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40-year trends in meal and snack eating behaviors of American adults

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Abstract

Background—Understanding of changes in profiles of eating behaviors over time may provide insights into contributors to upward trajectories of obesity in the United States population. Yet, little is known about whether characteristics of meal and snack eating behaviors reported by adult Americans have changed over time.

Objective—This study examined time trends in the distribution of day's intake into individual meal and snack behaviors and related attributes in the United States adult population.

Design—The study was observational with cross-sectional data from national surveys fielded over 40 years.

Participant/setting—Nationally representative dietary data from nine National Health and Nutrition Examination Surveys conducted from 1971–74 to 2009–2010 (n=62298; age 20–74 years) were used to describe eating behaviors.

Outcomes examined—The respondent-labeled eating behaviors examined included main meals (breakfast, lunch, and dinner), and snacks (before breakfast, between breakfast and lunch, between lunch and dinner, after dinner, or other). For each eating behavior, percent of reporters; relative contribution to 24-hour energy intake; the clock time of report; and intermeal/snack intervals were examined.

Statistical Analysis—Multivariable logistic and linear regression methods for analysis of complex survey data adjusted for characteristics of respondents in each survey.

Results—Over the 40-year span examined: 1) reports of each individual named main meal (or all three main meals) declined, but reports of only two out of three meals or the same meal more than once increased; 2) the percentage of 24-hour energy from snacks reported between lunch and

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dinner or snacks that displaced meals increased; 3) clock times of breakfast and lunch were later, and intervals between dinner and after dinner snack were shorter. Changes in several snack reporting behaviors (e.g., report of any snack or ≥2 snacks), were significant in women only.

Conclusions—Several meal and snack eating behaviors of American adults changed over time, with a greater change in snack behaviors of women relative to men.

Keywords

NHANES; eating behavior; main meals; breakfast; lunch; dinner; snacks; intermeal intervals; time of eating

Introduction

Evidence from controlled laboratory feeding trials suggests that biological imperatives that reportedly regulate food and beverage intake in response to hunger and thirst have limited influence on energy balance.[1,2] The available national data on secular trajectories of increasing adiposity[3,4] and self-reported dietary exposures such as large portion sizes, away from home eating, snacking, and sweetened beverage consumption[5–12] also point to relative inadequacy of known biological mechanisms for regulation of food intake within the larger socio-ecological context of the food environment. Market response to increasing number of women in the labor force, changes in family structures, and technology is seen in expansion of available venues for food purchasing and consumption.[13–17] Over time, changes in the food environment have been accompanied by a degree of laxity in traditional social norms about when, where, and how much food may be consumed. There is also evidence of changing norms about what is the self- perceived “just right” body weight.[18] Consequently, it is reasonable to expect that the combined effect of these changes may be reflected in eating behavior patterns which may in turn relate to energy intake.

No accepted definition of “eating behavior” is available in the published literature. In the current report, the term eating behavior is used to describe the characteristics of named eating episodes in a 24-hour eating period. With sufficient knowledge and forethought, most eating behavior patterns are compatible with selection of nutritionally adequate diets of moderate energy content. Although the United States Department of Agriculture (USDA) issued sample menus with the Food Guide Pyramid and the MyPlate recommendations include three main meals and one or more snacks,[19,20] none of the Dietary Guidelines for Americans (DGA) issued prior to 2010 have included specific recommendations for meal and snack eating behaviors. The 2010 DGA committee recommendations for meal/snack behaviors in relation to energy balance were limited to a recommendation to eat a nutrient-dense breakfast and an eating frequency that does not promote higher energy intake.[21] Despite the lack of explicit guidance on recommended distribution of day’s intake into eating events, free-living individuals usually consume food in discrete bouts with commonly used labels to describe the eating episodes. Examination of these eating behaviors beyond overall frequency of eating meals and snacks provides information about distribution of eating throughout the day. Such information is necessary to understand which individual eating events are susceptible to change over time within the context of other eating events reported in the eating period. For example, change in one behavior may also be linked to a

compensatory change in other behaviors. Finally, an examination of secular changes in time of eating and intervals between eating episodes provides information about changes in the possible role of environmental cues for initiation of eating events. However, few published reports have taken this approach to understand changing eating behaviors of the American population.

To extend previous work on this subject,[8] the current paper examined secular trends in: 1) reporting of individual main meals (breakfast, lunch, dinner or equivalents) and intermeal ingestive episodes (called snacks hereafter) and their relative contribution to daily energy intake and, 2) time of reporting and intervals between respondent-named main meals and adjacent snacks.

Methods

Data source—Public domain data from nine cross-sectional National Health and Nutrition Examination Surveys (NHANES) conducted from 1971–74, 1976–1980, 1988–1994, 1999–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, and 2009–2010 were used for this observational study. The documentation and data for each of these surveys can be downloaded from the NHANES website.[22] Each NHANES is a multistage, stratified sample of the United States (US) population and is conducted by the National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention. Each survey collected information via an at-home interview and during a visit to a specially equipped mobile examination center (MEC). Dietary information was collected in the MEC. Over time, data collection methods have evolved from paper and pencil methods to automated computer assisted methods. The unweighted response rate for the MEC examined sample in each survey was >70%.[23] This study was approved by the City University of New York Human Subjects Protection Committee with an exempt review.

Dietary assessment methods—In all surveys a trained dietary interviewer used a standardized protocol to administer a 24-hour recall of foods and beverages.[22] The 1971–74 and 1976–1980 surveys used paper and pencil to collect dietary information; however, all subsequent surveys used computer assisted methods. One in-person dietary recall was collected in 1971–74, 1976–80, 1988–94, 1999–2000, and 2001 surveys. For 2002 and later surveys, a second recall was collected, via telephone, 3–10 days after the MEC visit. This study used the first recall for all surveys.

Information on covariates—Information on all covariates except body weight and height, used to compute the body mass index (BMI), was self-reported during the household interview.

Analytic sample—In each survey, all respondents aged 20–74 years, with a reliable 24-hour dietary recall were eligible (n=64410) for inclusion in the study. The NCHS determined the reliability of a recall by evaluation of its quality and completeness.[22] The upper age limit of 74 years was necessary because the 1971–74 and 1976–1980 surveys did not sample respondents >74 years of age. Pregnant and lactating women (n=2106), and

those reporting zero calories (n=6) in a recall considered reliable by the NCHS were excluded for a final analytic sample of 62298 respondents.

Eating behavior outcomes examined

During the 24-hour recall interview, respondents were asked to report the clock time when a food or beverage was consumed.[22] For every food or beverage item recalled, respondents also chose a name of the eating event from a list. All items reported in an event were given the same clock time and event name in the recall. In the 1971–74 and 1976–80 surveys, respondents could choose from AM, noon, between meal, PM, and total day, as names of eating events. In all subsequent surveys, the choices for eating event names were changed to commonly used names, e.g., breakfast, lunch, dinner, supper, snack, drink, or extended consumption, and their equivalents in Spanish language. From these data, several meal or non-meal associated variables were created for each respondent as described below. In every case, decisions about consideration of eating events as meals or snacks were based on the event label used by the respondent to describe the event.

Main meal and snack outcome variables—Reports of breakfast, brunch, lunch, supper, and dinner or their equivalents in Spanish were considered as main meals in the present study. Report of consumption of AM meal, breakfast, desayuno, or almuerzo was considered breakfast. Mention of events named noon meal, lunch, brunch, or comida was considered report of lunch, and mention of events named PM meal, dinner, supper, or cena was considered report of dinner. All other eating events were considered as snack. Beginning with the 2005–2006 surveys the 24- hour dietary recall collected information on plain water intake as part of the dietary recall. However, surveys prior to 2005–2006 did not ask respondents to include plain water intake in the recall. Therefore, for consistency, when the only reported item in a named eating event was plain tap or bottled water (which occurred in 2005–2010 surveys), it was not considered an event regardless of how the event was named by the respondent. All foods and beverages reported at one discrete clock time were considered as part of one eating event. (Overall, >99.5% of the 293741 eating episodes reported across surveys occurred at least 15 minutes apart, and only ~2% of the entire sample reported two eating episodes that were ≤ 15 minutes apart.) Reports of two similarly named main meals (e.g., 2 breakfasts) but at different clock times were considered as two main meals. (Nearly 98% of all instances of two mentions of the same meal were >15 minutes apart.) When an eating occasion named snack was reported at the same time as a named main meal eating occasion (this occurred in 1971–74 to 2001–2002 survey cycles), it was considered as part of the main meal eating occasion (e.g., chips reported with a lunch). (Of the 165860 mentions of main meals across surveys, 1115 or ~1.2 % mentions included a snack or equivalent item at the same time.) These methods to determine eating events have been reported previously.[8,24,25]

Five different types of snack variables were derived based on when the snack was reported in relation to a main meal. These included eating events reported before breakfast, between breakfast and lunch, between lunch and dinner, and after dinner. Snack eating occasions that did not meet any of these conditions (e.g., snack(s) before lunch by non-reporters of

breakfast or snack(s) between breakfast and dinner by non-reporters of lunch) were the fifth category of snack episodes.

For each type of main meal or snack eating event, the % of reporters, % of 24-hour energy, and the clock-time of its report were determined.

Frequency of reporting main meal and snack outcomes—As mentioned previously, each unique clock time when one or more foods or beverages were reported was considered as an eating event regardless of the number of items, energy intake, or the name of the reported event. However, if plain tap or bottled water was the only item mentioned for an event, it did not count as an eating event. Events labeled as a meal or snack using the criteria mentioned above were summed to get the number of main meals and snacks, respectively.

Clock time of eating, length of the ingestion period, and intermeal interval outcomes—The clock time of report of each eating event in the 24-hour recall was determined. For events named as extended consumption (1.6% of all reported eating events) by respondents, the time of consumption was the clock time of mention of the event. Interval between the reported time (in hours) of the first episode and the time of the last episode in each recall was the length of the eating period. The length of the eating period was divided by the frequency of eating to compute an average length of the interval between eating events. Other intervals assessed included length of the interval between the main meals (e.g., the difference between the time of breakfast and lunch or lunch and dinner), and the interval between a snack and the preceding or the subsequent main meal (where applicable) (e.g., interval between breakfast and the after-breakfast snack and the interval between the after-breakfast snack and the subsequent lunch). In every case, the intervals were between the *first* reported meal(s) or snack. (For example, for respondents who reported two breakfasts, the interval between breakfast and lunch refers to the interval between the time of the *first* breakfast and the time of the subsequent first lunch.) Interval between two mentions of the same main meal was the difference between the time of report of the first and the second mention.

Statistical Methods

In accord with analytic guidelines for the continuous NHANES,[26] two adjacent survey cycles were combined. Thus the analyses included combined data for 1971–74, 1976–1980, 1988–1994, 1999–2002, 2003–2006, and 2007–2010 surveys. To examine time trends in eating behaviors, multiple linear or logistic regression methods were used where each eating behavior was the dependent variable with a set of covariates/confounders as independent variables. These models included the survey cycles either as a categorical or as a trend variable. Survey as a trend variable used midpoint of calendar years of each survey cycle as values. The eating behaviors were operationalized as continuous (e.g., % energy from lunch) or as dichotomous (e.g., whether or not lunch was reported) dependent variables.

In the four decade span of the survey data used for analyses, the population distribution of a number of factors that may relate with eating behaviors has changed. Therefore, the final models included adjustment for known correlates of food intake. Because nine different

surveys were included in the current analysis, the final form of the covariates used in the models was determined by the type and extent of information available in each survey. For instance, the NHANES I and II did not include detailed information on Mexican-American ancestry, although this information was available for all other surveys, therefore, the race/ethnicity characterization was limited to non-Hispanic white, non-Hispanic black, and all others. Other reports of trend analysis that included these surveys have also used similar methods.[8,25] Other covariates included age in years, week day of recalled intake, month of MEC exam, level of education, family poverty income ratio, employment status, and BMI.

Possible sex differences in time trends were assessed by examining the interaction of the time trend variable with sex in the covariate-adjusted models mentioned above. The survey by sex interaction was significant for several eating behaviors, and because the percentage of women working outside the home--a possible correlate of meal and snack intake--increased markedly across surveys; therefore, for consistency, all analyses were stratified by sex.

The adjusted proportions or means and their standard errors (shown in tabular results) of eating behaviors were calculated from the logistic or linear regression models, respectively, for each survey. This method directly standardized the proportions and means to the distribution of the covariates for the US populations represented by the combined survey cycles, which are obtained from the weighted NHANES samples.[27] The tables present two-sided p-values for tests for time trends across the survey cycles. Time trends in many different eating behaviors were examined in this paper; the results presented are not adjusted for multiple comparisons. Although, p values associated with the Wald F test statistic are presented for all examined associations, the narrative of results, however, focuses on those association where p values were ≤0.01. The direction of a significant time trend is indicated by a directional arrow based on the regression coefficient associated with the survey as a trend variable. All analyses were conducted using the statistical software, SAS, version 9.2 (released 3/1/2008, SAS Institute, Cary, NC) and the SAS-callable-SUDAAN, version 11.0 (released 8/17/2012, RTI International, Research Triangle Park, NC), for analyzing sample weighted survey data with complex sample designs such as the NHANES.[28]

Two different types of estimates are presented in the tables: a “population” mean (e.g., % of energy from snack(s) reported between lunch and dinner by *all* men and women or percapita consumption), and an estimate limited to those who “reported” a behavior (e.g., % energy from snack(s) reported between lunch and dinner by reporters of the episode or consumption by consumers). The denominator for computation of the population mean includes consumers and non-consumers. In either case, the estimates presented in tables are clearly identified as either “all” or as among “reporters”.

Results

Women comprised roughly half of the surveyed population in each survey (Table 1). Over time, the percentage of Americans with 130–349% poverty income ratio and ≤12 years of education declined while that in the >349% poverty income ratio and >12 years categories increased. More recalls were obtained in months of November to April (relative to May to

October) and on Monday to Thursdays (relative to Friday to Sunday) in earlier surveys. The employment status variable is presented stratified by sex because of a secular increase in the number of women who worked.

Reporting of meals and snacks

In each survey, the dinner meal was reported by the largest percentage of Americans (≥90%), followed by breakfast (≥77%) and lunch meals (≥74%) (Table 2). The percentage of American adults reporting all three main meals (breakfast, lunch, and dinner), and each of the individual main meals declined over time (P_{trend} <0.0001). However, the percentage of Americans reporting any two out of three meals or the same meal more than once in the recall (e.g., 2 breakfasts) increased across surveys (P_{trend} <0.0001).

Across the surveys examined, 9–18 % of breakfast reporters also reported a snack before breakfast; 36–51% of breakfast and lunch reporters mentioned a snack between these two meals; ≥57% of those reporting lunch and dinner reported a snack between these two meals, and ≥60% of dinner reporters reported an after-dinner snack. The percentage of women reporting a snack before breakfast or between lunch and dinner increased across surveys (P_{trend} <0.0001) (Table 2). In both men and women, the percentage reporting a snack between breakfast and lunch and after dinner declined; however, reports of snacks which were not bracketed by consecutive meals (e.g., a snack in the interval between breakfast and dinner by those who did not report lunch) increased over time (P_{trend} <0.0001).

Distribution of 24-hour energy intake into individual main meals and snacks

The absolute amount of energy from both main meals and snacks increased over time; however the relative contribution of snack energy increased to a greater degree as the percentage energy from snacks increased while that from main meals (considered collectively) declined over time (P_{trend} <0.0001) (Table 3). In each survey the breakfast meal provided about ~16% of 24-hour energy, lunch provided around 25%, and dinner contributed about 35% of 24-hour energy intake (Table 3). Over time, in both men and women, the relative contribution of the breakfast meal to 24-hour energy intake (considered individually) was unchanged, but lunch energy declined (P<0.0001). Dinner energy contribution also declined in women (P<0.0001).

The 24-hour energy contribution of snacks reported between lunch and dinner, and other snacks not bracketed by consecutive meals increased for the population (P_{trend} ≤0.0001) (Table 3).

Clock time of reported meals and snacks, and intermeal/snack intervals

The clock times of reported breakfast and lunch (but not dinner) were later in later surveys (P_{trend} ≤0.0001) (Table 4). The after-dinner snack was reported earlier in later surveys (P_{trend} ≤0.0001). Over time, the length of the interval between the first and the last eating episodes decreased by about 30 minutes (P_{trend} ≤0.0001) (Table 5). This shorter eating period with slightly higher frequency of eating resulted in shortening of the intermeal/snack interval with breakfast being reported ~20 minutes later and after dinner snack earlier in later surveys. The length of the interval between breakfast and lunch was unchanged, the

interval between lunch and dinner was slightly longer, but the interval between dinner and the after-dinner snack decreased over time ($P_{trend} \leq 0.0001$).

Discussion

Notable findings of this detailed examination of 40-year trends in self-reported eating episode related behaviors of American adults include: 1) a decline in reporting of each main meal but an increase in reporting of the same meal more than once; 2) a decline in the percentage of 24-hour energy from lunch and dinner but an increase in energy from snacks reported between lunch and dinner and other snacks not bracketed by consecutive meals; 3) later mean clock times of breakfast and lunch but not dinner; 4) no change in the length of the mean intervals between breakfast and lunch, but shorter intervals between dinner and the after dinner snack.

Methodological caveats about interpretation of study results

Although study findings are derived from nationally representative dietary data, a reasonable and cautious interpretation of the findings summarized above (and discussed below) is best accomplished with full awareness of the inherent methodological limitations. First, although each NHANES in the trend analysis used a 24-hour dietary recall, the methodology of administration of the recall changed between 1971–74 and 1988–1994, and again from 2002 onwards. The methods in place since 2002 incorporate the USDA's Automated Multiple Pass Method algorithm and are believed to have increased the completeness of the recalled dietary information.[29] Second, both random and systematic errors are known to be present in all methods of dietary assessment including the 24-hour dietary recall used in the NHANES.[30] Because of random day-to-day variability of food intake of free-living individuals, the estimates of eating behaviors from a single 24-hour recall are not the "usual" intakes of individual respondents. However, study results are interpreted based on regression adjusted means of the population, for which a 24-hour recall is believed to provide an acceptable estimate.[31] Systematic errors introduced by possible intentional misreporting (mostly energy underreporting) of dietary intake are also believed to be present in national survey dietary data.[32–35] Although the analyses adjust for many known correlates of energy underreporting (e.g., BMI, level of education, and income),[32,36] at least some of the eating behaviors (e.g., reports of snacks) examined in this study are likely underreported; however, little is known about the relation of misreporting with eating time and intervals. Finally, no known objective markers of eating behaviors examined are available to avoid reliance on self-reported data. Despite these limitations, the NHANES dietary data remain an informative data set available for study of secular-trends analyses.

Interpretation of study findings

An unexpected finding of this study is the secular increase in the percentage of American adults who mentioned the same meal more than once in the recall. Given that nearly 98% of such repeat mentions were more than 15 minutes apart with a mean interval between two mentions of the same main meal episode of roughly ≥3 hours, it is unlikely that this finding is mostly due to the same meal being separated by mere minutes and thus being counted twice. One possible consequence of this apparent increase in mentions of duplicate main

meals is that while the reported number of main meals showed no change over time, fewer Americans reported all three main meals in the recall (down from >70% in 1971–80 to ~60% in later surveys) or each individual main meal. The extent to which these findings are an artifact of changes in dietary methods (as discussed above) cannot be determined from the available information. If anything, the expectation was that multiple passes through the recall and an expanded list of eating occasion names in later surveys should result in a more accurate picture of dietary intake. If the observed finding is a reporting artifact, the recall methodology needs to incorporate additional probing when such duplicate main meals are encountered during the recall. Further work to understand which meals are mentioned more than once, characteristics of respondents who mention such events, and the relation of such reports with other eating events in the recall is indicated; an area beyond the scope of the current trend analysis.

The study results on trends in prevalence of snacking and number of snacks differ from prior reports of sharp increases,[10,11] possibly due to different baseline surveys and other reasons outlined below. Prior reports of trend in snacking prevalence have used dietary data from USDA's Nationwide Food Consumption Survey 1977–78 as baseline.[10,11] These prior estimates average a dietary recall with diet records obtained in 1977–78 and compare them to average of two non-consecutive recalls in the NHANES 2003–2006. Differences in survey and sampling design, dietary assessment methods, response rates and analytic methods complicate the interpretation of trends when dietary data from the USDA and NHANES are compared. Finally, the mean self-reported energy intakes in USDA surveys contemporaneous to NHANES are lower than those estimated in the NHANES,[37,38] which suggests that misreporting may have been an even bigger problem in the USDA surveys.

Although changes in the food environment may be expected to have a population-wide effect, sex differences in reporting of several snack behaviors were present. For example, upward trends in the number of snacking episodes, reporting of any snack or two or more snacks, snack(s) before breakfast, and between lunch and dinner were stronger in women. The reasons for the observed upward trend in reporting of these eating behaviors in women are not apparent but may relate to increasing employment outside the home.

In both men and women, time trends in reporting of snacks between breakfast and lunch and after dinner were modestly downward but upward for mentions of snacks not bracketed by meals. This suggests that snacks possibly substituted for meals in later surveys, and is consistent with a decline in reports of each main meal over time.

The decline in the percentage of Americans reporting each main meal and all three main meals is also reflected in the declining contribution of each main meal (except breakfast), or all three main meals to 24-hour energy intake, with a corresponding increase (3–5%) in energy from snacks beginning around 1976–80. Given the changes in patterns of reporting of meals and snacks discussed above, the increase in percentage of 24-hour energy contribution of snacks is driven largely by snacks reported between lunch and dinner, and snacks reported by those who omitted one or more meals. Although the estimated percentage of Americans reporting each individual main meal and all snacks in the present study is lower than USDA estimates for NHANES 2005–2006, 2007–2008, and 2009–2010,

possibly due to inclusion of water only events as eating episodes by the USDA, the multivariate adjusted estimates of energy contribution of each main meal and all snacks reported here are similar to unadjusted estimates reported by the USDA for these survey years.[39]

Present study did not find remarkable secular changes in the extent of dinner and after-dinner eating. Earlier observational studies reported no association between time of eating and body weight,[40,41] but a recent animal study[42] and an intervention trial[43] have suggested that eating later in the day may promote weight gain or relate to the success of weight loss. Overall, the results of average clock times and intermeal intervals were remarkable for their relative stability over the span of past 40 years and are a testament to the strength of cultural norms about the time of day when meals are consumed. These results support the suggestion of Scheer et al that circadian patterns of distribution of food intake (with largest amount of energy from food intake later in the day) coincide with biological variation of peaks and troughs of hunger.[44] The longer mean intermeal interval (~3 hours between a snack and the subsequent meal) for reporters of a snack between breakfast and lunch or lunch and dinner in each survey is consistent with prior reports.[45,46] A recent review of experimental studies concluded that intermeal intervals following a preload were a strong determinant of the extent of energy compensation in the subsequent meal.[46]

Conclusions

The study results suggest modest changes in several meal and snack eating behaviors of Americans over time. However, snack behaviors changed to a greater extent in women relative to men. Nutrition practitioners may find the results of this study useful in understanding client eating behaviors within the context of reported average eating behaviors of the population. Further research on these eating behaviors among subgroups at high risk for obesity in the US population as well as secular changes in the types of foods selected for both main meal and snack eating episodes is indicated.

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Table 1

Socio-demographic characteristics (weighted % ± SE) of adult Americans, aged 20–74 years, National Health and Nutrition Examination Surveys (NHANES) 1971–74 to 2009–2010

	All surveys 1971–2010 (n=62298)	NHANES I 1971–74 (n=12606)	NHANES II 1976–1980 (n=11662)	NHANES III 1988–1994 (n=13799)	C-NHANES 1999–2002 (n=7306)	C-NHANES 2003–2006 (n=7214)	C-NHANES 2007–2010 (n=9711)
	%						
Women	50.8±0.2	52.3±0.5	51.7±0.5	50.8±0.4	49.7±0.7	49.9±0.6	51.0±0.5
Age, years							
20–39	43.0±0.4	44.7±0.9	47.6±0.8	48.4±0.9	41.4±1.0	39.8±1.1	39.3±0.9
40–59	38.9±0.3	37.7±0.8	34.0±0.6	34.1±0.6	40.6±0.9	41.5±0.7	42.4±0.6
60–74	18.1±0.3	17.7±0.6	18.3±0.5	17.5±0.8	18.0±0.7	18.7±0.9	18.3±0.6
Race/ethnicity							
Non-Hispanic White	74.8±0.8	85.5±0.9	82.7±1.4	75.8±1.3	70.7±1.7	72.1±2.5	68.5±2.5
Non-Hispanic Black	11.0±0.5	9.9±07	10.1±1.3	11.1±0.6	11.0±1.2	11.6±1.4	11.7±1.1
All others	14.2±0.6	4.6±0.9	7.2±1.0	13.1±0.9	18.3±2.0	16.3±1.5	19.8±2.0
Poverty income ratio, %							
<130	18.2±0.4	16.9±1.0	16.9±0.5	16.6±1.0	19.6±1.3	17.9±1.2	20.3±1.1
130–349	38.9±0.5	49.1±0.9	53.0±0.7	42.5±1.0	31.5±1.2	34.8±1.3	31.0±1.1
>349	37.0±0.6	29.4±1.0	26.0±0.7	34.9±1.3	40.7±1.6	43.2±1.6	41.5±1.4
Unknown	5.9±0.2	4.6±0.3	4.0±0.2	5.9±0.4	8.3±1.0	4.2±0.4	7.2±0.6
Education, years							
<12	22.9±0.4	35.8±1.0	30.6±1.0	22.9±1.0	20.6±0.8	16.2±0.9	18.4±0.9
12	29.4±0.4	36.4±0.7	36.0±0.8	34.4±0.7	25.3±0.9	25.8±1.0	24.0±0.9
Some college	25.3±0.3	14.1±0.5	16.9±0.6	21.0±0.7	29.0±0.8	32.4±0.8	30.8±0.8
College	22.1±0.5	12.9±0.8	15.5±0.8	21.2±0.9	24.9±1.4	25.6±15	26.7±1.2
Unknown	0.3±0.03	0.7±0.1	0.9±0.1	0.4±0.1	0.2±0.05	0	0.1±0.05
Worked at a job in past one or two weeks?							
Yes (all)	64.6±0.4	60.1±0.8	63.3±0.8	70.8±0.6	64.3±1.0	64.5±1.0	63.4±1.0
Yes (men)	74.3±0.4	78.5±0.9	78.1±0.8	79.3±0.7	72.2±1.1	71.4±1.0	70.2±1.3

	All surveys 1971–2010 (n=62298)	NHANES I 1971–74 (n=12606)	NHANES II 1976–1980 (n=11662)	NHANES III 1988–1994 (n=13799)	C-NHANES 1999–2002 (n=7306)	C-NHANES 2003–2006 (n=7214)	C-NHANES 2007–2010 (n=9711)
Yes (women)	55.1±0.5	43.4±1.1	49.5±1.1	62.5±0.9	56.2±1.3	57.6±1.4	56.7±1.4
Month of mobile examination center examination							
November to April	45.2±1.8	44.5±4.0	50.1±0.4	61.7±3.7	38.1±4.8	41.5±4.3	39.1±3.9
May to October	54.8±1.8	55.5±4.0	49.9±3.6	38.3±3.7	61.9±4.8	58.5±4.3	60.9±3.9
Day of recalled intake							
Monday–Thursday	60.5±0.4	76.2±0.6	74.6±0.5	50.0±1.2	56.9±1.3	57.0±0.9	56.8±0.9
Friday–Sunday	39.5±0.4	23.8±0.6	25.4±0.5	50.0±1.2	43.1±1.3	43.0±0.9	43.2±0.9
Body mass index (kg/m^2)							
<18.5	2.3±0.1	3.7±0.2	3.1±0.2	2.4±0.2	2.0±0.2	1.6±0.2	1.7±0.2
18.5–24.9	37.5±0.4	49.4±0.8	50.4±0.8	42.4±1.0	32.0±0.8	31.2±1.2	29.0±0.9
25–29.9	32.7±0.3	32.6±0.6	31.8±0.6	32.4±0.7	33.5±0.9	32.7±0.8	32.7±0.8
>=30	26.8±0.4	14.3±0.5	14.7±0.4	22.8±0.7	30.6±1.1	33.4±1.2	35.7±0.7
Unknown	0.7±0.07	0	0	0.04±0.01	1.8±0.2	1.1±0.2	0.8±0.1

Table 2

Mean[a] (±se) of number of meals and snacks, and percentage (±se) of adult Americans who reported main meal and snack events in a 24-hour recall, National Health and Nutrition Examination Surveys (NHANES) 1971–74 to 2007–2010

	NHANES I 1971–74	NHANES II 1976–1980	NHANES III 1988–1994	C-NHANES 1999–2002	C-NHANES 2003–2006	C-NHANES 2007–2010	P_{trend}
Number of main meal[b] episodes reported in the recall							
Men (n=28945)	2.72±0.01	2.69±0.01	2.61±0.03	2.69±0.02	2.65±0.02	2.75±0.02	0.4
Women (n=32621)	2.76±0.01	2.71±0.01	2.67±0.02	2.71±0.02	2.68±0.02	2.76±0.01	0.7
Number of snack[c] episodes reported in the recall							
Men (n=28945)	2.45±0.05	2.29±0.06	2.38±0.05	2.27±0.04	2.24±0.04	2.23±0.03	0.004 ↓
Women (n=32621)	2.09±0.04	2.04±0.04	2.22±0.03	2.25±0.04	2.21±0.03	2.30±0.04	<0.0001 ↑
Reported all main three meals (breakfast, lunch, and dinner) in the recall (%)							
Men (n=28945)	73±1.0	71±0.9	52±1.3	53±1.2	55±1.3	59±1.3	<0.0001 ↓
Women (n=32621)	75±0.9	72±0.9	60±0.9	58±1.4	61±1.2	63±1.0	<0.0001 ↓
Reported any two of three different main meals in the recall[d] (%)							
Men (n=28945)	24±0.9	25±0.8	38±1.1	37±1.0	36±1.5	33±1.3	<0.0001 ↑
Women (n=32621)	22±0.7	24±0.8	33±0.7	34±1.3	32±1.1	31±0.8	<0.0001 ↑
Reported the same main meal more than once[e] in the recall (%)							
Men (n=28945)	3.0±.03	3.4 ±0.4	15.9±1.2	22.2±1.6	16.7±1.1	21.4±1.1	<0.0001 ↑
Women (n=32621)	3.1±0.4	3.2±0.4	13.3±0.9	17.9±1.3	13.4±1.0	17.8±0.8	<0.0001 ↑
Reported all three main meals (breakfast, lunch, and dinner) *and at least one snack* in the recall (%)							
Men (n=28945)	65±1.0	62±0.9	45±1.2	46±1.0	49±1.3	53±1.3	<0.0001 ↓
Women (n=32621)	65±0.9	62±1.0	51±1.0	50±1.3	53±1.4	56±1.1	<0.0001 ↓
Reported any snack (%)							
Men (n=28945)	90±0.6	89±0.6	88±0.9	88±0.6	89±0.8	90±0.7	0.5
Women (n=32621)	87±0.7	86±0.5	89±0.7	88±0.7	89±0.7	90±0.4	0.0002 ↑
Reported ≥ 2 snacks (%)							
Men (n=28945)	67±1.0	63±0.9	65±1.1	65±1.4	66±1.1	64±0.9	0.7
Women (n=32621)	60±1.1	58±1.1	63±0.9	65±1.1	63±1.2	67±1.01	<0.0001 ↑
Reported >50% of 24-hour energy from snack events (%)							

	NHANES I 1971–74	NHANES II 1976–1980	NHANES III 1988–1994	C-NHANES 1999–2002	C-NHANES 2003–2006	C-NHANES 2007–2010	P_{trend}
Men (n=28945)	5.9±0.5	7.1±0.5	10.2±0.6	11.4±0.8	10.3±0.7	8.7±0.5	<0.0001 ↑
Women (n=32621)	4.8±0.3	5.6±0.4	8.7±0.7	10.1±0.7	9.4 ±0.8	9.4±0.6	<0.0001 ↑
Reported a snack *before* breakfast (%) (Among breakfast reporters)							
Men (n=20166)	12±1.0	13±0.9	18±1.1	17±1.0	16±1.0	12±0.9	0.3
Women (n=23289)	9±0.6	11±0.8	15±0.9	18±1.0	15±0.8	14±0.7	<0.0001 ↑
Reported breakfast (%)							
Men (n=28945)	87±0.8	85±0.7	78±0.8	77±1.0	80±0.9	81±0.9	<0.0001 ↓
Women (n=32621)	88±0.8	87±0.9	82±0.8	80±1.1	83±0.9	81±0.9	<0.0001 ↓
Reported a snack *between* breakfast and lunch (%) (among breakfast and lunch reporters)							
Men (n=15429)	51±1.4	47±1.3	41±1.4	41±1.6	40±1.7	36±1.5	<0.0001 ↓
Women (n=18637)	44±1.1	40±1.3	39±1.1	40±1.6	38±1.6	40±1.3	0.05
Reported lunch (%)							
Men (n=28945)	88±0.7	85±0.8	74±0.9	74±0.9	76±1.0	78±1.2	<0.0001 ↓
Women (n=32621)	88±0.5	85±0.5	78±0.7	79±1.1	79±1.1	79±0.9	<0.0001 ↓
Reported a snack *between* lunch and dinner (%) (among lunch and dinner reporters)							
Men (n=16928)	61±1.4	57±1.3	62±1.4	65±1.5	64±1.7	62±1.2	0.02
Women (n=20025)	60±0.9	57±1.0	63±1.1	66±1.2	67±1.3	69±1.0	<0.0001 ↑
Reported dinner (%)							
Men (n=28945)	94±0.5	95±0.4	90±0.7	90±0.7	91±0.7	92±0.5	<0.0001 ↓
Women (n=32621)	95±0.3	95±0.3	92±0.5	90±0.6	91±0.6	93±0.4	<0.0001 ↓
Reported a snack *after* dinner (%) (among dinner reporters)							
Men (n=22305)	71±1.1	69±1.0	63±1.2	62±1.3	64±1.5	67±1.2	0.0006 ↓
Women (n=25305)	68±0.9	68±0.9	63±0.9	61±1.4	63±1.6	64±1.2	<0.0001 ↓
Reported any other snack[f] (%)							
Men (n=28945)	21±0.9	21±0.9	34±1.3	32±1.1	29±1.2	27±1.0	<0.0001 ↑
Women (n=32621)	19±0.9	19±0.9	29±0.9	30±1.0	27±1.2	25±0.9	<0.0001 ↑

[a]Estimates are adjusted means or proportions from sex-specific linear or logistic regression models with each eating behavior variable as a dichotomous outcome. Independent variables were: survey cycle (NHANES I, NHANES II, NHANES III, C-NHANES 1999–2002, 2003–2006, 2007–2010) as a categorical value or as a trend variable, age (continuous), race/ethnicity (non-Hispanic white, non-Hispanic black, Other), family poverty income ratio (<130, 130–349, >349, unknown %), level of education (<12 y, 12 y, some college, ≥ college), season of mobile examination center exam (Nov.–April, May–

Oct.), weekday of recalled dietary intake (Monday–Thursday, Friday–Sunday), BMI (continuous), and employment status in the past one or two weeks (yes or no). *n* refers to number with complete covariate information. P_{trend} refers to the *P* value associated with the survey as a trend variable.

[b]Main meal episodes comprised eating events named as breakfast, lunch, and dinner or equivalents by respondents. **Breakfast** eating event was defined as AM meal (NHANES I and II), breakfast, desayuno, almuerzo (NHANES III, 1999–2002, 2003–2006, 2007–2010); **lunch** eating event defined as: noon meal (NHANES I and II), lunch, brunch or comida (H3, 1999–2002, 2003–2006, 2007–2010); **dinner** defined as: PM meal (NHANES I and II), dinner, supper, or cena (NHANES III, 1999–2002, 2003–2006, 2007–2010).

[c]Snack defined as any eating event identified as snack, drink, between meal, extended consumption, (which was not labeled breakfast, lunch, dinner or equivalent in Spanish by the respondent). Events where only plain or bottled water was reported were not considered an eating episode.

[d]Defined as report of any combination of two of the three main meals

[e]Mentioned more than one breakfast, lunch, or dinner in the recall

[f]Snacks not reported before breakfast, or between breakfast and lunch, or between lunch and dinner, or after dinner (e.g., snack(s) reported before lunch by subjects who reported no breakfast, etc).

Table 3

Percentage[a] (±se) of 24-hour energy from meals and snacks reported in a 24-hour recall by adult Americans, National Health and Nutrition Examination Surveys (NHANES) 1971–74 to 2007–2010

	NHANES I 1971–74	NHANES II 1976–1980	NHANES III 1988–1994	C-NHANES 1999–2002	C-NHANES 2003–2006	C-NHANES 2007–2010	P_{trend}
Energy from main meals[b] (kcal) (among all--population average)							
Men (n=28945)	1904±21	1894±23	2010±22	1968±25	2030±15	1967±22	0.0003 ↑
Women (n=32621)	1246±14	1220±12	1363±14	1395±17	1405±16	1358±15	<0.0001 ↑
Energy from snacks [c] (kcal) (among all--population average)							
Men (n=28945)	502±15	538±13	647±16	666±15	666±18	634±13	<0.0001 ↑
Women (n=32621)	296±7	295±7	399±8	444±9	424±11	438±8	<0.0001 ↑
% of 24-hour energy from main meals (among all--population average)							
Men (n=28945)	80±0.4	79±0.4	77±0.4	76±0.4	77±0.4	77±0.4	<0.0001 ↓
Women (n=32621)	82±0.4	81±0.3	78±0.4	77±0.4	77±0.5	77±0.4	<0.0001 ↓
% of 24-hour energy from snacks (among all--population average)							
Men (n=28945)	20±0.4	20±0.4	23±0.4	24±0.4	23±0.4	23±0.4	<0.0001 ↑
Women (n=32621)	18±0.4	19±0.3	22±0.4	23±0.4	23±0.5	23±0.4	<0.0001 ↑
% of 24-hour energy from snack(s) reported before breakfast (among reporters of before-breakfast snack)							
Men (n=3018)	8.0±0.9	7.6±0.6	9.0±0.6	8.4±0.5	9.1±0.5	8.2±0.6	0.3
Women (n=3005)	5.7±0.5	6.9±0.6	7.3±0.5	9.7±0.6	7.7±0.6	7.0±0.5	0.03
% of 24-hour energy from snack(s) reported before breakfast (among all--population average)							
Men (n=28945)	0.8±0.1	0.8±0.08	1.1±0.9	0.9±0.08	1.1±0.08	0.7±0.09	0.6
Women (n=32621)	0.4±0.05	0.5±0.07	0.8±0.07	1.2±0.1	0.8±0.08	0.8±0.06	<0.0001 ↑
% of 24-hour energy from breakfast(s) (among all--population average)							
Men (n=28977)	16.7±0.3	16.2±0.2	15.8±0.2	15.5±0.3	15.8±0.3	16.4±0.3	0.3
Women (n=32657)	17.3±0.2	16.7±0.3	15.8±0.2	16.8±0.4	16.5±0.4	16.9±0.3	0.5
% of 24-hour energy from snack(s) reported between breakfast and lunch (among reporters of snack between breakfast and lunch)							
Men (n=6301)	6.6±0.2	6.4±0.2	7.4±0.3	9.6±0.5	8.1±0.4	8.3±0.4	<0.0001 ↑
Women (n=7070)	6.9±0.3	6.9±0.3	7.8±0.3	9.3±0.4	9.2±0.5	9.2±0.4	<0.0001 ↑
% of 24-hour energy from snack(s) reported between breakfast and lunch (among all--population average)							

	NHANES I 1971–74	NHANES II 1976–1980	NHANES III 1988–1994	C-NHANES 1999–2002	C-NHANES 2003–2006	C-NHANES 2007–2010	P_{trend}
Men (n=28945)	2.4±0.1	2.0±0.1	1.5±0.1	2.0±0.2	1.7±0.2	1.7±0.1	0.0001 ↓
Women (n=32621)	2.1±0.1	1.8±0.1	1.7±0.1	2.1±9.1	2.0±0.1	2.2±0.1	0.1
% of 24-hour energy from lunch (among all--population average)							
Men (n=28945)	26.6±0.3	25.4±0.3	23.1±0.4	23.5±0.4	24.1±0.3	24.2±0.5	<0.0001 ↓
Women (n=32621)	26.8±0.3	25.9±0.3	24.0±0.3	25.8±0.6	25.0±0.5	23.3±0.3	<0.0001 ↓
% of 24-hour energy from snack(s) reported between lunch and dinner (among reporters of snack between lunch and dinner)							
Men (n=9982)	9.1±0.3	10.0±0.3	10.9±0.3	12.2±0.4	12.3±0.3	12.8±0.4	<0.0001 ↑
Women (n=12062)	9.8±0.3	10.4±0.3	11.0±0.3	12.5±0.4	12.6±0.5	13.3±0.4	<0.0001 ↑
% of 24-hour energy from snack(s) reported between lunch and dinner (among all--population average)							
Men (n=28945)	4.2±0.2	4.1±0.2	3.8±0.2	4.6±0.2	4.8±0.2	5.1±0.3	0.0001 ↑
Women (n=32621)	4.3±0.2	4.1±0.1	4.4±0.2	5.1±0.2	5.4±0.3	6.0±0.2	<0.0001 ↑
% of 24-hour energy from dinner (among all--population average)							
Men (n=28945)	36.9±0.4	38.0±0.3	38.0±0.5	37.2±0.5	36.5±0.5	36.2±0.5	0.04
Women (n=32621)	37.6±0.3	38.8±0.3	38.4±0.4	34.4±0.4	35.9±0.4	36.5±0.5	<0.0001 ↓
% of 24-hour energy from snack(s) reported after dinner (among reporters of after-dinner snack)							
Men (n=14303)	13.6±0.4	15.4±0.3	16.1±0.4	15.8±0.3	16.3±0.5	15.9±0.4	<0.0001 ↑
Women (n=16166)	13.6±0.3	14.3±0.2	14.7±0.3	15.2±0.5	15.1±0.4	14.8±0.4	0.009 ↑
% of 24-hour energy from snack(s) reported after dinner (among all--population average)							
Men (n=28945)	8.1±0.3	8.9±0.2	8.0±0.3	7.8±0.2	8.4±0.3	8.8±0.3	0.8
Women (n=32621)	7.8±0.2	8.1±0.2	7.5±0.2	7.3±0.3	7.7±0.3	7.9±0.2	0.6
% of 24-hour energy from all other[d] snacks (among reporters of “other” snack)							
Men (n=8256)	21.2±0.9	22.5±0.9	25.3±0.6	26.6±0.7	25.8±0.9	24.6±0.9	0.001 ↑
Women (n=8374)	20.0±0.7	21.4±0.8	25.6±0.8	24.6±0.7	24.8±1.1	25.3±0.8	<0.0001 ↑
% of 24-hour energy from all other[d] snacks (among all--population average)							
Men (n=28945)	4.3±0.3	4.5±0.3	8.6±0.4	8.4±0.4	7.5±0.3	6.8±0.3	<0.0001 ↑
Women (n=32621)	3.6±0.3	4.1±0.3	7.4±0.3	7.3±0.3	6.6±0.4	6.5±0.3	<0.0001 ↑

[a]Estimates are predicted means from sex-specific linear regression models with each meal behavior variable as a continuous outcome. Independent variables were: survey cycle (NHANES I, NHANES II, NHANES III, C-NHANES 1999–2002, 2003–2006, 2007–2010) as a categorical value or as a trend variable, age (continuous), race/ethnicity (non-Hispanic white, non-Hispanic black, Other), family poverty income ratio (<130, 130–349, >349, unknown %), level of education (<12 y, 12y, some college, ≥ college), season of mobile examination center exam (Nov.–April, May–Oct.), weekday of recalled

dietary intake (Monday–Thursday, Friday–Sunday), BMI (continuous), and employment status in the past one or two weeks (yes or no). *n* refers to number with complete covariate information. P_{trend} refers to the *P* value associated with the survey as a trend variable.

[b] Main meal episodes comprised eating events named as breakfast, lunch, and dinner or equivalents in Spanish by respondents. **Breakfast** eating event was defined as AM meal (NHANES I and II), breakfast, desayuno, almuerzo (NHANES III, 1999–2002, 2003–2006, 2007–2010); **lunch** eating event defined as: noon meal (NHANES I and II), lunch, brunch or comida (NHANES III, 1999–2002, 2003–2006, 2007–2010); **dinner** defined as: PM meal (NHANES I and II), dinner, supper, or cena (NHANES III, 1999–2002, 2003–2006, 2007–2010).

[c] Snack defined as any eating event identified as snack, drink, between meal, extended consumption, (any eating event which was not labeled as breakfast, lunch, dinner or equivalents in Spanish by the respondent). Events where only plain or bottled water was reported were not considered an eating episode.

[d] Snacks not reported before breakfast, or between breakfast and lunch, or between lunch and dinner, or after dinner (e.g., snack(s) reported before lunch by subjects who reported no breakfast, etc).

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Table 4

Clock time (HH:MM) (mean±se[a]) of main meals[b] and snacks[c] reported by adult Americans in a 24-hour recall, National Health and Nutrition Examination Surveys (NHANES) 1971–74 to 2007–2010

	NHANES I 1971–74	NHANES II 1976–1980	NHANES III 1988–1994	C-NHANES 1999–2002	C-NHANES 2003–2006	C-NHANES 2007–2010	P_{trend}
Clock time of first snack reported BEFORE breakfast (Among reporters of before-breakfast snack)							
Men (n=3018)	4:33±12	4:49±11	3:53±11	5:13±15	4:53±15	5:06±12	0.04
Women (n=3005)	5:35±10	5:30±10	5:03±14	5:34±8	5:15±11	5:52±12	0.4
Clock time of reported breakfast (Among breakfast reporters)							
Men (n=23693)	7:41±2	7:43±2	7:56±2	7:56±3	7:58±4	7:59±3	<0.0001 ↑
Women (n=27406)	7:54±2	8:001±2	8:09±2	8:14±2	8:12±3	8:16±2	<0.0001 ↑
Clock time of reported snack between breakfast and lunch (among reporters of a snack between breakfast and lunch)							
Men (n=6301)	9:47±3	9:38±3	9:41±5	10:02±6	10:04±7	10:07±6	0.0001 ↑
Women (n=7070)	9:57±3	9:55±3	10:05±3	10:24±6	10:22±6	10:24±4	<0.0001 ↑
Clock time of reported lunch (Among lunch reporters)							
Men (n=22139)	12:29±2	12:26±2	12.31±3	12:37±4	12:39±3	12:37±3	<0.0001 ↑
Women (n=26049)	12:29±1	12:30±2	12:34±2	12:42±3	12:47±2	12:42±2	<0.0001 ↑
Clock time of reported snack between lunch and dinner (among reporters of a snack between lunch and dinner)							
Men (n=9982)	15:17±3	15:19±3	15:12±3	15:27±5	15:36±5	15:28±4	0.001 ↑
Women (n=12062)	15:13±2	15:18±3	15:14±3	15:16±4	15:17±4	15:05±3	0.2
Clock time of reported dinner (Among dinner reporters)							
Men (n=26082)	18:28±2	18:31±3	18:11±4	18:21±4	18:28±5	18:23±5	0.4
Women (n=29768)	18:17±2	18:24±2	18:16±3	18:26±3	18:27±3.9	18:21±3	0.1
Clock time of reported snack AFTER dinner (among reporters of an after-dinner snack)							
Men (n=14303)	21:00±2	20:57±2	20:18±4	20:28±5	20:27±3	20:22±4	<0.0001 ↓
Women (n=16166)	20:59±2	20:56±2	20:21±2	20:30±3	20:24±5	20:18±5	<0.0001 ↓

[a]Estimates are predicted means from sex-specific linear regression models with each meal behavior variable as a continuous outcome. Independent variables were: survey cycle (NHANES I, NHANES II, NHANES III, C-NHANES 1999–2002, 2003–2006, 2007–2010) as a categorical value or as a trend variable, age (continuous), race/ethnicity (non-Hispanic white, non-Hispanic black, Other), family poverty income ratio (<130, 130–349, >349, unknown %), level of education (<12y, 12y, some college, ≥ college), season of mobile examination center exam (Nov.–April, May–Oct.), weekday of recalled dietary intake (Monday–Thursday, Friday–Sunday), BMI (continuous), and employment status in the past one or two weeks (yes or no). *n* refers to number with complete covariate information. P_{trend} refers to the *P* value associated with the survey as a trend variable.

[b]Main meal episodes comprised eating events named as breakfast, lunch, and dinner or equivalents by respondents. **Breakfast** eating event was defined as AM meal (NHANES I and II), breakfast, desayuno, almuerzo (NHANES III, 1999–2002, 2003–2006, 2007–2010); **lunch** eating event defined as: noon meal (NHANES I and II), lunch, brunch or comida (NHANES III, 1999–2002, 2003–2006, 2007–2010); **dinner** defined as: PM meal (NHANES I and II), dinner, supper, or cena (NHANES III, 1999–2002, 2003–2006, 2007–2010).

[c]Snack defined as any eating event identified as snack, drink, between meal, extended consumption, (an eating event which was not labeled as breakfast, lunch, dinner or equivalent in Spanish by the respondent). Events where only plain or bottled water was reported were not considered an eating episode.

Table 5

Length of the interval (hours) (mean±se[a]) between main meals[b] and snacks[c] reported by adult Americans in a 24-hour recall, National Health and Nutrition Examination Surveys (NHANES) 1971–74 to 2007–2010

N	NHANES I 1971–74	NHANES II 1976–1980	NHANES III 1988–1994	C-NHANES 1999–2002	C-NHANES 2003–2006	C-NHANES 2007–2010	P_{trend}
Interval between the first and the last ingestive episode in the 24-hour recall, hours (among all-population average)							
Men (n=28945)	13.2±0.07	13.1±0.06	12.9±0.09	12.5±0.07	12.6±0.08	12.6±0.09	<0.0001 ↓
Women (n=32621)	12.5±0.05	12.4±0.05	12.3±0.05	12.1±0.07	12.2±0.06	12.0±0.07	<0.0001 ↓
Average interval between eating episodes[d], hours (among all-population average)							
Men (n=28945)	2.75±0.02	2.82±0.02	2.79±0.02	2.69±0.02	2.72±0.01	2.67±0.02	<0.0001 ↓
Women (n=32621)	2.74±0.01	2.78±0.02	2.67±0.01	2.59±0.02	2.64±0.02	2.51±0.02	<0.0001 ↓
Length of the interval between snack reported BEFORE breakfast and subsequent breakfast, hours (among reporters of a snack before breakfast)							
Men (n=3018)	4.24±0.2	4.00±0.18	4.89±0.19	3.75±0.20	4.19±0.25	3.92±0.18	0.3
Women (n=3005)	3.35±0.17	3.60±0.19	4.15±0.23	3.54±0.14	3.83±0.17	3.20±0.20	0.5
Length of the interval between breakfast and subsequent AFTER breakfast snack, hours (among reporters of a snack between breakfast and lunch)							
Men (n=6301)	2.60±0.05	2.45±0.04	2.43±0.05	2.60±0.07	2.68±0.07	2.66±0.06	0.04
Women (n=7070)	2.56±0.04	2.53±0.04	2.57±0.04	2.58±0.08	2.71±0.05	2.60±0.06	0.1
Length of the interval between snack reported AFTER breakfast and subsequent lunch, hours (among reporters of a snack between breakfast and lunch)							
Men (n=6301)	2.78±0.05	2.87±0.04	3.19±0.11	3.04±0.08	2.90±0.08	2.90±0.08	0.1
Women (n=7070)	2.56±0.04	2.62±0.05	2.85±0.06	2.69±0.07	2.77±0.08	2.69±0.07	0.1
Length of the interval between breakfast and lunch, hours (among reporters of breakfast and lunch)							
Men (n=18252)	5.05±0.04	4.96±0.03	4.94±0.05	5.02±0.08	5.04±0.04	4.97±0.04	0.9
Women (n=22084)	4.75±0.02	4.67±0.03	4.77±0.04	4.70±0.04	4.83±0.04	4.68±0.05	0.8
Length of the interval between lunch and the subsequent after-lunch snack. hours (among reporters of a snack between lunch and dinner)							
Men (n=9982)	2.97±0.05	3.01±0.05	3.05±0.06	3.13±0.08	3.20±0.05	3.15±0.07	0.008 ↑
Women (n=12062)	2.87±0.04	2.96±0.05	2.91±0.05	2.85±0.07	2.78±0.06	2.62±0.05	0.0001 ↓
Length of the interval between snack reported AFTER lunch and subsequent dinner, hours (among reporters of a snack between lunch and dinner)							
Men (n=9982)	3.39±0.06	3.55±0.05	3.73±0.06	3.75±0.09	3.63±0.05	3.64±0.05	0.004 ↑
Women (n=12062)	3.31±0.04	3.42±0.04	3.58±0.04	3.69±0.08	3.67±0.07	3.75±0.06	<0.0001 ↑
Length of the interval between lunch and dinner, hours (among reporters of lunch and dinner)							

N	NHANES I 1971–74	NHANES II 1976–1980	NHANES III 1988–1994	C-NHANES 1999–2002	C-NHANES 2003–2006	C-NHANES 2007–2010	P_{trend}
Men (n=19918)	6.15±0.03	6.30±0.04	6.45±0.04	6.55±0.07	6.40±0.05	6.41±0.04	<0.0001 ↑
Women (n=23696)	5.93±0.03	6.05±0.04	6.15±0.04	6.23±0.06	6.11±0.04	6.07±0.04	0.006 ↑
Length of the interval between dinner and after-dinner snack, hours (among reporters of an after-dinner snack)							
Men (n=14303)	2.90±0.04	2.80±0.04	2.66±0.05	2.75±0.06	2.64±0.05	2.59±0.08	0.0001 ↓
Women (n=16166)	2.99±0.04	2.86±0.04	2.58±0.05	2.60±0.06	2.51±0.05	2.42±0.06	<0.0001 ↓
Length of the interval between two mentions of the same meal[e]**, hours** (among reporters of more than one breakfast, lunch, or dinner)							
Men (n=3990)	3.86±0.32	3.43±0.40	3.58±0.23	2.98±0.21	3.64±0.24	3.41±0.26	0.7
Women (n=3644)	4.09±0.32	4.18±0.35	2.94±0.15	2.76±0.19	3.23±0.21	2.92±0.13	0.03 ↓

[a] Estimates are predicted means from sex-specific linear regression models with each meal behavior variable as a continuous outcome. Independent variables were: survey cycle (NHANES I, NHANES II, NHANES III, C-NHANES 1999–2002, 2003–2006, 2007–2010) as a categorical value or as a trend variable, age (continuous), race/ethnicity (non-Hispanic white, non-Hispanic black, Other), family poverty income ratio (<130, 130–349, >349, unknown %), level of education (<12y, 12y, some college, ≥ college), season of mobile examination center exam (Nov.–April, May–Oct.), weekday of recalled dietary intake (Monday–Thursday, Friday–Sunday), BMI (continuous), and employment status in the past one or two weeks (yes or no). *n* refers to number with complete covariate information. P_{trend} refers to the *P* value associated with the survey as a trend variable.

[b] Main meal episodes comprised eating events named as breakfast, lunch, and dinner or equivalents by respondents. **Breakfast** eating event was defined as AM meal (NHANES I and II), breakfast, desayuno, almuerzo (NHANES III, 1999–2002, 2003–2006, 2007–2010); **lunch** eating event defined as: noon meal (NHANES I and II), lunch, brunch or comida (NHANES III, 1999–2002, 2003–2006, 2007–2010); **dinner** defined as: PM meal (NHANES I and II), dinner, supper, or cena (NHANES III, 1999–2002, 2003–2006, 2007–2010).

[c] Snack defined as any eating event identified as snack, drink, between meal, extended consumption (or equivalents in Spanish) (i.e., an eating event which was not breakfast, lunch, or dinner). Events where only plain or bottled water was reported were not considered eating episode.

[d] Interval between the first and the last eating episode/number of all eating episodes in the recall

[e] Reported more than one breakfast, lunch, or dinner in the recall