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Added sugars intake across the distribution of US children and adult consumers: 1977–2012

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Abstract

Background—Public health organizations in the United States (US) have recently increased focus on reducing population consumption of added sugars.

Objective—The objective of this study is to provide in-depth information on national trends in added sugars consumption and examine both the mean and the distribution of added sugars intake from 1977 to 2012.

Design—We conducted a descriptive study using 6 cross-sectional nationally representative surveys of food intake in the United States: the 1977–1978 National Food Consumption Survey (NFCS; n = 29,668), the 1989–1991 Continuing Survey of Food Intake by Individuals (CSFII; n = 14,827), the 1994–1998 CSFII (n = 19,027), the 2003–2004 National Health and Nutrition Examination Survey (NHANES; n = 8,273), the 2009–2010 NHANES (n = 9,042), and the 2011–2012 NHANES (n = 16,451).

Analysis—We examined the key dependent variables calories from added sugars and percentage of total energy intake from added sugars at the mean and by quintiles of added sugars consumption for children (2–18 years) and adults (≥ 19 years) across the survey years. We also examined trends in added sugars intakes from foods and beverages. We used ordinary least squares regression to examine linear trends between survey years and multinomial logistic regressions to examine sociodemographics by quintile of added sugars consumption. We adjusted estimates by gender, race, income, and education.

Results—The US mean adjusted intake of added sugars remains high. In 2011–2012 children and adults consumed 326 kilocalories/day and 308 kilocalories/day, respectively, of added sugars,

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or 14% and 17%, respectively, of total their energy. For both children and adults, there was a significant increase in calories from added sugars from 1977 to 2003, followed by a significant decline from 2003 to 2012. There was no decline in the percentage of the total energy intake from added sugars from 2003 to 2012. Changes over time were consistent across each quintile of added sugars consumption. The highest quintile of consumption was more likely to be male and in children was more likely to be non-Hispanic white.

Conclusion—Despite a decline in consumption of added sugars since 2003 in the United States, mean adjusted added sugars intakes continue to be above the recommended level of 10% of the total energy intake. Changes in added sugars consumption from 1977 through 2012 occurred evenly across the distribution of added sugars intakes.

Key phrases

Added sugars; Trends in intake; Distribution of consumers; Children Adults

Introduction

Overconsumption of added sugars is an important public health concern. Added sugars are those added during food processing or preparation as opposed to intrinsically occurring sugars, such as the fructose in fruit or the lactose in milk. Consumption of added sugars is associated with reduced diet quality, increased energy intake, cardiovascular disease mortality, and dental caries.[1–3] Consequently, reducing intake of added sugars has long been a target of public health organizations.[4, 5]

Reducing added sugars consumption has recently attracted greater attention in the United States. In February 2015 the Dietary Guidelines Advisory Committee (DGAC) released for public commentary a recommended limit of 10% of daily energy intake from added sugars.[6] In 2015 the Food and Drug Administration proposed a new rule requiring the inclusion of added sugars on the nutrition facts label in an effort to both reduce added sugars consumption and encourage manufacturers to add less sugar to foods.[7] The World Health Organization (WHO) recently made a conditional recommendation to lower added sugars intake to 5% of total energy intake from the previously recommended limit of 10%.

Despite these recent efforts, there is a lack of studies examining more recent shifts in the US population's consumption of added sugars. From 1977 through 2000 added sugars contributed a growing proportion of calories to the US diet.[8, 9] However, after decades of increases, total added sugars consumption declined from 1999 through 2008 for both children and adults.[9] Yet it has been unclear whether these downward trends have continued or leveled off.[10]

There is also little research into how consumption of added sugars from food versus beverage sources have changed, particularly in recent years. Previous research and policy efforts have focused on added sugars from beverages due to their substantial contribution to total added sugars intake and because additional calories from beverages are not compensated for by reduced food intake, leading to increased overall energy intake.[11–13] Between 2000 and 2008 much of the reduction in calories from added sugars came from a

reduction in consumption of added sugars from beverages.[9] But it is unclear how consumption of calories from added sugars in foods has changed. Since 1999 there have been decreases in consumption of some foods that are the largest contributors to added sugars intake, such as ready-to-eat cereals, but little change in others, such as grain-based desserts and candy.[9, 14]

Previous analyses of trends in intake of added sugars have focused on mean intake, which misses the potentially wide distribution of such consumption.[15] Examining changes across the distribution of added sugars intake can identify whether trends have occurred evenly across the population, or whether some segments of the population are changing less. For example, it is important to identify whether declines in mean consumption are driven by decreases only among the lowest consumers while the highest consumers fail to reduce intake. Further, examining the distribution of added sugars intake can identify the highest-consuming segment of the population. One study found that among adults the highest quintile of added sugars consumption is associated with a hazard of cardiovascular disease mortality 2.43 (95% CI: 1.63–3.62) times higher than that of the lowest quintile of consumption.[2] Understanding whether sociodemographic disparities in mean added sugars intake persist among the highest consumers can help identify those with the greatest health risks.

The purpose of this study was to provide knowledge about national consumption of added sugars in the United States through an in-depth exploration of trends using six nationally representative surveys of food intake. Specifically, our objectives were to (1) examine whether declines in added sugars intake in the early 2000s continued through 2011–2012, (2) investigate the respective contributions of added sugars from foods and beverages, (3) document shifts in added sugars intake across the distribution of consumption, and (4) find out which sociodemographic characteristics are associated with the highest added sugars consumers.

Methods

Participants

This descriptive study used cross-sectional data on children and adults aged 2 years and older from 6 nationally representative surveys of food intake in the United States: the 1977–1978 National Food Consumption Survey (NFCS; n = 29,668), the 1989–1991 Continuing Survey of Food Intake by Individuals (CSFII; n = 14,827), the 1994–1998 CSFII (n = 19,027), the 2003–2004 National Health and Nutrition Examination Survey (NHANES; n = 8,273), the 2009–2010 NHANES (n = 9,042), and the 2011–2012 NHANES (n = 16,451). All of the surveys used a complex multistage, stratified sampling of the US noninstitutionalized civilian population, which has been described in detail elsewhere.[16–19]

Dietary data

Detailed methodology on US national nutrition surveys has been reported elsewhere (U.S. Department of Agriculture; U.S. Department of Agriculture and DHHS; U.S. Department of Agriculture and DHHS). Interviewer administered 24h recalls were used to collect data on

food and beverage type and quantity. The NFCS77 and the CSFII89 collected 1 in-home, interviewer-administered 24-hour recall and 1 self-administered 24-hour recall on 2 consecutive days. The CSFII94, the NHANES03, the NHANES09, and the NHANES11 collected 2 nonconsecutive 24h recalls conducted by trained interviewers. The first day was collected in person, and the second day was collected either in person (CSFII) or by phone (NHANES). To maximize comparability between surveys, we used only the first 24h recall in this analysis. For NHANES, a proxy respondent completed recalls for children 6 years and younger, and recalls for children 6 to 11 were proxy assisted. For the CSFII, the main meal planner/preparer in a household reported for children 11 and younger.

We recorded dietary intake data using discrete food codes and linked them to food composition databases that reflect the foods available at the time of the survey. All databases are based on the US Department of Agriculture (USDA) National Nutrient Database for Standard Reference.[20] The University of North Carolina (UNC) Institutional Review Board deemed this study exempt.

Energy from added sugars

We used the USDA's MyPyramid Equivalents Database (MPED) to examine consumption of added sugars. The USDA defines added sugars as all sugars used as ingredients in processed and prepared foods and does not include naturally occurring sugars, such as fructose in fruit or lactose in milk, unless the sugar is added to the food item. A list of sugars included in the database as added sugars is publically available.[21] The USDA also does not include sugars from fruit juice concentrates as added sugars.[22]

We used MPED 1.0 for CSFII94, MPED 2.0 for NHANES03, the Food Patterns Equivalents Database (FPED) for NHANES09, and the FPED 2.0 for NHANES11. There is no MPED for the NFCS77 or the CSFII89, so we matched the food codes in those surveys to the food codes in the NHANES9904 and used the MPED values from the oldest available year. In the infrequent cases when we could not make a direct match, we imputed MPED values using the following method. We categorized foods according to University of North Carolina food groups. We then divided each food group into three subsets: no added sugar, below the mean of added sugars in that food group, and at or above the mean of added sugars in that food group. We imputed the food code with the missing value to have the average amount of added sugars in the subset of the food group to which it was assigned. This approach has been detailed elsewhere, and the imputed added sugars values have been published previously.[14, 23] We converted values for added sugars based on 4 kilocalories (kcal) per gram.

Data analysis

We conducted all analyses using Stata version 13 (College Station, TX). We used survey commands and sample weights to take into account a complex survey design, including different probabilities of selection and nonresponse. We analyzed trends from 1977 to 2012 for total added sugars consumed (kcal), added sugars consumed from foods, and added sugars consumed from beverages. Using linear regression, we tested linear trends using the Wald F-test. These were adjusted for race, income, and education for both children and

adults and for gender for adults to adjust for the effect of changing participant demographics over the survey years (table 1). Race, income, and education were self-reported in all survey years, and were analyzed in the categories presented in table 1. To test for statistical significance between years, we used a student's t-test at the $p < 0.05$ level.

Results

Table 1 presents the sociodemographic characteristics of the study participants. Over the survey years, there have been shifts in the distributions of race, income, and education for both children (2–18 years) and adults (19 years and older) and in gender for adults.

Mean trends in added sugars

The mean adjusted added sugars intake among children increased from 275 kcal/day in 1977–78 to 387 kcal/day in 2003–04 ($p < 0.01$) and then declined to 326 kcal/day in 2011–12 ($p < 0.01$). There was no change between 2009 and 2012 ($p > 0.05$). In 2011–12 children consumed 51 kcal/day more in added sugars than they did in 1977–1978 (figure 1a).

Similarly, the mean adjusted added sugars intake among adults increased from 228 kcal/day in 1977–78 to 341 kcal/day ($p < 0.01$) in 2003–04 and then declined to 308 kcal/day in 2011–2012 ($p < 0.01$) (figure 1b). From 2010 to 2012 there was a small, nonsignificant increase in added sugars intake. In 2011–12 adults consumed 81 kcal/day more in added sugars that they did in 1977.

The percentage of total calories consumed from added sugars also increased between 1977 and 2003, however, there were no meaningful subsequent declines through 2012. In 1977–78 children consumed 14% of their total energy from added sugars, which increased to 18% in 2003–04. In 2011–12 children consumed 17% of their total energy from added sugars. In 1977–78 adults consumed 12% of their total energy from added sugars, which increased to 15% in 2003–04. In 2011–12 adults consumed 14% of their total energy from added sugars.

Added sugars from foods and beverages

For children, added sugars consumed from beverages rose significantly between 1977–78 and 2003–04 and then decreased between 2003–04 and 2011–12 ($p < 0.001$). Calories of added sugars from foods similarly rose from 163 kcal/day in 1977 to 179 kcal/day in 2003 but did not significantly decline after 2003.

Similarly, for adults added sugars consumed from beverages rose from 109 kcal/day to 199 kcal/day between 1977–78 and 2003–04 and then decreased to 164 kcal/day in 2011–12 ($p < 0.001$). Intake of added sugars from foods also rose from 119 kcal/day in 1977 to 142 kcal/day in 2003. However, again there was no change in added sugars from foods between 2003 and 2012 (figures 1a and 1b).

The percentage of totals calories from added sugars in foods was stable between 1977 and 2012 for both children and adults (table 2). In 2012 added sugars contributed 11% of food calories for children and 8% of food calories for adults. The percent of calories from added sugars from beverages changed for children and adults over the observed period. For

children, added sugars accounted for 26% of their beverage calories in 1977–78, which rose to 43% in 2003–04 ($p < 0.01$), and then declined to 38% in 2011–12 ($p < 0.05$). For adults, the proportion of their beverage calories from added sugars rose from 29% in 1977–78 to 39% in 2003–04 ($p < 0.01$) then declined slightly to 37% in 2012 ($p < 0.05$).

Trends by quintiles of added sugars consumption

Among children, in 1977–78 the adjusted mean intake of calories from added sugars ranged from 39 kcal/day in the lowest quintile to 566 kcal/day in the highest. In 2011–2012 this range was 53 kcal/day in the lowest quintile to 620 kcal/day in the highest (figure 2). Among adults, in 1977–78 the adjusted mean intake of calories from added sugars ranged from 37 kcal/day in the lowest quintile to 557 kcal/day in the highest. In 2011–12 this range was 47 kcal/day in the lowest quintile to 708 kcal/day in the highest. Changes were even across quintiles and followed the shape of the adjusted mean trend, with gains from 1977 through 2003 followed by declines from 2003 through 2012 for both children and adults (figure 2).

The adjusted predicted probability of being in the highest quintile of calories consumed from added sugars was lower for females among both children and adults, −6% and −7%, respectively ($p < 0.05$ for both). It was also lower among children for non-Hispanic blacks (−9%; $p < 0.05$) and Mexican Americans (−10%; $p < 0.05$) compared to non-Hispanic white children (supplemental materials). However, non-Hispanic black adults were more likely to be in the highest quintile of calories consumed from added sugars (5%; $p < 0.05$).

There were no gender differences in the adjusted predicted probability of being in the highest quintile of the proportion of energy intake from added sugars among children or adults. However, the race gap persists among children and adults. Non-Hispanic black and Mexican American children were less likely to be in the highest quintiles (−10% and −21%, respectively). Non-Hispanic black adults were more likely to be in the highest quintile of the proportion of energy intake from added sugars (7%; $p < 0.05$).

Discussion

The present analysis of nationally representative US dietary data found that the mean adjusted added sugars intake is above the limit of 10% that the DGAC proposed and above other current evidence-based recommendations. The WHO conditionally recommends limiting added sugars intake to 5% of daily calories, and the American Heart Association recommends fewer than 100 kcal/day for women and fewer than 150 kcal/day for men from added sugars.[4, 24] Although there are no child-specific recommendations on added sugars consumption, the mean intake for US children is excessive and suggests significant adverse health-related consequences.[25–27]

For both children and adults, from 2003 through 2012 there were significant declines in absolute calories of added sugars consumed, indicating that previously reported downward trends from the early 2000s have continued.[9] However, there was not a clinically relevant decline in the percentage of the total energy intake from added sugars over the same period. This is consistent with findings that in the United States there were reductions in the total calories consumed by children and adults through 2010.[10, 28] Our results indicate that the

reduction in added sugars intake is occuring at approximately the same rate as the reduction of total calorie intake. One of the justifications for the DGAC recommendation to limit added sugars to 10% of total calories is that it is extremely difficult to comply with the dietary guidelines above that level of added sugars intake.[2] Given that the proportion of total calories from added sugars is over recommended levels, attention must continue to focus on shifting calories away from added sugars and toward healthier substitutes in addition to reducing overall calorie intake.

Additionally, this research shows a marked skewness in added sugars consumption. Notably, across each survey year from 1977 through 2012 there was a consistent skew to the right across added sugars quintiles for both children and adults. Without longitudinal data, it is not clear if this persistence of the very high consumption group over time indicates long-term high added sugars intake or a heterogeneous high-risk population that has changed over time. However, it is still important that the increases from 1977 through 2003 and subsequent declines happened across the population distribution. This is unlike the body mass index (BMI), which not only has had a highly skewed distribution from at least 1974 but over time has increased significantly more in the higher categories.[29] A similar trend in waist circumference has been shown for adults.[30] Thus it is reassuring that increases in added sugars intake from 1977 through 2004 do not appear to have been driven solely by increases among the highest added sugars consumers and that subsequent declines aren't driven by large reductions in low consumers switching to non-consumption. Further research using longitudinal datasets is needed to better understand long-term added sugars consumption at an individual level.

Our results indicate that in 2011–12 individuals in the highest quintile of added sugars consumption were moderately more likely to be non-Hispanic white among children and non-Hispanic black among adults. This is consistent with gender and race gaps shown in the mean consumption of added sugars.[31, 32] These findings specify high-risk groups among children and adults, however, the difference in predicted probabilities is moderate. Thus from this analysis it appears that population-wide efforts targeting the highest consumers will have better success addressing the health risks than efforts targeting sociodemographic characteristics. Further research is needed to elucidate underlying causal predictors of being in the highest quintile of added sugars consumption.

Our findings show that much of the reduction in consumption of added sugars over the past decade has come from a decrease in consumption of added sugars from beverages, while consumption of added sugars from foods shows no significant change. This is in line with the findings of J. A. Welsh et al. that from 1999 to 2008 two-thirds of the decrease in added sugars consumption came from reductions in sugar-sweetened beverage consumption. Concomitant with this trend has been an increase in purchases that contain low- or no-calorie sweeteners, a transition that has occurred primarily in beverages.[33] Our findings show that with this decline in beverages, foods are an increasingly important contributor of added sugars. M. M. Slining et al. found that among children 2 to 18 years old, grain-based desserts, candy, and ready-to-eat cereals were large contributors of added sugars.[14] A meta-analysis of total dietary sugars found that increased weight and cardiometabolic risk was linked with added sugars in food,[3] but there is limited research focusing on the health

impacts of added sugars specifically from foods. Further attention to this relationship is needed.

Important limitations of this study include the reliance on self-reported energy intakes.[34] A known limitation to self-reported 24-hour recalls is misreporting.[35, 36] Underreporting of foods perceived as unhealthy, which may include those high in added sugars, has been previously reported.[37, 38] During our study period there were several changes in the methods of recording dietary intake, although steps were taken to maximize comparability between survey years.[39] Although this study uses the most recently released USDA equivalents database to estimate added sugars, the USDA food composition tables are not updated as quickly as new products or product reformulations emerge.[33, 40, 41] Further, this analysis does not have the ability to determine whether some of the decline in added sugars may come from a switch to sweeteners not currently counted as added sugars by the USDA databases, such as fruit juice concentrates. One recent study found that in 2004–2009 over 11% of the foods and beverages in the US packaged food supply contained fruit juice concentrates. It would be expected that with the attention towards natural and organic products the use of this sweetener would have increased during that period.[22] More in-depth analysis of recent added sugars consumption may require datasets that capture in better detail the breadth of products currently available that contain added sugars. Despite these limitations, the present study provides useful information on overall trends in added sugars intake in a nationally representative sample.

In conclusion, our analysis finds that over the past decade the United States has seen declines in consumption of calories from added sugars but not in the proportion of added sugars in total energy intake. In 2012 adjusted mean intakes were above the recommended intake levels. Continued efforts are needed to reduce added sugars among the high-consuming subpopulation as a strategy to combat diet-related weight gain and cardiovascular disease.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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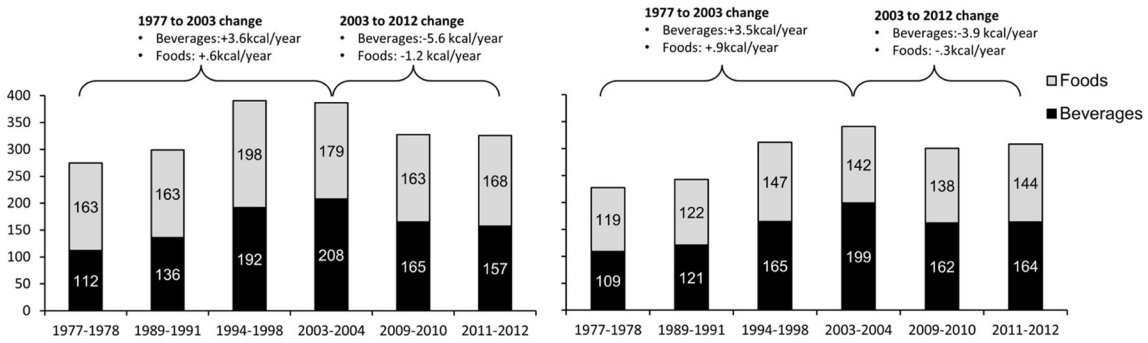

Figure 1.

Adjusted mean calories of daily added sugars consumed by (a) children age 2–18 in the United States and (b) by adults age 19 and up in the United States from 1977 to 2012 for foods and beverages, adjusted by gender, race, income and education, weighted to be nationally representative

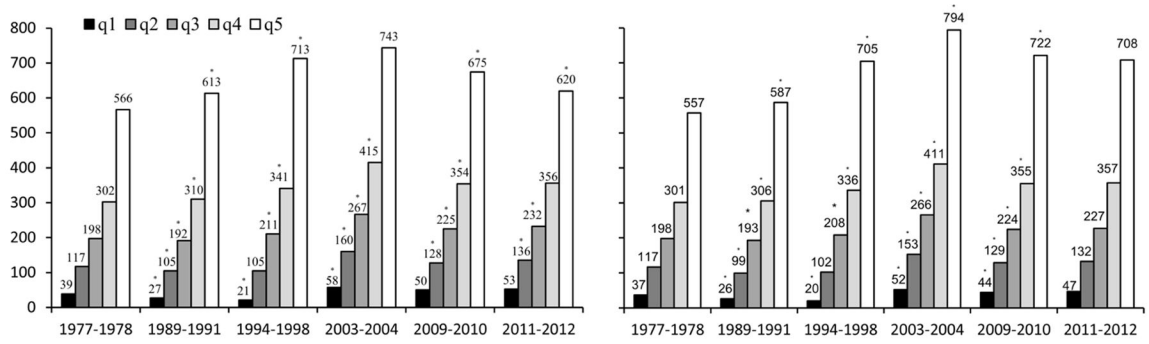

Figure 2.

Mean calories of quintiles of daily added sugars consumed by (a) children age 2–18 in the United States and (b) by adults age 19 and up in the United States from 1977 to 2012 for foods and beverages, adjusted by gender, race, income and education, weighted to be nationally representative. * indicates significantly different from previous survey year ($p<.05$)

Table 1

Sociodemographic characteristics of US children and adults from six nationally representative surveys of food intake, 1977–2012[a]

	Nationwide Food Consumption Survey 1977–1978	Continuing Survey of Food Intakes by Individuals and 1994–1996 Diet and Health Knowledge Survey (CSFII) 1989–1991	Continuing Survey of Food Intakes by Individuals and 1994–1996 Diet and Health Knowledge Survey (CSFII) 1994–1998	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2003–2004	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2009–2010	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2011–2012
Ages 2 to 18						
n	9275 %	3859 %	5471 %	2139 %	2244 %	3823 %
Male	0.50	0.51	0.51	0.52	0.50	0.51
Race/Ethnicity						
Non- Hispanic White	0.75	0.71	0.70	0.65	0.62	0.58
Non- Hispanic Black	0.16	0.15	0.17	0.16	0.14	0.16
Mexican American	0.08	0.11	0.07	0.13*	0.15	0.16
Other	0.01	0.02*	0.05*	0.06	0.08	0.09
Income as % of federal poverty limit						
<130%	0.25	0.24	0.26	0.34*	0.34	0.37
130–300	0.44	0.36*	0.35	0.31	0.29	0.31
300+	0.31	0.40*	0.39	0.35	0.37	0.32
HH Education						
Less than High School	0.23	0.14*	0.11*	0.20*	0.21	0.24
High School	0.38	0.30*	0.30	0.27	0.21*	0.20
Some College	0.20	0.23	0.26	0.34*	0.30*	0.29
College or higher	0.20	0.33*	0.34	0.19*	0.29*	0.27
Ages 19 and older						
n	20662.26 %	10904.06 %	15532.81 %	6530.854 %	7153.067 %	12628.32 %
Male	0.41	0.47*	0.48	0.48	0.48	0.49
Race/Ethnicity						
Non- Hispanic White	0.83	0.79	0.80	0.75	0.72	0.71
Non- Hispanic Black	0.11	0.11	0.12	0.12	0.12	0.13
Mexican American	0.05	0.07	0.04*	0.08	0.09	0.09

	Nationwide Food Consumption Survey 1977–1978	Continuing Survey of Food Intakes by Individuals and 1994–1996 Diet and Health Knowledge Survey (CSFII) 1989–1991	Continuing Survey of Food Intakes by Individuals and 1994–1996 Diet and Health Knowledge Survey (CSFII) 1994–1998	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2003–2004	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2009–2010	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2011–2012
Ages 2 to 18						
Other	0.01	0.03*	0.04*	0.05	0.07	0.08
Income as % of federal poverty limit						
<130%	0.17	0.15	0.16	0.22*	0.22	0.26
130–300	0.38	0.30*	0.31	0.29	0.28	0.27
300+	0.45	0.55*	0.53	0.49	0.50	0.46
HH Education						
Less than High School	0.24	0.19*	0.16*	0.18	0.19	0.16
High School	0.34	0.35	0.35	0.27*	0.23*	0.20
Some College	0.20	0.22	0.23	0.32	0.31	0.33
College or higher	0.22	0.23	0.26	0.23*	0.27	0.30

* indicates p<.05 from previous survey year

Table 2

Added sugars consumed as a proportion of total energy, energy from beverages and energy from foods by US children and adults

	Nationwide Food Consumption Survey 1977–1978	Continuing Survey of Food Intakes by Individuals and 1994–1996 Diet and Health Knowledge Survey (CSFII) 1989–1991	Continuing Survey of Food Intakes by Individuals and 1994–1996 Diet and Health Knowledge Survey (CSFII) 1994– 1998	What We Eat in America, National Health and Nutrition Examinati on Survey (WWEIA, NHANES) 2003–2004	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2009–2010	What We Eat in America, National Health and Nutrition Examination Survey (WWEIA, NHANES) 2011–2012
	Percent (Standard error)					
Ages 2 to 18y						
% total energy from added sugars	14% (.2)	16%(.4)	19%(.2)	18%(.5)	17%(.3)	17%(.4)
% beverage calories from added sugars	26%(.7)	29%(1.1)	37%(.7)	43%(1.5)	39%(.9)	38%(1.5)
% food calories from added sugars	10%(.1)	11%(.3)	12%(.2)	11%(.2)	11%(.2)	11%(.2)
Adults 19y and older						
% total energy from added sugars	12%(.1)	13%(.2)	15%(.2)	15%(.4)	14%(.2)	14%(.3)
% beverage calories from added sugars	29%(.5)	29%(.6)	34%(.7)	39%(1.4)	34%(.9)	36%(1.1)
% food calories from added sugars	7%(.1)	7%(.1)	8%(.1)	8%(.2)	8%(.1)	8%(.1)