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Secular trends in patterns of self-reported food consumption of adult Americans: NHANES 1971–1975 to NHANES 1999–2002[1,2,3]

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Abstract

Background—The contributors to trends in increasing prevalence of obesity in the US population are poorly understood.

Objective—We examined secular trends in food consumption behaviors to understand their possible contribution to increasing energy intakes and adiposity in the American population.

Design—We used dietary data from 4 consecutive National Health and Nutrition Examination Surveys (NHANES) to examine trends (1971–2002) in frequency of eating episodes, meal and snack consumption, quantity of food consumed, and the energy density of foods reported by adult Americans (n = 39 094). Logistic and linear regression methods were used to adjust for multiple covariates and survey design.

Results—The reported number of all eating episodes increased slightly in women from 4.90 in 1971–1975 to 5.04 in 1999–2002 (P for trend = 0.002). The amount (in g) of foods and beverages consumed, the energy density of foods, and energy intake per eating episode increased, but the mention of breakfast declined in both sexes (P for trend < 0.0001). The observed trends in mention of a snack (in men) and percentage of energy from evening food intake (in women) were downward. The amount (in g) of foods and their energy density were independent positive correlates of obesity in combined data from all surveys (P for trend < 0.0001).

Conclusions—Our results do not support large increases in eating frequency, snacking, or evening eating by the American population from 1971 to 2002. The quantity of foods and their energy density increased beginning in NHANES III (1988–1994) with trajectories roughly parallel to the rates of prevalence of obesity in the US population. However, we urge cautious interpretation of these results because of concurrent changes in dietary methods during this period.

Keywords

Secular trends; National Health and Nutrition Examination Surveys; NHANES; eating frequency; snack intake; breakfast intake; energy density; evening eating; portion size; energy intake; obesity; body mass index

INTRODUCTION

Data from recent national surveys indicate a continuation of the trend for increasing prevalence of obesity in the US population (1,2). Food disappearance and survey data implicate an increase

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in energy intake without a corresponding increase in energy expenditure as a possible explanation for the persistent positive energy balance and eventually weight gain in the US population (3–5). Multiple factors may be responsible for increasing energy intakes, but they are poorly understood. Many food consumption behaviors, including portion size of foods, number of meals eaten away from home, frequency of eating episodes, temporal distribution of food intake, and energy density of foods, may relate with energy intake (5–16). Because of an expanding food supply, aggressive food marketing, and changes in work and leisure patterns of Americans, it is reasonable to expect a change in some of these food consumption behaviors over the course of the past 3 decades. An examination of changing patterns of food consumption can help in understanding the correlates of increasing energy intake. In this context, trends in away-from-home eating (6,7), portion sizes of foods (8–11), and snacking (17,18) have been the subject of recent reports; however, little is known about changes in the other food consumption behaviors mentioned earlier. The objective of this study was to examine secular (time) trends (1971–2002) in food consumption behaviors—as reflected in the frequency of eating episodes, snacking, breakfast consumption, evening eating, the amount of food consumed (in g), and the energy density of foods—of American men and women.

SUBJECTS AND METHODS

We used data collected in the National Health and Nutrition Examination Survey (NHANES) I (1971–75) (19), II (1976–1980) (20), III (1988–1994) (21), 1999–2000 (22), and 2001–2002 (23), conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention. Each survey was a stratified, multistage, national probability sample of the civilian noninstitutionalized population of the United States. The subjects surveyed in NHANES I and II were aged 1–74 y, those surveyed in NHANES III were aged ≥2 mo, and those surveyed in NHANES 1999–2002 were of all ages. Each survey included a household interview of the sample person conducted by a trained interviewer and a health examination in the mobile examination center (MEC). The health examination included a physical examination, a dental examination, radiography, measurements of weight and height, an interview to collect a 24-h dietary recall, and the collection of blood and urine specimens. Survey response rates for MEC-examined persons for NHANES I (19), II (20), III (21), and 1999–2000 (22) were 74%, 73%, 78%, and 78%, respectively.

Dietary methods

All surveys collected dietary information with the use of a 24-h recall administered by a trained dietary interviewer in the MEC (19–23). Dietary interviewers used paper-and-pencil methods in the NHANES I and II, which changed to computer-assisted, automated methods in later surveys. The dietary recalls collected for the NHANES 1999–2000 and 2001 survey years used a computer-assisted dietary interview that included a 4-step multiple pass approach (22,23). In the NHANES 2002, the dietary data were collected with the use of a 5-step multiple pass approach with dietary recall methods that are part of the integrated US Department of Agriculture and NHANES protocol of What We Eat in America(23).

Analytic sample

For each of the 4 surveys, all nonpregnant, nonlactating respondents aged 25–74 y with a reliable, self-reported 24-h dietary recall and measured height and weight were included in the analytic sample. The upper age cutoff of 74 y was necessary because the NHANES I and II did not include respondents aged >74 y. The final analytic sample comprised 39 094 respondents (NHANES I = 10 537; NHANES II = 10 118, NHANES III = 12 042, and NHANES 1999–2002 = 6397).

Food consumption variables

The food consumption behaviors examined in this study were derived from a 24-h recall as described below. The behaviors examined included frequency of eating episodes, breakfast consumption, snack intake, evening eating, and dietary energy density.

Frequency of eating episodes—Each 24-h recall included information on the time of day (clock time) when foods or beverages were consumed. Using methods we previously reported (15), we determined the frequency of eating episodes from the discrete number of clock times when foods or beverages were consumed in the 24-h recall. One eating episode comprised all foods and beverages consumed at 1 clock time, regardless of the type or the amount of food reported.

Breakfast consumption—In each recall the respondents were asked to identify or name the eating occasion for each reported food and beverage. In the NHANES I and II, for each food item recalled, information was collected on the "ingestion period" (AM, noon, PM, or between meals). For the NHANES III and the NHANES 1999–2002, the subject was asked to name the eating occasion when each food was recalled and included the following choices (breakfast, lunch, dinner, snack, or their equivalents in Spanish). We determined breakfast consumption based on whether the respondent mentioned any foods and beverages for the AM meal or for breakfast, desayuno, or brunch. The resulting variable was expressed as whether breakfast was reported, and the proportion of 24-h energy intake from foods and beverages mentioned in the eating episodes considered as breakfast.

Snack intake—Snack intake was also determined from named eating occasions described above. The number of different clock times at which "between meals" or "snack" were mentioned contributed to snack events. We expressed snacking behavior as whether a snack was reported, number of snacking episodes on the recall day, and percentage of 24-h energy intake from snacks.

Evening eating—We used methods previously reported by us (12,13) to assess evening eating. Accordingly, all foods and beverages reportedly consumed at or after 1700 until the last reported eating episode were considered to comprise evening eating. Evening eating is expressed as a variable that is the proportion of 24-h energy intake from foods and beverages consumed at or after 1700.

Dietary energy density—No consensus exists about how energy density should be defined (24). The association of different energy density measures with energy intake and body weight varies depending on its definition (24–26). For example, the association of energy intake with energy density variables that included beverages was not as strong as energy density variables that were derived from solid foods (25), possibly because of different physiologic mechanisms for regulation of beverage intake, as suggested by Rolls et al (27). The NHANES dietary data include weight (in g) and the energy content of each food and beverage reported in the 24-h recall. From these data, we assessed dietary energy density (kcal/g) as 2 different measures: *1*) overall energy density or energy content of all foods and beverages reported in the 24-h recall [energy from all foods and beverages was divided by the weight (in g) of all foods and beverages], and *2*) energy density of all foods and nutritive beverages [energy from all foods and nutritive beverages was divided by the weight (in g) of all foods and nutritive beverages]. Milk and 100% juice were considered as nutritive beverages, and all alcoholic and nonalcoholic energy-yielding or nonenergy-yielding beverages (eg, coffee, tea, sodas, juice drinks) were excluded from this measure. For those reporting breakfast, evening eating, or snacking in the recall, we also computed the energy density of all foods and beverages reported at these eating occasions.

Analytic methods

We used linear or logistic multiple regression models to assess secular trends in food consumption behaviors examined in this study. Although we tested for sex by survey interactions, all primary results are presented stratified by sex. This reflects a priori decisions about sex-specific hypothesis testing because of differences in dietary intakes and prevalence of obesity between men and women. Because of differences in the distribution of several potential factors that may be associated with reporting of food consumption patterns among surveys, the regression models included sex, age, race (white, black, and other), education (<12 y, 12 y, >12 y), day of the recall (Sunday to Monday), smoking status (never, former, current), any leisure-time physical activity (yes, no), body mass index (BMI; in kg/m^2) (continuous), self-reported chronic disease (heart disease, diabetes, high blood pressure) (yes, no), and survey (NHANES I, NHANES II, NHANES III, and NHANES 1999–2002), as independent variables with each food consumption behavior as a continuous or binary outcome. Output from linear or logistic multiple regression models was used to calculate the adjusted means or proportions (predictive margins) of food consumption variables (with SEs) for each sex and survey group. This method directly standardized the means to the distribution of the covariates for the combined US populations represented by the weighted NHANES samples (28). We note that results of regression analysis with adjustment for multiple covariates were substantively similar to those obtained in our preliminary analyses with adjustments limited to age, race, and education (data not shown, available from authors). The race or ethnicity categories available in the NHANES 1999–2002 differ markedly from race categories in earlier surveys. The NHANES I and II provide only white, black, and other categories. The NHANES III provides both race- and ethnicity-specific categories. However, in the NHANES 1999–2002, the race of Hispanic participants was not available. For the present analyses we grouped Mexican Americans and other Hispanics with whites in the NHANES 1999–2002. This allowed us to categorize race for all surveys as white, black, and other. Respondents missing information on any covariate were excluded from regression models. In tests for trend across surveys, the 4 surveys from 1971 to 2002 were modeled as an ordinal independent variable.

We examined the association of food consumption variables with energy intake and odds of obesity (BMI ≥ 30) by using sex-specific linear and logistic regression models, respectively. These models included age, race, leisure-time physical activity, education, smoking status, chronic disease status, and survey as covariates. Reports have pointed out a high occurrence of low-energy reporting in national survey data (29–32). Higher body weight was shown to be associated with low-energy reporting in several reports (29–32). Whether this reflects a reporting bias or low intakes to manage weight cannot be determined for all surveys examined in this study. However, low-energy reporting is believed to affect the ability to detect association of dietary variables with outcomes such as body weight (33). In an attempt to understand whether low-energy reporting modified the associations of food consumption behaviors with the risk of obesity, we also present results adjusted for the ratio of reported energy intake to calculated energy requirement for basal energy expenditure (BEE) (34). BEE was computed with the use of sex-specific equations recommended by the committee for dietary reference intakes (35). We used a ratio of energy intake to BEE of <1.2 to signify low-energy reporting.

We combined data from 4 surveys for these analyses, and we treated the data from the 4 different surveys as independent samples from different populations for purposes of variance estimation. We weighted the data in our analyses by using the NCHS-assigned survey-specific sample weights so as to produce estimates that represented each population (36). All statistical analyses were adjusted for the sample weights and complex sample design of the NHANES by using SAS callable SUDAAN, version 9.0 (37). All reported *P* values were 2 sided.

RESULTS

The characteristics of respondents in the 4 surveys are shown in Table 1. The distribution of all characteristics examined varied across surveys ($P \leq 0.002$, chi-square test of independence for all variables). The proportion of the population with >12 y of education and never smokers increased, and those reporting <12 y of education, current smoker status, or a ratio of energy intake to BEE <1.2 decreased from NHANES I to NHANES 1999–2002.

Over the 3-decade span of the 4 surveys, the number of eating episodes reported in the 24-h recall increased slightly in women (from 4.9 in NHANES I to 5.04 in NHANES 1999–2002) (*P* for trend = 0.002) but was unchanged in men (Table 2). Across surveys, the reported amount (in g) of all foods and beverages, total energy intake, and the amount (in g) of food and energy per eating episode increased in both men and women (*P* for trend < 0.0001).

Americans reporting breakfast declined from 89% in NHANES I to 82% in NHANES 1999–2002 (*P* for trend < 0.0001); however, the mean percentage of 24-h energy intake from breakfast declined only in men (Table 3). The percentage of energy from evening food intake declined slightly in women but was unchanged in men. Among men, the percentage reporting a snack and the number of snacking episodes decreased from 1971–75 to 1999–2002 (*P* for trend < 0.0001); these snack behaviors were unchanged in women. However, the percentage of daily energy from snacks remained unchanged in men and increased slightly in women (*P* for trend = 0.007). Among snack reporters, although the amount (in g) of foods and beverages reported per snacking episode did not change from 1971 to 2002, the amount of energy consumed per snacking episode increased in both men and women (*P* for trend < 0.0001).

The energy density (in kcal/g) of all foods and beverages reported in the recall increased in women but declined slightly in men (Table 4). The energy density (in kcal/g) of foods and nutritive beverages increased over the period of the 4 surveys in both men and women (*P* for trend < 0.0001). The energy density of all foods and beverages reported as snack, breakfast, or evening intake increased across surveys (*P* for trend < 0.0001). The sex differences in mean energy density of foods and beverages reported for breakfast or evening were present in earlier surveys but not in 1999–2002 (sex by survey interaction, $P < 0.05$).

The number of eating and snack episodes, mention of breakfast or a snack, and the amount (in g) of foods and beverages and their energy density were significant independent predictors of higher energy intake in both men and women [$P < 0.0001$ for all variables, except mention of breakfast in women ($P = 0.02$)] (data not shown). Shown in Table 5 is the regression coefficient ($\beta \pm$ SE) associated with each food consumption variable with obesity (BMI ≥ 30) as outcome, from logistic regression models with and without adjustment for low-energy reporting for all surveys combined. The interaction of sex and each food consumption variable (except mention of breakfast) for predicting obesity was not significant ($P > 0.05$). The inverse association of the number of eating and snacking episodes with likelihood of obesity was not significant after adjustment for low-energy reporting in both sexes. With adjustment for low-energy reporting status, the reported amount (in g) of foods and beverages predicted obesity in all surveys combined ($P \leq 0.001$). For all surveys combined, the energy density of foods and nutritive beverages was a positive correlate of obesity irrespective of energy reporting status. The association of obesity with the amount (in g) of food intake and energy density of foods and nutritive beverages–adjusted for low-energy reporting status–was also significant in each individual survey (except energy density in NHANES I) (data not shown).

DISCUSSION

The results of this study suggest relatively small shifts in patterns of food consumption over the past 3 decades. These results are contrary to our expectation of a population-wide increase in frequency of eating as a result of an increase in the “grazing” type of food consumption behaviors. Instead, our results suggest an increase in the quantity and energy density of foods over the past 3 decades. It is not surprising, therefore, that the quantity of food and the energy intake per eating episode were higher in later surveys relative to earlier ones.

To our knowledge, no published reports are available of secular trends in overall eating frequency or energy density of self-reported American diets. In our study, little change in amounts (in g) reported or energy density was apparent from 1971 to 1980; increases in amounts or energy density first appeared in the NHANES III (1988–1994), and a further increase occurred in the NHANES 1999–2002. These trends roughly parallel the trends in increasing prevalence of adiposity first noted in NHANES III and subsequent surveys relative to the NHANES I and II (1,2). Although, given these trajectories, it is tempting to speculate that the amount (in g) and energy density of foods may have contributed to the trend for increasing body weight (Figure 1), methodologic limitations (discussion to follow) temper the possible conclusions. Our finding of a positive trend for amounts of foods and beverages reported is consistent with other reports of an increase in portion sizes of foods reported in US surveys (9,10). Rolls et al (38) have shown that higher portion sizes increased energy intake irrespective of body weight in both men and women. Furthermore, the effects of portion size and energy density on energy intake were additive (39).

Our results suggest that changes in food selections of women over the past 3 decades were somewhat worse than those of men. For example, the increase in total amount of foods and beverages from NHANES I to NHANES 1999–2002 was similar in men and women (≈14% increase); however, the corresponding increase in mean energy intake was 8% in men and 18% in women. This may reflect a greater increase in energy density of foods selected by women. In all surveys, the energy density of snacks reported by women was higher than for men. In the NHANES I and II, the energy density of breakfast and evening foods was lower in women than in men; however, in later surveys, the sex differences in energy density of breakfast and evening foods disappeared, because the slope of energy density was steeper in women. These results suggest a putative reason for the sex disparity in the rate of increase in adiposity. [The prevalence of obesity and the percentage increase in prevalence of obesity is slightly higher among women than among men (1,2)].

The decline in the number of adult Americans who report breakfast over the span of the 4 surveys in our study is in accord with a previous report that used 1 d of dietary data from the Continuing Survey of Food Intakes by Individuals, 1965–1991 (40). The finding of a decline in the number of Americans who reported breakfast should be viewed with concern given that breakfast consumption has been reported as a characteristic of successful weight-loss maintainers in the National Weight Control Registry (41). Also, breakfast intake is generally believed to be a positive predictor of adequacy of micronutrient intake, although the results vary with foods selected (42,43).

In our study, the percentage of men (not women) mentioning a snack decreased from 91% in the NHANES I to 86% in the NHANES 1999–2002. Other reports on trends in snacking patterns were limited to children (17,44) and young adults (18) and are not directly comparable to our study. Nicklas et al (44) reported that the number of eating and snacking episodes reported in a 24-h recall by children in the Bogalusa Heart Study declined from 1973 to 1994. In 2 reports from the Continuing Survey of Food Intakes by Individuals (1977–1996), the investigators concluded that the prevalence of snacking had increased among children aged 2–18 y and young adults aged 19–29 y (17,18). Those studies estimated prevalence of snacking in a different reference period based on 3 d of dietary data that included a mixture of recalls and records and used a slightly different definition of snacking, and the prevalence rates were not adjusted for differences (if any) in characteristics of respondents in these surveys.

We urge cautious interpretation of our results because of changes in the methods used to collect the 24-h dietary recall in the NHANES over the course of the 4 surveys (19–23). Because the NCHS did not conduct any bridging studies to determine the systematic effect of changes in dietary methods on reporting of meals, snacks, or food and nutrient intakes, the confounding of time effect with the method effect remains a possibility. The multiple pass methods used for obtaining dietary recalls in later surveys may be expected to improve the recall of all possible eating and snacking episodes. However, the eating episodes in earlier surveys may be underreported; in which case, we may expect a positive secular trend in estimates of reporting of eating episodes (or other variables obtained from the dietary recall). As is evident from Tables 2 and 3, this was not the case. Notably, the observed shifts in these food consumption variables were relatively minor and rarely in the expected direction. For example, the mention of breakfast on the recall day declined consistently in both men and women, and the number of snacking episodes either declined (men) or remained unchanged (women) from 1971 to 2002. Nevertheless, the increase in reported quantity of foods, energy intake, and energy density in the NHANES III coincides with changes in dietary methods and is in the expected direction with improved recalls from the use of multiple-pass methods (45). Therefore, the results for these variables should be interpreted with due consideration for possibility of confounding. Clearly, the importance of bridging studies to allow understanding of these effects cannot be overstressed.

We also note that the recalls obtained in the NHANES I and II were limited to weekdays, whereas weekend days were included in later surveys (19–23). Because food consumption and selection behaviors on weekends may differ from weekdays, we included day of the recall as a covariate in regression models used to obtain the estimates presented in Tables 2–4. As mentioned in Subjects and Methods, the eating occasions we considered as breakfast or snack were labeled differently in the NHANES I and II than in later surveys. The extent to which our results reflect these differences is not known. Finally, the survey nutrient database used for estimating energy and nutrient intake has changed over the period of the 4 surveys (46). The database on nutrient composition of foods has expanded, and values of some nutrients may have changed because of improved analytic technology and food-sampling methods (46). However, energy content of foods (variable used in this study) is not among the attributes that have changed in the database.

Low-energy reporting has been noted in the NHANES II and the NHANES III and is more likely to occur in association with higher body weight and a low level of education (29–32). Low-energy reporting may attenuate the possible association of dietary variables and outcomes such as body weight examined in this study. In our evaluation of the association of food consumption patterns with obesity, we also examined these associations after adjustment for energy reporting status. The number of eating episodes, breakfast reporting, snacking, and, not surprisingly, the amount (in g) of food and its energy density predicted higher energy intake in all surveys. However, after adjustment for low-energy reporting status, only the amount (in g) of foods and beverages and the energy density of foods and nutritive beverages consistently predicted a higher BMI in both sexes.

In conclusion, our results do not support large increases in eating frequency, snacking, or evening eating by the American population over the past 3 decades. The quantity of foods and their energy density increased beginning with the NHANES III and may be implicated in contributing to higher energy intake and weight gain. However, these results coincide with changes in dietary methods in NHANES III and warrant cautious interpretation.

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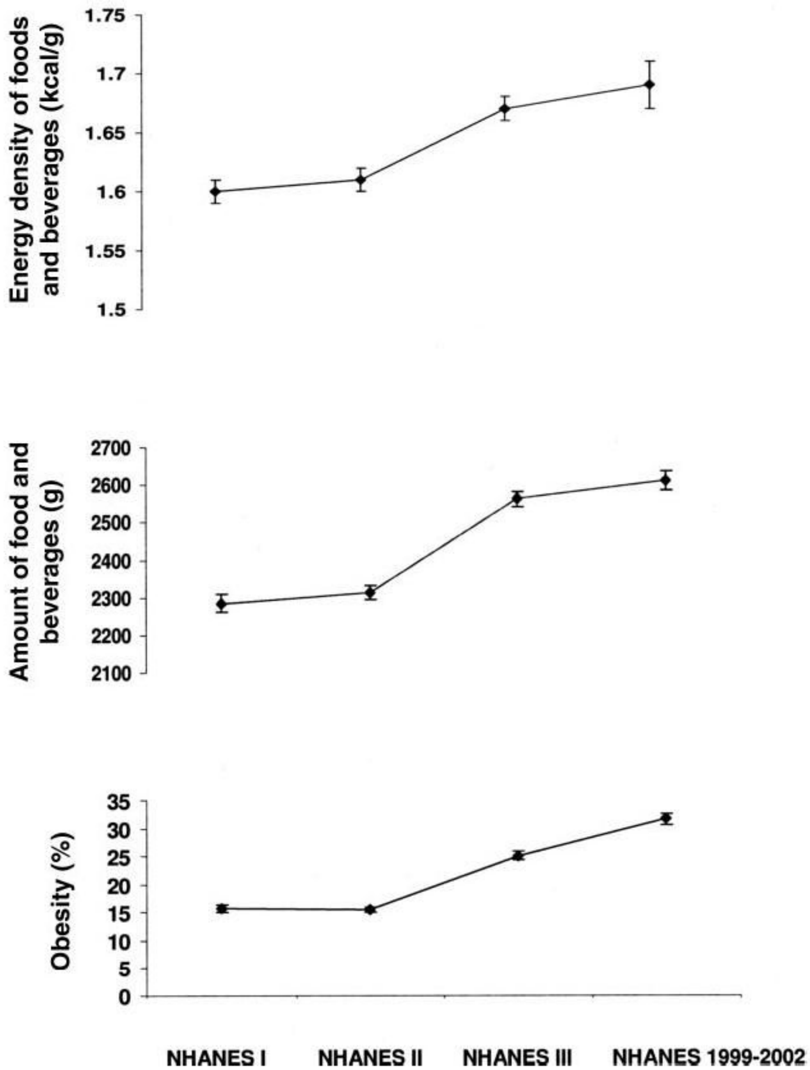

FIGURE 1.
Secular trends (1971–2002) in adjusted mean (±SE) energy density of foods and nutritive beverages, and amount of all foods and beverages, and the prevalence of obesity (BMI ≥ 30) in the US population. Data are from National Health and Nutrition Examination Survey (NHANES) I, II, III, and 1999–2002. Estimates were from multiple regression models with all surveys combined (*n* = 37 530) and were adjusted for the covariates in Table 2 [amount (in g) of food], Table 4 (energy density), and Table 5 (BMI): *P* for trend across surveys < 0.0001.

TABLE 1

Characteristics of survey respondents from National Health and Nutrition Examination Survey (NHANES) I to NHANES 1999– 2002[1]

	All (*n* = 39 094)	**NHANES I (*n* = 10 537)**	**NHANES II (*n* = 10 118)**	**NHANES III (*n* = 12 042)**	**NHANES 1999–2002 (*n* = 6397)**
	%				
Women	51.4 ± 0.3	53.2 ± 0.5	51.8 ± 0.5	51.1 ± 0.5	50.2 ± 0.7
Race					
White	86.6 ± 0.6	89.4 ± 0.7	87.7 ± 1.6	85.0 ± 0.8	85.5 ± 1.3
Black	10.4 ± 0.5	9.7 ± 0.7	10.0 ± 1.2	11.1 ± 0.6	10.5 ± 1.2
Other	2.9 ± 0.3	0.9 ± 0.2	2.2 ± 0.9	3.8 ± 0.4	4.0 ± 0.5
Age group					
25–39 y	38.0 ± 0.5	36.0 ± 0.9	39.2 ± 0.8	42.1 ± 1.0	34.7 ± 1.2
40–59 y	42.3 ± 0.4	43.8 ± 0.8	39.7 ± 0.6	38.4 ± 0.7	47.1 ± 0.9
60–74 y	19.7 ± 0.4	20.2 ± 0.7	21.2 ± 0.6	19.5 ± 0.9	18.2 ± 0.7
Education					
<12 y	27.2 ± 0.5	38.1 ± 1.1	32.9 ± 1.0	22.8 ± 1.1	20.0 ± 0.8
12 y	32.7 ± 0.5	36.6 ± 0.8	36.3 ± 1.0	34.7 ± 0.8	25.6 ± 1.1
>12 y	40.1 ± 0.7	25.3 ± 1.1	30.8 ± 1.2	42.4 ± 1.2	54.3 ± 1.5
Smoking status					
Never smoked	43.4 ± 0.5	40.4 ± 0.8	38.9 ± 0.7	43.4 ± 0.9	48.6 ± 1.3
Former smoker	25.1 ± 0.4	21.0 ± 0.7	24.3 ± 0.5	27.1 ± 0.7	26.3 ± 1.0
Current smoker	31.4 ± 0.4	38.6 ± 0.8	36.7 ± 0.6	29.5 ± 0.9	25.0 ± 0.9
No leisure-time physical activity	33.1 ± 0.6	43.4 ± 1.2	37.5 ± 0.7	21.2 ± 1.0	33.9 ± 1.1
Self-reported chronic disease[2]	28.2 ± 0.4	23.1 ± 0.5	28.9 ± 0.5	28.6 ± 0.7	30.5 ± 1.1
EI:BEE <1.2	46.1 ± 0.4	51.2 ± 1.0	53.1 ± 0.7	42.0 ± 0.7	41.5 ± 0.8

[1] All estimates are ±SE. EI, energy intake; BEE, basal energy expenditure. The chi-square test of independence for each variable in the table was significant, $P \leq 0.002$.

[2] Chronic disease included diabetes, hypertension, and heart disease.

TABLE 2

Number of eating episodes and amount of food self-reported in a 24-h recall from National Health and Nutrition Examination Survey (NHANES) I to NHANES 1999–2000[1]

	NHANES I	NHANES II	NHANES III	NHANES 1999–2002	*P* for trend
Number of eating episodes[2]					
All	5.06 ± 0.03	4.90 ± 0.04	5.01 ± 0.04	5.06 ± 0.04	0.41
Men	5.22 ± 0.05	5.00 ± 0.06	5.06 ± 0.06	5.09 ± 0.05	0.20
Women	4.90 ± 0.03	4.79 ± 0.04	4.96 ± 0.04	5.04 ± 0.04	0.002
Total amount of foods and beverages (g)[2]					
All	2285 ± 24	2314 ± 19	2562 ± 22	2611 ± 25	< 0.0001
Men	2656 ± 39	2718 ± 30	3006 ± 32	3051 ± 39	< 0.0001
Women	1925 ± 18	1933 ± 19	2140 ± 20	2198 ± 30	< 0.0001
Foods and beverages (g/eating episode)[2]					
All	467 ± 5	495 ± 6	542 ± 7	555 ± 7	< 0.0001
Men	532 ± 7	572 ± 7	635 ± 10	646 ± 11	< 0.0001
Women	405 ± 4	424 ± 6	454 ± 5	467 ± 6	< 0.0001
Energy intake (kcal)[2]					
All	1968 ± 20	1942 ± 16	2172 ± 18	2205 ± 16	< 0.0001
Men	2420 ± 30	2409 ± 26	2627 ± 27	2616 ± 22	< 0.0001
Women	1537 ± 17	1503 ± 13	1741 ± 14	1820 ± 20	< 0.0001
Energy intake (kcal/eating episode)					
All	410 ± 4	422 ± 4	470 ± 6	470 ± 4	< 0.0001
Men	496 ± 6	517 ± 6	567 ± 9	555 ± 6	
Women	329 ± 4	334 ± 4	379 ± 3	389 ± 5	

[1] Estimates were derived from regression models with each variable in the table as a continuous outcome; independent variables were sex (in models for all), age, age^2, race (white, black, other), education (<12 y, 12 y, >12), day of the recall, smoking status (never, former, current), any weekly leisure-time physical activity (yes, no), self-reported chronic diseases (diabetes, heart disease, hypertension) (yes, no), BMI (continuous), and survey (NHANES I, NHANES II, NHANES III, NHANES 1999–2002) as trend. The estimates are adjusted $\bar{x} \pm$ SE from weighted regression models that included respondents with complete covariate information total (*n* = 37 530; 17 173 men and 20 357 women).

[2] Interaction of sex by survey was significant, $P < 0.05$. Sex-specific *P* values are not given for variables for which the sex-by-survey interaction was not significant.

TABLE 3

Meal and snack consumption self-reported in a 24-h recall from National Health and Nutrition Examination Survey (NHANES) I to NHANES 1999–2002[1]

	NHANES I	NHANES II	NHANES III	NHANES 1999–2002	*P* for trend
Reported breakfast (%)					
All	89 ± 0.6	88 ± 0.6	82 ± 0.8	82 ± 0.6	< 0.0001
Men	88 ± 0.8	87 ± 0.7	80 ± 1.0	80 ± 0.7	
Women	90 ± 0.7	88 ± 0.8	84 ± 0.8	84 ± 1.0	
Energy from breakfast (%)[2,3]					
All	17.0 ± 0.2	16.5 ± 0.2	16.2 ± 0.2	16.6 ± 0.2	0.3
Men	16.8 ± 0.3	16.4 ± 0.3	16.0 ± 0.3	15.6 ± 0.3	0.006
Women	17.2 ± 0.3	16.7 ± 0.3	16.4 ± 0.2	17.5 ± 0.4	0.6
Energy from evening foods (%)[2–4]					
All	45.9 ± 0.3	47.1 ± 0.3	46.0 ± 0.4	44.2 ± 0.4	< 0.0001
Men	45.8 ± 0.4	47.1 ± 0.4	46.5 ± 0.5	46.0 ± 0.6	0.9
Women	46.0 ± 0.4	47.0 ± 0.4	45.6 ± 0.4	42.5 ± 0.4	< 0.0001
Reported snack consumption (%)[2,3]					
All	90 ± 0.4	88 ± 0.4	87 ± 0.6	86 ± 0.6	< 0.0001
Men	91 ± 0.7	89 ± 0.5	87 ± 0.9	86 ± 0.8	< 0.0001
Women	89 ± 0.6	87 ± 0.6	88 ± 0.7	87 ± 0.9	0.2
Number of snacking episodes[2,3]					
All	2.3 ± 0.04	2.2 ± 0.04	2.3 ± 0.04	2.1 ± 0.04	0.001
Men	2.5 ± 0.05	2.4 ± 0.05	2.3 ± 0.06	2.2 ± 0.04	< 0.0001
Women	2.2 ± 0.04	2.1 ± 0.04	2.2 ± 0.04	2.1 ± 0.04	0.9
Energy from snacks (%)[2,3]					
All	19.7 ± 0.3	20.0 ± 0.3	21.5 ± 0.3	20.8 ± 0.2	0.001
Men	20.4 ± 0.5	20.6 ± 0.3	21.8 ± 0.5	21.0 ± 0.4	0.2
Women	19.2 ± 0.3	19.4 ± 0.3	21.3 ± 0.3	20.6 ± 0.5	0.007
Snack foods and beverages (g/snacking episode)[5]					
All	289 ± 5	333 ± 7	328 ± 4	303 ± 5	0.4
Men	338 ± 8	400 ± 11	392 ± 7	364 ± 8	
Women	244 ± 4	270 ± 7	266 ± 4	244 ± 5	
Energy from snacks (kcal/snacking episode)[5]					
All	185 ± 4	199 ± 3	230 ± 4	234 ± 4	< 0.0001
Men	221 ± 6	247 ± 5	279 ± 6	277 ± 4	
Women	152 ± 3	154 ± 3	184 ± 3	192 ± 4	

[1] Estimates were derived from regression models with each variable in the table as a continuous or binary outcome; independent variables were sex (in models for all), age, age^2, race (white, black, other), education (<12 y, 12 y, >12 y), smoking status (never, former, current), any weekly leisure-time physical activity (yes, no), self-reported chronic diseases (diabetes, heart disease, hypertension) (yes, no), BMI (continuous), and survey (NHANES I, NHANES II, NHANES III, NHANES 1999–2002) as trend. The estimates are adjusted $\bar{x} \pm$ SE or % ± SE from weighted regression models that included respondents with complete covariate information (total *n* = 37 530; 17 173 men and 20 357 women).

[2] Interaction of sex by survey was significant, $P < 0.05$. Sex-specific *P* values are not given for variables for which the sex-by-survey interaction was not significant.

[3] Population average includes those who reported no breakfast, no evening food intake, or no snack.

[4] Evening foods were those reported eaten at or after 1700.

[5] Limited to those with complete covariate information among snack reporters (total *n* = 31 869; 14 540 men and 17 329 women).

TABLE 4

Energy density of self-reported dietary components in a 24-h recall from National Health and Nutrition Examination Survey (NHANES) I to NHANES 1999–2002[1]

Energy density	NHANES I	NHANES II	NHANES III	NHANES 1999–2002	*P* for trend
All foods and beverages (kcal/g)[2]					
All	0.90 ± 0.006	0.89 ± 0.007	0.90 ± 0.005	0.91 ± 0.01	0.15
Men	0.95 ± 0.008	0.94 ± 0.007	0.93 ± 0.007	0.93 ± 0.01	0.04
Women	0.84 ± 0.007	0.84 ± 0.008	0.88 ± 0.006	0.90 ± 0.01	< 0.0001
All foods and nutritive beverages (kcal/g)					
All	1.60 ± 0.01	1.61 ± 0.01	1.67 ± 0.01	1.69 ± 0.02	< 0.0001
Men	1.65 ± 0.01	1.68 ± 0.01	1.72 ± 0.01	1.74 ± 0.02	
Women	1.54 ± 0.01	1.55 ± 0.04	1.62 ± 0.01	1.65 ± 0.02	
All foods and beverages reported as snacks (kcal/g)[3]					
All	0.89 ± 0.02	0.89 ± 0.02	1.02 ± 0.02	1.32 ± 0.03	< 0.0001
Men	0.85 ± 0.02	0.86 ± 0.02	0.96 ± 0.02	1.28 ± 0.03	
Women	0.94 ± 0.02	0.92 ± 0.02	1.08 ± 0.03	1.37 ± 0.03	
All foods and beverages reported as breakfast (kcal/g)[2,4]					
All	0.75 ± 0.01	0.78 ± 0.01	0.83 ± 0.01	0.97 ± 0.02	< 0.0001
Men	0.84 ± 0.01	0.86 ± 0.01	0.86 ± 0.01	0.97 ± 0.02	< 0.0001
Women	0.68 ± 0.01	0.71 ± 0.01	0.81 ± 0.02	0.97 ± 0.02	< 0.0001
All foods and beverages reported in the evening (kcal/g)[2,5]					
All	1.10 ± 0.01	1.11 ± 0.01	1.11 ± 0.01	1.22 ± 0.01	< 0.0001
Men	1.12 ± 0.01	1.15 ± 0.01	1.12 ± 0.01	1.22 ± 0.01	0.0001
Women	1.08 ± 0.01	1.08 ± 0.01	1.11 ± 0.01	1.23 ± 0.02	< 0.0001

[1]Estimates were derived from regression models with each variable in the table as a continuous outcome; independent variables were sex (in models for all), age, age^2, race (white, black, other), education (<12 y, 12 y, >12 y), smoking status (never, former, current), any weekly leisure-time physical activity (yes, no), self-reported chronic diseases (diabetes, heart disease, hypertension) (yes, no), BMI (continuous), and survey (NHANES I, NHANES II, NHANES III, NHANES 1999–2002) as trend. The estimates are adjusted $\bar{x} \pm SE$ from weighted regression models that included respondents with complete covariate information (total *n* = 37 530; 17 173 men and 20 357 women).

[2]Interaction of sex by survey was significant, $P < 0.05$. Sex-specific *P* values are not given for variables for which the sex-by-survey interaction was not significant.

[3]Limited to those with complete covariate information among snack reporters (total *n* = 31869; 14 540 men and 17 329 women).

[4]Limited to those with complete covariate information among breakfast reporters (*n* = 31 714 all; 14 307 men; 17 407 women).

[5]Limited to those with complete covariate information among evening food intake reporters (total *n* = 36 107 all; 16 490 men and 19 617 women).

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TABLE 5

The association of food consumption patterns with BMI ≥ 30 from the National Health and Nutrition Examination Survey (NHANES) I to NHANES 1999–2002[1]

	All	Men	Women
Number of eating episodes			
Model 1[2]	−0.07 ± 0.01 (<0.0001)	−0.06 ± 0.02	−0.07 ± 0.02
Model 2[3]	−0.02 ± 0.01 (0.03)	−0.02 ± 0.02	−0.03 ± 0.02
Mentioned breakfast			
Model 1,[2,4]	−0.14 ± 0.06 (0.02)	−0.02 ± 0.08	−0.25 ± 0.08
Model 2,[3,4]	−0.07 ± 0.06 (0.2)	0.04 ± 0.08	−0.19 ± 0.08
Percentage of energy consumed in the evening			
Model 1[2]	−0.0005 ± 0.001 (0.6)	−0.0005 ± 0.001	−0.0005 ± 0.001
Model 2[3]	−0.0004 ± 0.001 (0.6)	−0.0005 ± 0.001	−0.0005 ± 0.001
Mentioned a snack			
Model 1[2]	−0.10 ± 0.05 (0.06)	−0.10 ± 0.07	−0.10 ± 0.08
Model 2[3]	0.01 ± 0.05 (0.8)	0.02 ± 0.07	0.009 ± 0.08
Number of snacking episodes			
Model 1[2]	−0.05 ± 0.01 (<0.0001)	−0.05 ± 0.02	−0.06 ± 0.02
Model 2[3]	−0.02 ± 0.01 (0.06)	−0.01 ± 0.02	−0.03 ± 0.02
Amount of reported foods and beverages (kg)			
Model 1[2]	0.01 ± 0.02 (0.5)	0.01 ± 0.02	0.01 ± 0.03
Model 2[3]	0.15 ± 0.02 (<0.0001)	0.13 ± 0.03	0.19 ± 0.04
Energy density of all reported foods and beverages (kcal/g)			
Model 1[2]	−0.05 ± 0.06 (0.4)	−0.09 ± 0.09	−0.04 ± 0.09
Model 2[3]	0.24 ± 0.07 (0.0004)	0.18 ± 0.10	0.29 ± 0.10
Energy density of foods and nutritive beverages (kcal/g)			
Model 1[2]	0.17 ± 0.03 (<0.0001)	0.15 ± 0.05	0.17 ± 0.04
Model 2[3]	0.24 ± 0.03 (<0.0001)	0.23 ± 0.05	0.25 ± 0.03

[1] All estimates are β ± SE; *P* values in parentheses. Estimates were derived from weighted logistic regression models with BMI ≥ 30 as a binary outcome.

[2] Included the independent variables of age, age^2, race (white, black, other), education (<12 y, 12 y, >12 y), smoking status (never, former, current), any leisure-time physical activity (yes, no), self-reported chronic diseases (diabetes, heart disease, hypertension) (yes, no), and survey as trend (NHANES I, NHANES II, NHANES III, NHANES 1999–2002).

[3] Included the ratio of energy intake to basal energy expenditure (<1.2 or ≥1.2) in addition to all independent variables in model 1. Both models included respondents with complete covariate information (total *n* = 37 530; 17 173 men and 20 357 women).

[4] Interaction of sex by mentioned breakfast was significant, $P \leq 0.004$. The association of mentioned breakfast with BMI ≥30 was significant in women (model 1: $P = 0.0009$; model 2: $P = 0.01$).