8	16.6
p-value	0.0000						0.0000			
Participate in any poverty assistance programs										
Yes	7.2	19.0	23.0	5.6	27.5	9.8	32.7	30.7	10.0	28.7
No	92.8	81.0	77.0	94.4	72.5	90.2	67.3	69.3	90.0	71.3
p-value	0.0000						0.0000			
Region										
Northeast	19.2	12.4	13.0	15.1	2.6	19.8	15.1	14.1	20.4	6.7
Midwest	29.8	18.8	8.9	12.1	17.4	29.3	19.1	8.5	13.4	16.0

Demographic Characteristic	Men (Unw. N = 12,711)					Women (Unw. N = 16,406)				
	Non-Hispanic White (Unw. N = 8439)	Non-Hispanic Black (Unw. N = 1508)	Hispanic (Unw. N = 2234)	Asian (Unw. N = 420)	AI/AN (Unw. N = 110)	Non-Hispanic White (Unw. N = 10592)	Non-Hispanic Black (Unw. N = 2418)	Hispanic (Unw. N = 2790)	Asian (Unw. N = 458)	AI/AN (Unw. N = 148)
Percentage Distribution (using Wt. N)										
South	32.9	61.5	36.9	24.8	35.5	33.1	58.1	37.6	21.1	28.3
West	18.1	7.3	41.2	48.0	44.5	17.8	7.7	39.7	45.1	49.0
p-value	0.0000					0.0000				

Table 2

Estimated mean^a (and 95% CI)^b intake of added sugar (tsp/day) by demographic characteristics: NHANES^c 2003–04 and NHIS^d 2005

Demographic characteristic	Men				Women			
	NHANES 2003–04 (24HR)		NHIS 2005 (Screener)		NHANES 2003–04 (24HR)		NHIS 2005 (Screener)	
	n	LS Mean (95% CI)	n	LS Mean (95% CI)	n	LS Mean (95% CI)	n	LS Mean (95% CI)
All subjects ≥ 18 y	2191	19.7 (18.6–20.8)	9121	18.8 (18.6–19.0)	2379	14.3 (13.5–15.1)	11562	12.7 (12.6–12.9)
Age (y)								
18–39	871	25.7 (23.2–28.4)	3473	22.6 (22.2–23.1)	1019	17.9 (16.5–19.5)	4365	14.9 (14.6–15.2)
40–59	580	19.0 (17.2–20.9)	3522	17.8 (17.5–18.1)	583	13.8 (12.3–15.3)	4234	12.2 (12.0–12.4)
≥60	740	11.8 (10.9–12.8)	2126	13.9 (13.5–14.2)	777	10.1 (9.3–10.9)	2963	10.1 (9.9–10.3)
p-value for general heterogeneity	0.0000		<0.0001		0.0000		<0.0001	
p-value for trend	0.0000		<0.0001		0.0000		<0.0001	
Race/ethnicity								
Non-Hispanic White	1176	20.3 (18.8–21.9)	6798	18.8 (18.5–19.1)	1263	14.2 (13.3–15.2)	8310	12.5 (12.4–12.7)
Non-Hispanic Black	480	18.8 (16.6–21.2)	1196	19.7 (19.0–20.5)	530	16.4 (14.3–18.6)	1843	14.2 (13.8–14.6)
Hispanic	535	18.6 (15.9–21.5)	1127	18.1 (17.3–18.9)	586	11.7 (10.6–12.8)	1409	12.6 (12.2–13.0)
p-value for general heterogeneity	0.5812		0.0158		0.0023		<0.0001	
Education completed								
< HS grad	672	20.1 (18.3–22.1)	1499	20.9 (20.0–21.7)	730	13.5 (12.1–14.9)	1877	13.8 (13.3–14.3)
HS grad	572	22.3 (20.2–24.6)	2536	20.5 (20.0–21.0)	587	16.1 (14.1–18.3)	3245	13.5 (13.2–13.7)
> HS grad	947	18.7 (17.5–20.0)	5086	17.5 (17.2–17.8)	1062	13.6 (12.8–14.4)	6440	12.1 (12.0–12.3)

Demographic characteristic	Men				Women			
	NHANES 2003–04 (24HR)		NHIS 2005 (Screener)		NHANES 2003–04 (24HR)		NHIS 2005 (Screener)	
	n	LS Mean (95% CI)	n	LS Mean (95% CI)	n	LS Mean (95% CI)	n	LS Mean (95% CI)
	0.0172		<0.0001		0.0597		<0.0001	
p-value for general heterogeneity	0.2746		<0.0001		0.9268		<0.0001	
p-value for trend	Family income (as percentage of poverty level)							
< 125%	591	21.4 (19.4–23.6)	1424	20.4 (19.7–21.1)	761	16.3 (15.1–17.6)	2548	14.0 (13.6–14.4)
125% – 349%	908	20.1 (17.9–22.4)	3442	19.2 (18.8–19.6)	948	14.2 (13.2–15.3)	4561	13.1 (12.9–13.3)
> 349%	692	18.8 (17.8–19.8)	4255	18.2 (17.8–18.5)	670	13.2 (12.0–14.5)	4453	12.0 (11.8–12.2)
p-value for general heterogeneity	0.1039		<0.0001		0.0055		<0.0001	
p-value for trend	0.0371		<0.0001		0.0031		<0.0001	
Race/ethnicity * Education								
Non-Hispanic White, < HS	197	21.2 (18.6–24.0)	721	21.0 (20.0–22.0)	227	13.0 (11.4–14.8)	904	13.7 (13.1–14.3)
Non-Hispanic White, HS	344	23.2 (20.0–26.7)	1883	20.5 (20.0–21.1)	345	16.3 (14.2–18.6)	2347	13.2 (12.9–13.5)
Non-Hispanic White, > HS	635	18.6 (17.0–20.3)	4194	17.4 (17.1–17.7)	691	13.7 (12.6–14.9)	5059	11.9 (11.7–12.1)
p-value for general heterogeneity	0.0379		<0.0001		0.0745		<0.0001	
p-value for trend	0.1470		<0.0001		0.5023		<0.0001	
Non-Hispanic Black, < HS	174	16.5 (13.1–20.4)	291	20.9 (19.6–22.3)	175	16.6 (13.4–20.2)	394	15.0 (14.0–16.1)
Non-Hispanic Black, HS	112	20.0 (15.9–24.7)	390	21.1 (19.9–22.4)	130	17.9 (14.0–22.4)	542	15.1 (14.4–15.8)
Non-Hispanic Black, > HS	194	19.0 (16.3–22.0)	515	18.8 (17.7–19.9)	225	15.6 (13.4–18.0)	907	13.6 (13.1–14.1)

Demographic characteristic	Men				Women			
	NHANES 2003–04 (24HR)		NHIS 2005 (Screener)		NHANES 2003–04 (24HR)		NHIS 2005 (Screener)	
	n	LS Mean (95% CI)	n	LS Mean (95% CI)	n	LS Mean (95% CI)	n	LS Mean (95% CI)
p-value for general heterogeneity	0.4058		0.0051		0.4002		0.0003	
p-value for trend	0.3536		0.0118		0.6268		0.0167	
Hispanic, < HS	301	17.3 (14.9–19.8)	487	19.7 (18.7–20.8)	328	13.3 (11.2–15.7)	579	13.0 (12.4–13.6)
Hispanic, HS	116	18.9 (14.5–24.1)	263	19.7 (18.5–20.9)	112	13.1 (9.8–17.0)	356	13.7 (12.9–14.4)
Hispanic, > HS	118	18.8 (16.0–22.0)	377	16.9 (15.7–18.1)	146	10.6 (9.0–12.4)	474	12.1 (11.5–12.6)
p-value for general heterogeneity	0.7285		0.0004		0.1606		0.0035	
p-value for trend	0.4652		0.0002		0.0679		0.0303	
p-value for interaction	0.3280		0.6440		0.3572		0.3421	

^a using multiple regression model with age, race/ethnicity, educational status, family income (as percentage of poverty level), and race/ethnicity x educational status. Analyses were conducted on the transformed scale and back-transformed for presentation.

^b CI=confidence interval.

^c NHANES=National Health and Nutrition Examination Survey.

^d NHIS=National Health Interview Survey.

Table 3

Estimated mean^a (and 95% CI^b) intake of added sugar (tsp/day) by race/ethnicity, family income, and education, by gender: NHIS 2005

Demographic Characteristic	Male		Female	
	n	Mean (95%CI)	n	Mean (95%CI)
Race/Ethnicity				
White, non-Hispanic	8406	18.8 (18.6–19.1)	10548	12.6 (12.4–12.7)
Black, non-Hispanic	1500	19.4 (18.7–20.1)	2400	13.9 (13.5–14.2)
Hispanic	2213	18.0 (17.5–18.5)	2757	12.5 (12.1–12.8)
Asian, non-Hispanic	418	15.2 (14.3–16.2)	450	10.7 (10.1–11.3)
American Indian/Alaskan Native	110	18.8 (16.9–20.9)	146	13.9 (12.6–15.3)
<i>p</i> -value for general heterogeneity	0.0000		0.0000	
Education				
< High school	2328	20.8 (20.1–21.6)	3067	13.9 (13.5–14.3)
High school	3574	19.9 (19.5–20.3)	4660	13.3 (13.0–13.5)
Some college	3404	18.2 (17.8–18.6)	4740	12.7 (12.5–12.9)
≥ College degree	3341	16.5 (16.2–16.8)	3834	11.2 (11.0–11.5)
<i>p</i> -value for general heterogeneity	0.0000		0.0000	
<i>p</i> -value for test for trend	0.0000		0.0000	
Family income as percentage of poverty				
< 200%	3884	19.2 (18.8–19.6)	6477	13.3 (13.0–13.5)
200–399%	3953	18.8 (18.5–19.2)	4896	12.8 (12.6–13.0)
≥ 400%	4810	18.1 (17.8–18.4)	4927	12.0 (11.8–12.2)
<i>p</i> -value for general heterogeneity	0.0001		0.0000	
<i>p</i> -value for test for trend	0.0000		0.0000	
Race/ethnicity by Education				
White, non-Hispanic				
< High school	916	21.3 (20.3–22.3)	1193	13.9 (13.4–14.4)
High school	2419	20.2 (19.8–20.7)	3128	13.2 (13.0–13.5)
Some college	2413	18.2 (17.8–18.6)	3264	12.4 (12.2–12.7)
≥ College degree	2658	16.6 (16.3–17.0)	2963	11.3 (11.1–11.5)

Demographic Characteristic	Male		Female	
	n	Mean (95%CI)	n	Mean (95%CI)
<i>p</i> -value for general heterogeneity	0.0000		0.0000	
<i>p</i> -value for test for trend	0.0000		0.0000	
Black, non-Hispanic				
< High school	350	21.5 (20.2–22.8)	529	15.1 (14.3–15.9)
High school	509	20.5 (19.4–21.6)	723	14.6 (14.0–15.3)
Some college	413	18.7 (17.4–20.1)	766	14.2 (13.6–14.7)
≥ College degree	228	17.8 (16.6–19.0)	382	12.0 (11.1–12.8)
<i>p</i> -value for general heterogeneity	0.0001		0.0000	
<i>p</i> -value for test for trend	0.0000		0.0000	
Hispanic				
< High school	995	19.5 (18.8–20.3)	1242	12.9 (12.4–13.4)
High school	545	18.9 (18.0–19.9)	682	13.2 (12.7–13.8)
Some college	449	18.5 (17.5–19.4)	569	13.0 (12.4–13.6)
≥ College degree	224	15.7 (14.5–17.0)	264	10.8 (10.0–11.6)
<i>p</i> -value for general heterogeneity	0.0000		0.0001	
<i>p</i> -value for test for trend	0.0000		0.0000	
Asian, non-Hispanic				
< High school	32	15.5 (13.0–18.2)	65	12.1 (10.0–14.5)
High school	68	14.7 (12.7–16.9)	77	9.3 (8.3–10.4)
Some college	99	16.7 (15.0–18.6)	103	12.0 (10.7–13.4)
≥ College degree	219	14.3 (13.3–15.3)	205	10.0 (9.4–10.7)
<i>p</i> -value for general heterogeneity	0.1493		0.0048	
<i>p</i> -value for test for trend	0.7278		0.3383	
American Indian/Alaskan Native				
< High school	35	23.3 (18.3–29.2)	38	14.7 (11.5–18.4)
High school	33	20.9 (18.1–23.9)	50	16.7 (13.8–19.9)
Some college	30	19.2 (15.2–23.7)	38	13.8 (12.0–15.7)
≥ College degree	12	14.2 (10.2–19.1)	20	10.9 (9.3–12.8)

Demographic Characteristic	Male		Female	
	n	Mean (95%CI)	n	Mean (95%CI)
<i>p</i> -value for general heterogeneity	0.0614		0.0015	
<i>p</i> -value for test for trend	0.0082		0.0146	
<i>p</i> -value for interaction	0.0395		0.0005	

^aLeast square means in model of age, race/ethnicity, education, family income as percentage of poverty level, and race/ethnicity*education. Analyses were conducted on the transformed scale and back-transformed for presentation.

^bCI=confidence interval