Increasing consumption of sugar-sweetened beverages among US adults: 1988–1994 to 1999–2004[1–3]

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ABSTRACT

Background: Consumption of sugar-sweetened beverages (SSBs) has been linked to obesity and type 2 diabetes.

Objective: We examined national trends in SSB consumption among US adults by sociodemographic characteristics, body weight status, and weight-loss intention.

Design: We analyzed 24-h dietary recall data to estimate beverage consumption among adults (aged ≥20 y) obtained from the third National Health and Nutrition Examination Survey (NHANES III, 1988–1994; $n = 15979$) and NHANES 1999–2004 ($n = 13431$).

Results: From 1988–1994 to 1999–2004 on the survey day, the percentage of adult SSB drinkers increased from 58% to 63% ($P < 0.001$), per capita consumption of SSB increased by 46 kcal/d ($P = 0.001$), and daily SSB consumption among drinkers increased by 6 oz ($P < 0.001$). In both survey periods, per capita SSB consumption was highest among young adults (231–289 kcal/d) and lowest among the elderly (68–83 kcal/d). Young blacks had the highest percentage of SSB drinkers and the highest per capita consumption compared with white and Mexican American adults ($P < 0.05$). Overweight-obese adults with weight-loss intention (compared with those without) were significantly less likely to drink SSB, but they still consumed a considerable amount in 1999–2004 (278 kcal/d). Among young adults, 20% of SSB calories were consumed at work.

Conclusions: Over the past decade, US adult SSB consumption has increased. SSB comprises a considerable source of total daily intake and is the largest source of beverage calories. SSB consumption is highest among subgroups also at greatest risk of obesity and type 2 diabetes. *Am J Clin Nutr* 2009;89:372–81.

INTRODUCTION

Consumption of sugar-sweetened beverages (SSBs) has been linked to the obesity epidemic (1), which currently affects one-third of US adults (2, 3), and type 2 diabetes (4). From 1977 to 2001, energy intake from soft drinks and fruit drinks increased by 135% (5), and the prevalence of adult obesity doubled (6). Over the same period, the percentage of calories from all beverages increased by >50% (7).

Much of the literature on adult beverage consumption has focused on specific drink types (8, 9) or on broad temporal trends and patterns (5, 7, 10). With the exception of a few studies (5, 11), little research has focused on national changes in adult beverage consumption by sociodemographic groups, body weight status, and weight-loss intention. To our knowledge, no research has examined these factors simultaneously. The disproportionate effect of obesity on minority and low socioeconomic status (SES) communities (2, 3, 12–14), the positive association between intention to lose weight and weight control behaviors (15–17), the significant effect of even modest weight loss on the elimination or reduction of adverse health conditions associated with obesity (18), and evidence suggesting that calories in liquid may be less well compensated than calories from solid foods (19, 20) make this is an important area of study.

Although the complex interactions between factors that cause obesity are not fully understood, it is widely accepted that a positive energy balance (higher caloric intake than energy expenditure) leads to weight gain (21, 22). Reduction of SSBs in the adult diet may help prevent weight gain and promote weight loss. Such efforts may offer relatively simple, low-cost solutions to weight reduction and are consistent with recommended beverage consumption patterns (23, 24). Moreover, the identification of variations in beverage consumption by subpopulation groups will be useful for the development of targeted policies or nutrition programs aimed at reducing intake of ''empty calories'' among adults, particularly those from SSBs.

The purpose of this study was to describe national changes (1988–1994 to 1999–2004) in the percentage of drinkers, amount consumed, consumption location, and type of beverage among US adults by sociodemographic characteristics, weight category, and weight-loss intention. This analysis does not attempt to estimate the effect of SSB intake on obesity incidence, given our reliance on cross-sectional data. Other research, supported by longitudinal data, provides strong evidence for a causal relation between SSB intake and increased body mass index (BMI; in kg/m^2) (1, 4, 25–27).

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SUBJECTS AND METHODS

Data and design

Nationally representative data from the third National Health and Nutrition Examination Survey (NHANES III; 1988–1994) and NHANES 1999–2004 were used. The NHANES is a population-based survey designed to collect information on the health and nutrition of the US population. Participants were selected based on a multistage, clustered, probability sampling strategy. Survey respondents are representative of the noninstitutionalized US population. Since 1999, data have been collected annually. Our analysis combined the continuous NHANES data collection (1999–2004) and compared it with NHANES III (1988–1994). A complete description of data collection procedures and analytic guidelines are available elsewhere (www.cdc.gov/nchs/nhanes.htm).

Study sample

The study sample consists of adults aged ≥20 y with completed 24-h dietary recalls from the 2 cross-sectional NHANES surveys. Survey respondents were excluded if they were pregnant at the time of data collection or if their dietary recall was incomplete or unreliable (as determined by the NHANES staff). Because of the small sample size of the other race-ethnicity category, we only included non-Hispanic white, non-Hispanic black (hereafter referred to as whites and blacks), and Mexican Americans in the analyses.

Measures

Beverages

Survey respondents reported all food and beverages consumed in a prior 24-h period (midnight to midnight) and reported type, quantity, time, and location of each food and beverage consumption occasion. After the dietary interview, all reported food and beverage items were systemically coded with the use of the US Department of Agriculture (USDA) Food and Nutrient Database. Caloric content and other nutrients derived from each consumed food or beverage item were calculated based on the quantity of food and beverages reported and the corresponding nutrient contents by the National Center for Health Statistics (NCHS). Given that only the NHANES 1999–2004 included a second dietary recall, we only use the first dietary recall from each survey for this analysis.

We identified 6 mutually exclusive beverage categories in the NHANES III (from 549 beverage items) and the NHANES 1999–2004 (from 523 beverage items) including *1*) SSBs (soda, sport drinks, fruit drinks and punches, low-calorie drinks, sweetened tea, and other sweetened beverages), *2*) 100% juice, *3*) diet beverages, *4*) milk (including flavored milk), *5*) coffee or tea, and *6*) alcohol (23). *See* **Appendix A** for more details. Of note, some milk, coffee or tea, or alcoholic beverages may have added sugar. To relate our results to dietary guidelines and inform intervention strategies, we used kilocalories (1 kcal = 4.2 kJ) and fluid ounces (1 oz = 28.57 mL) as 2 primary measures to evaluate consumption patterns. Of note, information on consumption location (where the beverage was consumed) was only available in 1999–2004.

Body weight status

In both surveys, weight and height were measured with the use of standard procedures in a mobile examination center. Normal weight was defined as a BMI from 18.5 to 24.9; overweight was defined as BMI from 25 to 29.9, and obese was defined as BMI ≥ 30 (28).

Intention to lose weight

Respondent intention to lose weight was assessed by the survey question, "During the past 12 months, have you tried to lose weight?" Respondents who answered "yes" were categorized as trying to lose weight.

Socioeconomic status

The poverty:income ratio (PIR; the ratio of household income to a family's appropriate poverty threshold) was based on self-reported household income. We dichotomized the PIR into lower and higher income groups based on eligibility for food assistance programs (ie, ≤ 130% of the poverty level). Education was categorized into the following mutually exclusive 3 categories: *1*) less than high school, *2*) high school (or GED), and *3*) more than high school.

Analysis

All analyses were weighted to be representative of the general population and conducted using STATA, version 9.2 (Stata Corp, College Station, TX) to account for the complex sampling structure. Multivariate regressions were used to adjust for potential changes in population composition over the 2 time periods, including race-ethnicity, sex, income, age, marital status, employment status, and education. All tables and figures report predicted means based on the adjusted models.

RESULTS

The 2 samples had comparable distributions of sex, age, employment status, and income status, but the 1999–2004 sample had significantly fewer non-Hispanic whites and normal-weight persons, and significantly more Mexican Americans, persons with a high school education, obese persons, and persons trying to lose weight ($P < 0.001$) (**Table 1**).

Overall adult beverage consumption

The percentage of adults consuming beverages, per capita caloric consumption, and the daily caloric contribution among drinkers on a typical day are given in **Table 2**. Over the period, the percentage of drinkers and quantity consumed increased the most for SSBs compared with the other beverage categories. In 1999–2004, 63% of adults consumed SSBs on a given day, up from 58% in 1988–1994 ($P < 0.001$). Over the period, SSBs represented the largest source of beverage calories for adults. From 1988–1994 to 1999–2004, daily per capita consumption of SSBs increased by 46 kcal/d ($P < 0.001$), and average daily intake among adults who consumed SSBs increased by 55 kcal/d ($P < 0.001$). Alcohol was the second largest source of adult per capita beverage calories. For other beverage categories, the percentage of milk drinkers declined most over the period ($P = 0.045$) followed by coffee and tea drinkers ($P < 0.001$). The per

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TABLE 1
Characteristics of US adults (aged ≥20 y) in the third National Health and Nutrition Examination Survey (NHANES III; 1988–1994) and NHANES 1999–2004[1]

	1988–1994	1999–2004	*P* for trend
Total [*n* (%)]	15,979 (100)	13,431 (100)	
Sex [*n* (%)]			
Male	7470 (47)	6364 (48)	0.443
Female	8509 (53)	7067 (52)	
Race-ethnicity [*n* (%)]			
Non-Hispanic white	6654 (83)	6836 (75)	<0.001
Non-Hispanic black	4466 (12)	2585 (11)	
Mexican American	4335 (6)	3637 (13)	
Age [*n* (%)]			
20–44 y	7885 (57)	5713 (50)	<0.001
45–64 y	3722 (26)	3692 (33)	
≥65 y	3885 (17)	3589 (18)	
Education [*n* (%)]			
Less than high school	6428 (25)	4344 (20)	<0.001
High school (or GED)	4874 (34)	3178 (26)	
More than high school	4571 (41)	5883 (54)	
Employment status [*n* (%)]			
Unemployed	6866 (32)	6148 (36)	0.002
Employed	9110 (68)	7278 (64)	
Income [*n* (%)]			
Lower income[2]	6873 (30)	5165 (32)	0.138
Higher income[2]	7621 (70)	7117 (68)	
Body weight status [*n* (%)]			
Normal weight [BMI (kg/m^2) 18.5–24.9]	6303 (45)	4100 (34)	<0.001
Overweight (BMI 25–29.9)	5555 (33)	4693 (34)	
Obese (BMI ≥ 30)	4086 (22)	4269 (31)	
Weight-loss intention [*n* (%)]			
Currently trying to lose weight	5856 (41)	3834 (35)	<0.001
Not currently trying to lose weight	10,118 (59)	8250 (65)	

[1] Percentage of US population estimated with weights to adjust for unequal probability of sampling.
[2] Income level was dichotomized based on the poverty:income ratio (ratio of annual family income to federal poverty line). Lower income refers to persons at or below 130% of poverty, which represents eligibility threshold for the federal food stamp program.

capita consumption and daily caloric contribution from milk and coffee or tea remained relatively constant.

Consumption patterns of SSBs and other beverages by sex, race-ethnicity, and age

Overall, the percentage of SSB drinkers increased significantly from 58% in 1988–1994 to 63% in 1999–2004 ($P < 0.001$) (**Table 3**). For both sexes and all race-ethnicity groups, young adults (aged 20–44 y) had the highest percentage of SSB drinkers in 1988–1994 (68%) and in 1999–2004 (72%), a significant upward trend ($P = 0.024$). The elderly (aged ≥65 y) had the lowest percentage at both time points, but it did increase significantly over the period ($P < 0.001$). Among the race-ethnicity groups, young black men had the highest percentage of SSB drinkers in 1988–1994 (78%) and in 1999–2004 (82%), and the increase over the period was significant ($P < 0.05$).

Notable patterns were also observed for diet drinks, milk, and coffee or tea. The percentage of diet drinkers increased significantly among the elderly overall (13–16%; $P = 0.032$) and elderly whites (12–16%; $P = 0.022$). The percentage of milk drinkers declined most among elderly blacks (57–41%; $P < 0.001$). Coffee and tea drinking declined most among young whites (54–48%; $P = 0.006$) and young men (51–45%; $P = 0.002$).

Per capita intake of SSBs by age, sociodemographics, obesity, and weight-loss intention

Per capita consumption of SSBs and its corresponding percentage contribution to daily energy intake by age, sociodemographic groups, weight, and weight-loss intention are shown in **Table 4**. Over the period, per capita consumption of SSBs increased significantly from 158 kcal/d in 1988–1994 to 203 kcal/d in 1999–2004 ($P < 0.001$) with the biggest increase among young adults. For adults aged 20–44 y, per capita SSB calories averaged 231 kcal/d (9% total daily intake) in 1988–1994 and 289 kcal/d (12% total daily intake) in 1999–2004 ($P < 0.001$). Among young adults, per capita consumption of SSBs increased significantly for all demographic, body weight, and weight-loss groups. In 1999–2004, the caloric contribution of SSBs to overall daily intake was the highest among young adults with less than a high school education and among persons with lower income (14%). Among all race-ethnicity groups, overall per capita consumption was the highest among blacks. For all ages combined, the increase in per capita SSB consumption was significant for both sexes and all race-ethnicity, education, income, weight status, and intention-to-lose-weight groups ($P < 0.05$).

The average quantity and caloric contribution among adults who had ≥1 consumption occasion of SSBs on the previous day are given in **Table 5**. In 1988–1994, daily consumption of SSBs

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TABLE 2
Percentage of US adults (aged ≥20 y) consuming beverages and per capita caloric contribution on the surveyed day, by beverage, in the third National Health and Nutrition Examination Survey (NHANES III, 1988–1994) and NHANES 1999–2004[1]

	1988–1994	1999–2004	Mean difference	*P* for trend
	%	%	%	
Consumed beverages on the surveyed day (%)				
Had SSBs	58 ± 1[2]	63 ± 1	5	<0.001
Had diet	18 ± 1	17 ± 1	−1	0.435
Had juice	20 ± 1	20 ± 1	0	0.459
Had milk	55 ± 1	48 ± 1	−7	<0.001
Had coffee or tea	64 ± 1	60 ± 1	−4	0.003
Had alcohol	23 ± 2	23 ± 2	0	0.748
Per capita caloric contribution (kcal/d)				
From SSBs	157 ± 5	203 ± 5	46	<0.001
From juice	31 ± 1	32 ± 1	2	0.420
From milk	92 ± 3	84 ± 2	−9	0.045
From coffee or tea	8 ± 0	11 ± 1	3	<0.001
From alcohol	88 ± 5	99 ± 5	11	0.124
Daily caloric contribution among drinkers (kcal/d)				
From SSBs	239 ± 5	294 ± 5	55	<0.001
From juice	151 ± 3	158 ± 4	7	0.051
From milk	174 ± 4	185 ± 3	11	0.030
From coffee or tea	13 ± 1	19 ± 1	6	<0.001
From alcohol	376 ± 13	418 ± 16	42	0.010

[1] SSBs, sugar-sweetened beverages. Multivariate regression was used to adjust for race-ethnicity, sex, age, education, marital status, income, and employment status. SEM < 0.05 is listed as 0.
[2] Mean ± SEM (all such values).

was highest among obese adults (26 oz). In 1999–2004, daily consumption of SSBs was highest among men (32 oz). From 1988–1994 to 1999–2004, average daily consumption increased from 22 to 28 oz ($P < 0.001$), average consumption rose from 239 to 294 kcal/d ($P < 0.001$), and the average serving size per SSB consumption occasion increased from 11 oz to 17 oz ($P < 0.001$). For all groups, average daily consumption and average consumption per occasion increased significantly. Not only did more adults drink SSBs but they also drank more each time they consumed SSBs. In 1999–2004, average consumption per drinking occasion was highest among males and whites (19 oz). Between the 2 time periods, the caloric contribution of SSBs increased the most among men (271–338 kcal/d) and persons with lower income (252–319 kcal/d).

Beverage consumption among overweight-obese adults by weight-loss intention

The beverage consumption patterns among overweight-obese adults by weight-loss intention are given in **Table 6**. In both NHANES III and NHANES 1999–2004, the percentage of overweight-obese adults who drank SSBs was significantly lower among persons with weight-loss intention than for persons without weight-loss intention ($P < 0.001$). Per capita consumption and the daily caloric contributions among SSB drinkers followed the same pattern. SSBs, on average, contributed more per capita calories to the diet of persons not trying to lose weight than to persons who did try to lose weight (NHANES III: 178 compared with 146 kcal/d; $P < 0.001$; NHANES 1999–2004: 231 compared with 186 kcal/d; $P < 0.001$). Likewise, among persons who reported ≥1 consumption occasion of SSBs on the previous day in 1999–2004, average consumption was significantly higher among persons without weight-loss intention than among persons trying to lose weight (313 compared with 278 kcal/d; $P < 0.001$). Of note, whereas per capita consumption and the daily caloric contribution from SSBs was lower in both survey periods among overweight-obese persons trying to lose weight, the consumption level increased over time, regardless of weight-loss intention, which is consistent with the trend observed in Table 4.

Reductions in the percentage of overweight-obese SBB drinkers among adults trying to lose weight were paralleled by increases in the percentage of diet drinkers among adults with weight-loss intention. In NHANES III and NHANES 1999–2004, the percentage of diet drinkers was significantly higher among overweight-obese persons trying to lose weight than among persons who were not ($P < 0.001$).

For other beverage categories, overweight-obese persons with weight-loss intention consumed less alcohol (NHANES III: 92 compared with 67 kcal/d; $P = 0.006$) and milk per capita than persons not trying to lose weight (NHANES III: 97 compared with 83 kcal/d; $P = 0.016$; NHANES 1999–2004: 88 compared with 74 kcal/d; $P = 0.018$).

Location of consumption of types of SSBs

Per capita consumption of SSBs by consumption location, sex, and age is shown in **Figure 1**. The largest share of SSB calories were consumed at home, a pattern that increased with age. Approximately half of SSB calories were consumed at home by young adults compared with approximately three-fourths consumed at home by the elderly. Among young adults, a sizable amount of SSB calories were consumed in restaurants or cafeterias (15%) and at work (20%).

The relative contribution of each beverage type to per capita SSB consumption by age is shown in **Figure 2**. Overall, soda represented the largest share of SSB calories and comprised

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TABLE 3
Percentage of US adults reporting ≥1 consumption occasion of beverages on the surveyed day, by sex, age, and race-ethnicity, in the third National Health and Nutrition Examination Survey (NHANES III, 1988–1994) and NHANES 1999–2004[1]

	All (age ≥20 y)		Aged 20–44 y		Aged 45–64 y		Aged ≥65 y	
	1988–1994	1999–2004	1988–1994	1999–2004	1988–1994	1999–2004	1988–1994	1999–2004
	%							
Overall								
Had SSBs	58 ± 1	63 ± 1[2]	68 ± 2	72 ± 1[2]	50 ± 2	57 ± 2	36 ± 2	43 ± 2[2]
Had diet	17 ± 1	17 ± 0	17 ± 1	14 ± 1[2]	21 ± 2	22 ± 2	13 ± 1	16 ± 2[2]
Had juice	21 ± 1	20 ± 0	16 ± 1	17 ± 1	21 ± 2	18 ± 1	29 ± 1	28 ± 1
Had milk	55 ± 1	48 ± 1[2]	52 ± 2	45 ± 1[2]	56 ± 2	47 ± 2[2]	69 ± 2	63 ± 2[2]
Had coffee or tea	62 ± 1	60 ± 1	50 ± 2	45 ± 2[2]	75 ± 2	72 ± 2[2]	80 ± 2	81 ± 1
Had alcohol	24 ± 2	23 ± 2	27 ± 2	26 ± 2	22 ± 2	22 ± 2	19 ± 3	15 ± 2
Women								
Had SSBs	55 ± 1	59 ± 1[2]	64 ± 2	67 ± 2	48 ± 2	55 ± 2[2]	33 ± 2	40 ± 2[2]
Had diet	21 ± 1	21 ± 1	21 ± 2	18 ± 1	25 ± 2	26 ± 2	13 ± 1	15 ± 2
Had juice	21 ± 1	20 ± 1	16 ± 2	17 ± 2	22 ± 2	19 ± 2	31 ± 2	27 ± 2
Had milk	54 ± 1	48 ± 1[2]	52 ± 2	45 ± 2[2]	55 ± 2	48 ± 2[2]	69 ± 2	63 ± 3[2]
Had coffee or tea	59 ± 2	60 ± 2	49 ± 2	47 ± 2	72 ± 2	70 ± 2	77 ± 3	82 ± 2[2]
Had alcohol	18 ± 2	16 ± 2	21 ± 2	18 ± 2	16 ± 3	16 ± 2	14 ± 3	11 ± 2
Men								
Had SSBs	62 ± 2	65 ± 1[2]	74 ± 2	76 ± 2	54 ± 3	59 ± 3	39 ± 2	47 ± 3[2]
Had diet	14 ± 1	14 ± 1	14 ± 2	11 ± 1[2]	16 ± 1	20 ± 2[2]	12 ± 1	15 ± 2
Had juice	20 ± 1	19 ± 2	17 ± 2	17 ± 2	19 ± 2	17 ± 2	26 ± 2	27 ± 2
Had milk	55 ± 1	49 ± 1[2]	51 ± 2	46 ± 2[2]	55 ± 3	47 ± 3[2]	69 ± 3	63 ± 3[2]
Had coffee or tea	64 ± 1	61 ± 2	51 ± 2	45 ± 2[2]	76 ± 2	73 ± 2	83 ± 2	81 ± 2
Had alcohol	30 ± 2	31 ± 2	34 ± 2	35 ± 2	28 ± 2	31 ± 2	25 ± 4	22 ± 3
Non-Hispanic whites								
Had SSBs	56 ± 1	60 ± 1[2]	67 ± 2	70 ± 2	48 ± 2	55 ± 2[2]	34 ± 2	41 ± 2[2]
Had diet	20 ± 1	19 ± 1	20 ± 2	16 ± 1[2]	23 ± 2	25 ± 2	12 ± 1	16 ± 2[2]
Had juice	20 ± 1	19 ± 1	15 ± 2	15 ± 2	20 ± 2	16 ± 1[2]	29 ± 2	27 ± 1
Had milk	57 ± 1	50 ± 1[2]	54 ± 2	46 ± 2[2]	58 ± 2	50 ± 2	71 ± 2	65 ± 2[2]
Had coffee or tea	65 ± 1	63 ± 2	54 ± 2	48 ± 2[2]	77 ± 2	75 ± 2	82 ± 2	83 ± 2
Had alcohol	23 ± 2	23 ± 2	26 ± 2	27 ± 2	21 ± 2	22 ± 2	19 ± 3	15 ± 2
Non-Hispanic blacks								
Had SSBs	73 ± 2	76 ± 1[2]	78 ± 2	82 ± 1[2]	68 ± 3	71 ± 3	58 ± 4	63 ± 3
Had diet	10 ± 1	8 ± 1	8 ± 2	5 ± 1	14 ± 2	11 ± 2	15 ± 3	13 ± 3
Had juice	20 ± 2	24 ± 2[2]	18 ± 2	24 ± 2[2]	20 ± 2	22 ± 3	26 ± 4	25 ± 4
Had milk	38 ± 2	32 ± 1[2]	33 ± 2	31 ± 2	42 ± 4	28 ± 3[2]	57 ± 3	41 ± 3[2]
Had coffee or tea	41 ± 2	38 ± 2	30 ± 2	25 ± 2[2]	61 ± 3	51 ± 4[2]	64 ± 4	65 ± 3
Had alcohol	22 ± 2	19 ± 1	28 ± 3	21 ± 2[2]	17 ± 2	20 ± 2	9 ± 2	12 ± 3
Mexican Americans								
Had SSBs	69 ± 2	70 ± 2	76 ± 2	79 ± 2	52 ± 4	56 ± 4	35 ± 3	46 ± 4[2]
Had diet	14 ± 2	13 ± 1	11 ± 2	10 ± 2	22 ± 3	18 ± 3	19 ± 5	11 ± 3
Had juice	17 ± 1	21 ± 2[2]	15 ± 2	20 ± 2[2]	18 ± 3	20 ± 3	31 ± 4	30 ± 4
Had milk	55 ± 3	48 ± 3[2]	55 ± 3	48 ± 3[2]	52 ± 4	47 ± 4	79 ± 2	70 ± 3
Had coffee or tea	53 ± 2	57 ± 2	46 ± 3	47 ± 3	72 ± 4	70 ± 4	83 ± 3	87 ± 2
Had alcohol	21 ± 1	20 ± 1	22 ± 2	21 ± 2	26 ± 4	21 ± 3	9 ± 2	12 ± 4

[1] All values are means ± SEMs. SSBs, sugar-sweetened beverages. Multivariate regression was used to adjust for sex, race-ethnicity, education, marital status, income, and employment status. SEM < 0.05 is listed as 0.
[2] *P* value for trend < 0.05.

≈60% of the total. Fruit drinks (which include all fruit punches and fruit nectars with added sugar) were the second largest source, representing about a quarter of total SSB calories. The contribution of soda to overall SSB consumption declined with age, whereas the contribution of fruit drink increased with age. Over the survey period, the relative contribution from both soda and fruit drink increased across all age groups. For example, soda contributed 61% of all SSB calories in 1999–2004, which was up from 56% in 1988–94.

DISCUSSION

The 2005 *Dietary Guidelines for Americans* recommends drinks without added sugar (24). Yet, our study shows that SSBs, which provide little nutritional benefit, represent a considerable source of total adult daily intake and is the largest source of beverage calories. In 1999–2004, two-thirds of adults (63%) drank SSBs, averaging 28 oz/d, 17 oz per consumption occasion, and 293 calories daily (15% of recommended 2000 kcal/d diet). More adults are drinking SSBs (primarily soda; ≈60%), and,

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TABLE 4
US adult per capita consumption of sugar-sweetened beverages (SSBs), measured in caloric contributions, in the third National Health and Nutrition Examination Survey (NHANES III, 1988–1994) and NHANES 1999–2004[1]

	All (age ≥20 y)		Age 20–44 y		Age 45–64 y		Age ≥65 y	
	1988–1994	1999–2004	1988–1994	1999–2004	1988–1994	1999–2004	1988–1994	1999–2004
	kcal/d							
Overall	158 ± 5 (7)	203 ± 5 (9)[2]	231 ± 7 (10)	289 ± 7 (12)[2]	124 ± 6 (6)	160 ± 6 (8)	68 ± 5 (4)	83 ± 5 (5)[2]
Sex								
Female	128 ± 4 (7)	163 ± 5 (8)[2]	170 ± 11 (10)	214 ± 11 (12)[2]	104 ± 6 (6)	136 ± 7 (7)[2]	62 ± 9 (4)	71 ± 7 (5)
Male	186 ± 7 (7)	243 ± 7 (9)[2]	276 ± 12 (10)	341 ± 12 (13)[2]	146 ± 6 (6)	183 ± 9 (8)[2]	72 ± 7 (4)	96 ± 6 (5)[2]
Race-ethnicity								
Non-Hispanic white	160 ± 6 (7)	205 ± 6 (9)[2]	251 ± 10 (11)	307 ± 11 (13)[2]	113 ± 7 (5)	150 ± 8 (7)[2]	56 ± 5 (3)	72 ± 5 (4)[2]
Non-Hispanic black	175 ± 4 (9)	234 ± 8 (11)[2]	235 ± 8 (10)	308 ± 12 (13)[2]	161 ± 6 (9)	205 ± 9 (11)[2]	107 ± 10 (7)	125 ± 11 (8)
Mexican American	153 ± 7 (7)	192 ± 8 (9)[2]	225 ± 8 (10)	274 ± 13 (11)[2]	108 ± 11 (5)	128 ± 9 (7)	65 ± 10 (4)	86 ± 9 (5)
Education								
Less than high school	174 ± 7 (8)	223 ± 6 (10)[2]	249 ± 16 (11)	325 ± 12 (14)[2]	133 ± 12 (7)	164 ± 9 (9)[2]	71 ± 9 (4)	91 ± 7 (6)[2]
High school or GED	169 ± 6 (8)	220 ± 8 (9)[2]	250 ± 10 (11)	318 ± 11 (13)[2]	134 ± 10 (6)	171 ± 12 (8)[2]	68 ± 8 (4)	84 ± 9 (5)[2]
More than high school	155 ± 8 (7)	194 ± 8 (8)[2]	218 ± 10 (9)	263 ± 11 (11)[2]	117 ± 12 (5)	152 ± 9 (7)[2]	73 ± 10 (4)	84 ± 8 (4)
Income[3]								
Lower income	168 ± 7 (8)	229 ± 7 (10)[2]	256 ± 8 (11)	334 ± 11 (14)[2]	130 ± 12 (7)	184 ± 11 (9)[2]	67 ± 14 (4)	84 ± 10 (5)
Higher income	156 ± 6 (7)	195 ± 5 (9)[2]	232 ± 10 (10)	279 ± 8 (11)[2]	119 ± 7 (6)	150 ± 7 (7)	71 ± 6 (4)	85 ± 7 (5)[2]
Body weight status[4]								
Normal weight	153 ± 7 (7)	198 ± 7 (9)[2]	222 ± 9 (10)	275 ± 11 (11)[2]	116 ± 11 (6)	160 ± 13 (8)[2]	69 ± 7 (4)	79 ± 8 (5)
Overweight	155 ± 6 (7)	194 ± 6 (9)[2]	232 ± 10 (10)	277 ± 12 (12)[2]	118 ± 9 (6)	152 ± 9 (8)[2]	59 ± 7 (4)	80 ± 6 (5)[2]
Obese	166 ± 5 (8)	220 ± 8 (10)[2]	244 ± 12 (10)	323 ± 14 (13)[2]	126 ± 7 (6)	157 ± 8 (8)[2]	75 ± 13 (4)	94 ± 13 (5)[2]
Weight-loss intention[5]								
Not trying to lose weight	162 ± 6 (7)	215 ± 6 (9)[2]	234 ± 9 (10)	303 ± 10 (12)[2]	129 ± 8 (7)	175 ± 9 (9)[2]	69 ± 6 (4)	86 ± 6 (5)[2]
Trying to lose weight	151 ± 6 (7)	190 ± 7 (9)[2]	218 ± 11 (10)	266 ± 11 (12)[2]	116 ± 6 (6)	143 ± 8 (7) [2]	68 ± 10 (4)	85 ± 11 (5)[2]

[1] All values are means ± SEMs; percentage of contribution to daily energy intake in parentheses. GED, General Education Development test that certifies high school-level skills. Multivariate regression was used to adjust for sex, race-ethnicity, education, marital status, income, and employment status. SEM < 0.05 is listed as 0.
[2] P for trend < 0.05.
[3] Income level was dichotomized based on the poverty:income ratio and eligibility for food assistance programs (ie, ≤130% of the poverty level).
[4] Normal weight was defined as a BMI (in kg/m^2) from 18.5 to 24.9, overweight as BMI from 25 to 29.9, and obese as BMI ≥ 30.
[5] Categories of trying to lose weight include all BMI groups.

among SSB drinkers, average caloric consumption and quantity consumed had increased, changes that parallel the rising prevalence of adult obesity (2) and type 2 diabetes (29).

An additional key finding is the considerable variation in adult SSB consumption by sociodemographic characteristics, with the highest rates concentrated among populations at highest risk of obesity (2, 3). Overall, SSB consumption declined steeply with age, which may be partially because of a cohort effect (ie, younger generations have increased their SSB consumption) (30). In 1999–2004, young adults had the highest prevalence of SSB drinkers (72%) and were the highest consumers of SSB calories (289 kcal/d) compared with older age groups. Among race-ethnicity groups, blacks had the highest percentage of SSB drinkers (76%) and the highest per capita consumption of SSBs (234 kcal/d) in 1999–2004, followed by Mexican Americans. Among all young adults, the caloric contribution of SSBs was highest among persons with lower income and persons with less than a high school education.

Increasingly, US adults are reporting a desire to lose weight (31). Yet, the extent to which this maps to changes in beverage consumption is not well known. This study offers useful information about SSB consumption patterns by weight-loss intention. Our results indicate that overweight-obese adults trying to lose weight (compared with those without weight-loss intention) are moving in the right direction. In both surveys, the percentage of SSB drinkers (61% compared with 67%, 1999–2004) and the amount of SSBs consumed (186 compared with 231 kcal/d, 1999–2004) was lower among overweight-obese persons with weight-loss intention compared with persons without this intention. This suggests that persons trying to lose weight are drinking less SSBs and selecting SSBs with lower energy content. Yet, per capita consumption of SSBs increased among all weight groups over the period regardless of weight-loss intention. However, differences between the groups are small, which indicates that greater efforts are needed to empower persons trying to lose weight to adopt healthy eating behaviors.

Both similarities and differences are found between our findings and previous research. This study is consistent with previous work that identified a consistent upward trend in calories from SSBs (5, 7, 9–11, 32) and high SSB consumption at home (5). Compared with trends in US children and adolescents, in whom the percentage of SSB drinkers remained constant from 1988–1994 to 1999–2004 and in whom per capita caloric consumption of SSB increased (30), we observed increases in both the percentage of SSB drinkers and the quantify of SSBs consumed among adults. This study improves our understanding of adult beverage consumption by focusing on variations by sociodemographic characteristics, weight status, and intention to lose weight. Previous studies have largely focused on overall averages, ignoring the heterogeneity by subpopulation. The considerable gradient we observe by age, for

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TABLE 5
Average quantity and caloric contributions from sugar-sweetened beverages among US adults who had ≥1 consumption occasion on the surveyed day, in the third National Health and Nutrition Examination Survey (NHANES III, 1988–1994) and NHANES 1999–2004[1]

	Daily consumption		Volume per consumption occasion		Energy intake	
	1988–1994	1999–2004	1988–1994	1999–2004	1988–1994	1999–2004
	oz		*oz*		*kcal*	
Overall	22 ± 1	28 ± 1[2]	11 ± 0	17 ± 0[2]	239 ± 6	294 ± 5[2]
Sex						
Female	19 ± 1	24 ± 1[2]	10 ± 0	15 ± 0[2]	207 ± 6	249 ± 6[2]
Male	25 ± 1	32 ± 1[2]	13 ± 0	19 ± 0[2]	271 ± 10	338 ± 8[2]
Race-ethnicity						
Non-Hispanic white	25 ± 1	31 ± 1[2]	13 ± 0	19 ± 1[2]	262 ± 8	316 ± 8[2]
Non-Hispanic black	22 ± 0	29 ± 1[2]	12 ± 0	17 ± 0[2]	247 ± 4	311 ± 7[2]
Mexican American	21 ± 1	26 ± 1[2]	12 ± 0	15 ± 1[2]	233 ± 8	275 ± 9[2]
Education						
Less than high school	24 ± 1	29 ± 1[2]	12 ± 0	18 ± 0[2]	253 ± 9	310 ± 8[2]
High school or GED	23 ± 1	30 ± 1[2]	12 ± 0	17 ± 0[2]	249 ± 9	302 ± 10[2]
More than high school	22 ± 1	28 ± 1[2]	12 ± 1	17 ± 0[2]	239 ± 11	293 ± 11[2]
Income[3]						
Lower income	23 ± 1	30 ± 1[2]	12 ± 0	18 ± 1[2]	252 ± 8	319 ± 9[2]
Higher income	22 ± 1	28 ± 1[2]	12 ± 0	17 ± 0[2]	235 ± 8	283 ± 6[2]
Body weight status[4]						
Normal weight	21 ± 1	27 ± 1[2]	11 ± 0	16 ± 1[2]	228 ± 9	289 ± 8[2]
Overweight	22 ± 1	27 ± 1[2]	12 ± 0	17 ± 0[2]	236 ± 7	276 ± 7[2]
Obese	26 ± 1	31 ± 1[2]	13 ± 0	18 ± 1[2]	270 ± 7	317 ± 9[2]
Weight-loss intention[5]						
Not trying to lose weight	22 ± 1	29 ± 1[2]	11 ± 0	17 ± 0[2]	238 ± 7	301 ± 7[2]
Trying to lose weight	23 ± 1	28 ± 1[2]	12 ± 0	17 ± 0[2]	243 ± 8	285 ± 9[2]

[1] All values are mean ± SEM. GED, General Education Development test that certifies high school-level skills. Conversion factor (1 oz = 28.57 mL). Multivariate regression was used to adjust for age, sex, race-ethnicity, education, marital status, income, and employment status. SEM < 0.05 is listed as 0.

[2] *P* for trend < 0.05.

[3] Income level was dichotomized based on the poverty:income ratio and eligibility for food assistance programs (ie, ≤130% of the poverty level).

[4] Normal weight was defined as a BMI (in kg/m^2) from 18.5 to 24.9, overweight as BMI from 25 to 29.9, and obese as BMI ≥ 30.

[5] Categories of trying to lose weight include all BMI groups.

example, suggests that prior research focused on the entire adult population may have underestimated the energy imbalance among younger adults.

Our focus on multiple subpopulations makes it possible to highlight several potential opportunities to reduce overall caloric intake as well as to identify concerning patterns for future study. To reduce adult intake of SSBs, the considerable consumption of SSBs in the workplace, particularly among young adults, suggests that initiatives focused in this area may have a significant effect. To achieve this goal, one possibility might be to reduce the standard serving size of SSBs in the workplace (eg, from a 20-oz bottle to a 12-oz can), given our finding of increased consumption per drinking occasion. Another might be to reduce the ready availability of SSBs, which undermines initiatives aimed at reducing consumption, or to replace SSB beverage options with noncaloric alternatives. This latter strategy has been effective in adolescents (33). Efforts to reduce SSB consumption in the workplace, where we found that young adults consume a fifth of their SSB calories, would complement the growing interest among employers of investing in health-promotion strategies (34). An additional approach might be to encourage the current trend toward decreased SSB consumption among overweight-obese persons trying to lose weight, an easy and concrete, behavioral target that may be best encouraged by physicians and health care professionals.

In general, strategies that promote reductions in SSB intake may be easier to attain than strategies that promote increases in physical activity, given the time trade-off between energy intake and expenditure. For example, an 85-kg man (187.4 lb) would need to walk for 50 min (rather than sit) to burn off 1 can (12 oz) of soda (140 kcal/d).

Additional research is needed to understand the drivers of increased SSB consumption among subgroups with higher intake. For example, the recent Institute of Medicine report that focused on food marketing to children (35) found that ethnic minorities living in poorer neighborhoods have fewer healthier options (36, 37). From a policy perspective, targeted programs among these subpopulations, promoting reduced consumption of empty calories, may be useful for reducing the upward trend in consuming SSBs.

The present study has several limitations. First, our reliance on single 24-h dietary recalls may introduce inaccuracy and bias to

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TABLE 6
Percentage of overweight-obese US adults (aged ≥20 y) consuming beverages and per capita caloric contribution on the survey day, by weight-loss intention and beverage, in the third National Health and Nutrition Examination Survey (NHANES III, 1988–1994; $n = 9639$) and NHANES 1999–2004 ($n = 7862$)[1]

	1988–1994		1999–2004	
	Not trying to lose weight	Trying to lose weight	Not trying to lose weight	Trying to lose weight
Consumed beverages on the surveyed day (%)				
Had SSBs	62 ± 2	54 ± 2[2]	67 ± 2	61 ± 2[2]
Had diet	17 ± 2	26 ± 2[2]	15 ± 1	21 ± 1[2]
Had juice	19 ± 1	17 ± 1	20 ± 1	19 ± 1
Had milk	54 ± 2	54 ± 2	47 ± 0	46 ± 0
Had coffee or tea	63 ± 2	62 ± 2	59 ± 0	59 ± 0
Had alcohol	22 ± 2	18 ± 2[2]	18 ± 0	20 ± 0
Per capita caloric contribution (kcal/d)				
From SSBs	178 ± 6	146 ± 5[2]	231 ± 6	186 ± 7[2]
From juice	29 ± 2	29 ± 1	34 ± 2	29 ± 2[2]
From milk	97 ± 5	83 ± 4[2]	88 ± 4	74 ± 4[2]
From coffee or tea	9 ± 0	7 ± 0 [2]	10 ± 1	11 ± 1
From alcohol	92 ± 5	67 ± 6 [2]	89 ± 6	91 ± 8
Daily caloric contribution among drinkers (kcal/d)				
From SSBs	261 ± 8	240 ± 7	313 ± 7	278 ± 9[2]
From juice	146 ± 6	150 ± 7	161 ± 6	148 ± 6
From milk	184 ± 7	161 ± 6[2]	195 ± 7	171 ± 6
From coffee or tea	15 ± 1	12 ± 1[2]	19 ± 1	21 ± 2
From alcohol	359 ± 21	336 ± 20	426 ± 19	409 ± 33

[1] All values are means ± SEMs. Overweight-obese was defined as BMI (in kg/m^2) ≥ 25. SEM < 0.05 is listed as 0. SSBs, sugar-sweetened beverages. Multivariate regression was used to adjust for age, sex, race-ethnicity, education, marital status, income, and employment status.
[2] P for between-group difference < 0.05.

our analyses because of underreporting, unreliability, and conversion error. Previous research indicates that adults underreport their dietary consumption by ≈25% (38, 39). In addition, restrained eating has been associated with underreporting of caloric intake (40). Therefore, the true difference in SSB consumption between persons with weight-loss intention and persons not trying to lose weight may be smaller than our results indicate. However, available evidence does suggest better recall accuracy with packaged beverage items such as SSBs (41). A single 24-h dietary recall may not accurately represent usual dietary intake for a person. Lack of reliability of the dietary recall for overall eating habits will reduce the precision of our

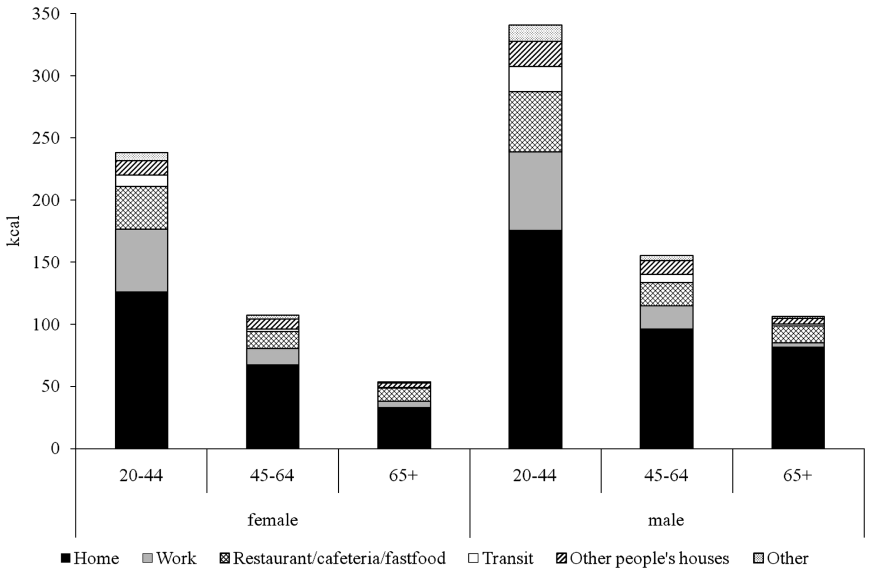

FIGURE 1. Per capita calories from sugar-sweetened beverages by location of consumption according to the National Health and Nutrition Examination Survey (NHANES) 1999–2000. Note: Multivariate regression was used to adjust for sex, race-ethnicity, education, marital status, income, and employment status.

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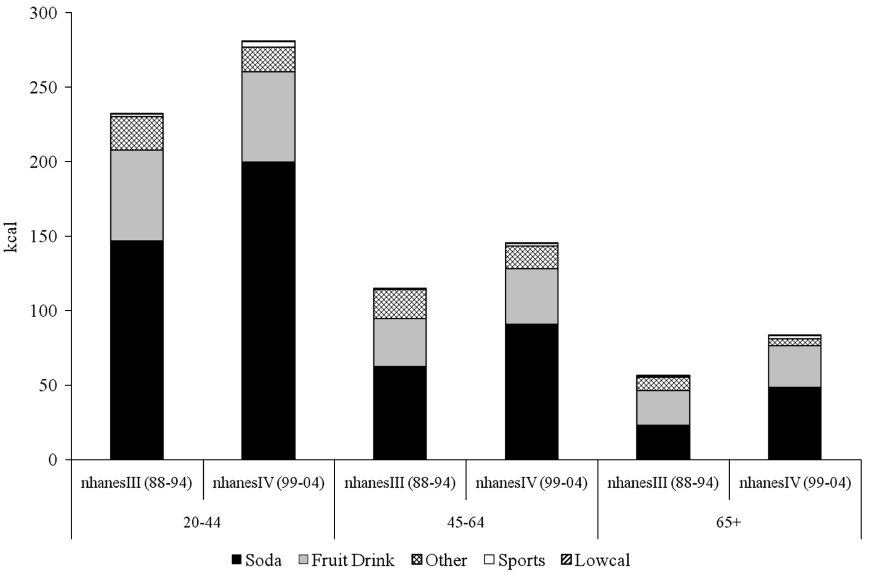

FIGURE 2. Per capita calories from sugar-sweetened beverages by beverage type, third National Health and Nutrition Examination Survey (NHANES III) compared with NHANES 1999–2004. Note: Multivariate regression was used to adjust for age, sex, race-ethnicity, education, marital status, income, and employment status.

estimates, but it will not bias our regression estimates when total energy intake is the dependent variable (42). Inaccuracy exists in converting reported beverage consumption to energy intake because the assumptions on serving size and food composition are defined by the food and nutrient database. This standard database assumes a representative nutritional content for a given food or beverage. The inevitable variation in actual intake and reporting bias may introduce measurement errors, particularly for the estimation of total energy intake. However, this error is likely less significant for packaged, standard-sized beverages. Second, although we used multivariate regression models to adjust for demographic variables, our inferences on secular changes and beverage consumption patterns between the 2 surveys may remain constrained by changes in other demographic variables, but the 2 samples had comparable distributions of sex, age, employment status, and income status. Third, the NHANES data are cross-sectional, which only allows us to address associations rather than causality. Fourth, the intention-to-lose-weight question asks respondents about the previous 12 mo, whereas the 24-h recall focuses on 1 d. Temporal differences may limit our ability to fully capture eating practices of persons trying to lose weight. In addition, differences in survey methods between the 2 study periods (eg, NHANES 1999–2004 used computer-assisted interviewing for the dietary interview, but NHANES III did not) may affect the comparability of data overtime.

To conclude, SSB consumption has increased dramatically in the past decade in the United States, in parallel with the rising prevalence of obesity and type 2 diabetes. Large epidemiologic studies provide strong evidence for the independent effect of SSBs on weight gain and type 2 diabetes (1, 4). Efforts to encourage replacing SSBs with low-caloric or noncaloric alternatives may be an important strategy to reduce consumption of empty calories. Physicians and public health professionals are well positioned to identify and promote concrete behavioral targets aimed at decreasing adult SSB consumption, making awareness of these changes critical among that group. The workplace and home offer key areas of intervention for reducing the energy imbalance in young adults.

The authors' responsibilities were as follows—SNB, YCW, and SLG: conceived the study and developed the hypotheses; SNB (guarantor) analyzed the data and drafted the manuscript; SNB, YCW, YW, and SLG: contributed to the interpretation of study findings and to the final draft. None of the authors had a personal or financial conflict of interest.

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APPENDIX A

Coding definition for nonalcoholic beverage categories: NHANES III and NHANES 1999–2004

1) Sugar-sweetened beverages (SSBs) includes all sodas, fruit drinks, sport drinks, low-calorie drinks, and other beverages [sweetened tea, rice drinks, bean beverages, sugar cane beverages, horchata (a traditional Mexican beverage made with rice), and nonalcoholic wines or malt beverages].
   a) Sport drink includes all drinks labeled Gatorade or thirst quencher (3 items in NHANES III, 7 items in NHANES 1999–2004).
   b) Fruit drink includes all fruit drinks, fruit juices, and fruit nectars with added sugar (166 items in NHANES III, 137 items in NHANES 1999–2004).
   c) Soda includes all carbonated beverages with added sugar (25 items in NHANES III, 21 items in NHANES 1999–2004).
   d) Low-caloric SSBs include all beverages described as "low-calorie." This includes fruit juices, teas, and fruit drinks (26 items in NHANES III, 26 items in NHANES 1999–2004).
   e) Other SSBs include sweetened tea, rice drinks, bean beverages, sugar cane beverages, horchata, nonalcoholic wines or malt beverages, etc (40 items in NHANES III, 37 items in NHANES 1999–2004).

2) Diet beverages include all diet sodas and sugar-free carbonated soda water (17 items in NHANES III, 17 items in NHANES 1999–2004).

3) Milk includes all whole, low-fat, skim milk, and flavored milk (62 items in NHANES III; 55 items in NHANES 1999–2004). Flavored milk includes fruit-flavored milk and chocolate milk (60 items in NHANES III; 69 items in NHANES 1999–2004).

4) 100% Juice (FJ) includes all 100% juices (eg, apple and orange) and all unsweetened juices (27 items in NHANES III; 17 items in NHANES 1999–2004).

5) Coffee or tea includes all coffee drinks and unsweetened teas (59 items in NHANES III; 67 items in NHANES 1999–2004).

6) Alcohol includes all alcoholic beverages (64 items in NHANES III; 70 items in NHANES 1999–2004).

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