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Secular trends in meal and snack patterns among adolescents from 1999 to 2010

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Abstract

Background—Linkages between snack patterns, diet, and obesity in adolescents likely depend on the consumption of main meals, how often snacks are prepared away from home, and whether energy-dense, nutrient-poor snack foods and sugary drinks are frequently consumed. Nutritional interventions need to be informed by an understanding of how secular changes in the contribution of snacks to dietary intake may be related to changes in meal frequency as well as how these trends differ by sociodemographics.

Objectives—To examine secular trends from 1999 to 2010 in meal and snack patterns among adolescents.

CONFLICT OF INTEREST DISCLOSURE

The authors have no conflicts of interest to report.

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Design—A repeated cross-sectional design was used.

Participants/setting—Participants from Minneapolis/St. Paul, MN secondary schools completed classroom-administered surveys and food frequency questionnaires in 1999 (n=2,598) and 2010 (n=2,540).

Main outcome measures—Weekly meal frequencies; number of snacks consumed on school and vacation/weekend days; frequent consumption of snacks prepared away from home (≥3 times/week); and daily servings of energy-dense, nutrient-poor food/drinks that are commonly consumed at snack occasions.

Statistical analyses performed—Trends from 1999 to 2010 were examined using inverse probability weighting to control for differences in sociodemographic characteristics in the two samples.

Results—Mean frequencies of breakfast and lunch increased modestly in the overall population (both $P<0.001$), and there were decreases in the number of snacks consumed on schools days ($P<0.001$) and vacation/weekend days ($P=0.003$). Although there was no change in the proportion of adolescents who reported frequent consumption of snacks prepared away from home, there was a secular decrease in energy-dense, nutrient-poor food/drink consumption ($P<0.001$). Sociodemographic differences in the identified trends were evident.

Conclusions—The observed pattern of sociodemographic differences in meal and snack trends among adolescents suggests the need for targeted efforts to ensure public health messages reach low-income and ethnic/racial minority population subgroups most vulnerable to poor nutrition and the development of obesity.

Keywords

Adolescents; Secular trends; Eating behavior; Meal patterns; Snack patterns

Few U.S. adolescents consume a diet consistent with the Dietary Guidelines for Americans and one third are overweight.[1, 2] Secular trends in several eating patterns, including increases in portion sizes, increases in the consumption of food prepared away from home, and increases in the contribution of snacks to total energy intake may be contributing to poor nutrition and corresponding increases in the prevalence of overweight and obesity that have occurred among adolescents over the past four decades.[3–9] National survey data have documented an increase over time in the contribution of snacks to dietary intake among adolescents as well as the contribution of energy-dense, nutrient-poor foods and drinks (e.g., candy, fruit-flavored drinks) to the calories consumed at snack occasions.[6] Data for 2011–2012 indicate that while only 54% of U.S. adolescents consume all three main meals (i.e., breakfast, lunch, and dinner), approximately three out of four adolescents have two or more snacks on a given day and the food and drinks consumed at snack occasions contribute a quarter of total daily energy intake.[10–12]

Linkages between snacking behaviors, dietary quality, and risk for overweight in adolescents likely depend in part on the consumption of main meals and the types of food and drinks consumed at snack occasions. The food and drinks consumed at snack occasions can be a significant source of healthful nutrients that help young people meet dietary

recommendations,[10] and frequent snacking may have little impact on overall daily energy intake or weight status for those who typically consume snacks in place of meals. Conversely, frequent snacking likely contributes to excess energy intake and weight gain when snacks are consumed in addition to main meals and particularly when energy-dense, nutrient-poor foods and drinks are often selected. The source of selected snacks is also likely an important consideration as frequent consumption of food prepared away from home has been consistently linked to greater weight gain over time and diets of lower overall nutritional quality.[13–15] Public health policies, messages, and services for adolescents therefore need to be informed by an understanding of how recent secular changes in snacking are related to changes in the frequency of consuming main meals as well as specific aspects of snacking behavior that may reflect on the nutritional contribution of snacks to overall dietary intake.[16] As prior research has defined snacking in multiple ways, there is a need to examine multiple aspects of snacking together to allow for stronger comparisons across overall population groups and among subgroups at greatest risk for overweight. Describing any differences in secular trends across sociodemographic subgroups is particularly important as cross-sectional studies cannot provide information on the perpetuating or widening nature of disparities that may be critical to address by intensifying or modifying responsive interventions.

The current study was designed to help fill these gaps in the scientific literature and inform the development of more effective policies, messages, and services to support adolescents in meeting dietary recommendations for health. The aim was to examine secular trends in adolescent reports of meal (breakfast, lunch, dinner) and snack (food or drinks between meals) patterns alongside trends in the consumption of snacks prepared away from home and energy-dense, nutrient-poor snack food and drinks. Trends were examined from 1999 to 2010 in a large, diverse sample and therefore capture a period in which there was growing attention given to the availability of snacks on school grounds as well as the typically large portions and high energy-density of foods and drinks prepared at other locations outside the home.[17–20] In addition, the diversity of the sample allowed for investigation of these trends by sociodemographic characteristics so that any identified disparities may be used to direct health promotion efforts to population subgroups of concern. It was hypothesized, based on prior research,[6, 21, 22] that meal frequency would decrease and reports of snacking would increase between 1999 and 2010, and that observed trends would disproportionately impact adolescents from ethnic/racial minority and low-income backgrounds.

METHODS

Study Design and Population

A repeated cross-sectional study design was used to compare meal and snack patterns between 1999 and 2010 among adolescent participants in Project EAT (Eating and Activity in Teens). Data from 1999 are drawn from Project EAT-I, the first wave of a longitudinal study that has followed adolescents into young adulthood.[23–26] Data from 2010 are drawn from EAT 2010, a multi-contextual study designed to examine dietary and weight-related outcomes in adolescents.[27–29] These two studies were designed to allow for the examination of secular trends by administering identical survey measures to student samples from the

same urban school districts at both time points.[30, 31] As part of Project EAT-I and EAT 2010, adolescents completed a survey and the semi-quantitative, Youth and Adolescent Food Frequency Questionnaire (FFQ) after completing the process of assent and signing a form to indicate they understood the study procedures.[32, 33] Consent was also obtained from the parents of adolescents prior to offering the opportunity to assent. Parental consent procedures were completed in accordance with the requests of the participating school districts at each time point; in some schools, passive consent procedures were used, whereas in others, active consent procedures were required. Approximately 90% of adolescents who were at school on survey administration days had parental consent and chose to participate in 1999 and 2010. All study procedures were approved by the University of Minnesota's Institutional Review Board Human Subjects Committee and by the research boards of the participating school districts.

In 1999, participants included ethically/racially diverse students from 31 public middle schools (6th–8th grades) and high schools (9th–12th grades) in the Minneapolis/St. Paul metropolitan area of Minnesota.[23, 24] Consideration was given to enrollment size and involvement in other research studies when recruiting school districts. In recruiting a new cohort during the 2009–2010 academic year, schools that had participated in 1999 were given priority along with demographically similar schools; however, enrolling an ethnically/racially diverse sample was also of particular concern. Therefore, for EAT 2010, only two urban school districts, which served a large number of schools and diverse students were included. To facilitate the examination of secular trends, the earlier sample was restricted to the two school districts that participated at both time points (n=27 schools in 1999 and n=20 schools in 2010, n=17 schools participated in both 1999 and 2010).[30, 34] Trained research staff administered the survey measures and FFQ to all interested students in selected health, physical education, and science classes at each time point. The sample for the analysis reported here includes 2,598 adolescents (51.5% female) from 1999 and 2,540 adolescents (53.7% female) from 2010 who provided plausible and complete responses for both the survey and FFQ. The mean age of the 1999 sample was 14.6 years (SD=1.8) and the mean age of the 2010 sample was 14.5 years (SD=2.0). Although there were demographic shifts within the participating school districts over the 11-year period, the study sample was ethnically/racially and socioeconomically diverse in both 1999 (63.5% nonwhite, 45.5% eligible for free or reduced-price school lunch) and 2010 (80.3% nonwhite, 57.7% eligible for free or reduced-price school lunch). The student sample was also similar in terms of ethnic/racial composition to the overall student population within each district in 1999 and 2010 based on data maintained by the Minnesota Department of Education.[35]

EAT Survey Measures

The EAT survey was used to assess adolescent meal patterns and sociodemographic characteristics. Test-retest reliability was assessed in diverse adolescent samples at EAT-I (N=161) and at EAT 2010 (N=129); psychometric properties from 2010 are reported here.

Meal patterns—The number of days adolescents ate meals during the past week was assessed using three questions, which separately asked about breakfast, lunch, and dinner. Response categories for each item were never, one to two days, three to four days, five to six

days, and every day [Test-retest r(breakfast)=0.60, r(lunch)=0.60, r(dinner)=0.76]. To allow for comparison over time of mean weekly meal frequencies, the number of meals was assigned a score of 0.0, 1.5, 3.5, 5.5, or 7 to correspond to the five possible responses.

Sociodemographic characteristics—Sex, grade level, ethnicity/race, and socioeconomic status (SES) were assessed by self-report. Ethnicity/race was assessed with the question "Do you think of yourself as…? (1) White, (2) Black or African American, (3) Hispanic or Latino, (4) Asian American, (5) Native Hawaiian or Pacific Islander, (6) American Indian or Native American, or (7) Other" (Test-retest agreement=98–100%). Since very few adolescents reported "Hawaiian or Pacific Islander" they were coded as "mixed/other". The prime determinant of SES was the higher education level of either parent with adjustments made for student eligibility for free/reduced-price school meals, family public assistance receipt, and parent employment status.[23, 36]

Youth and Adolescent FFQ

The Youth and Adolescent FFQ was used to assess how many snacks adolescents consumed on school days and vacation/weekend days, how often adolescents consumed snacks prepared away from home, and usual daily servings of common energy-dense, nutrient-poor snack food and drinks. The validity and reliability of the Youth and Adolescent FFQ have been previously examined and found to be within acceptable ranges for dietary assessment.[32, 33] Responses to the FFQ were excluded for 194 participants in 1999 and 121 participants in 2010 that reported a biologically implausible level of total energy intake (<400 kcal/day or >7,000 kcal/day).

Snacks on school days and vacation/weekend days (number of snacks/day)—Adolescents were asked to indicate the number of snacks (food or drinks) they usually consumed between breakfast and lunch, after lunch and before dinner, and after dinner separately for school days and vacation/weekend days. Response categories for each item were none, one, two, three, and four or more. To allow for comparison over time of mean daily number of snacks, the number of snacks consumed at each time of day was assigned a score of 0.0, 1.0, 2.0, 3.0, or 4.0 to correspond to the five possible responses prior to summing these scores to obtain totals for a typical school day and vacation/weekend day.

Snacks prepared away from home (snack occasions/week)—The number of times per week (including weekdays and weekends) adolescents consumed snacks prepared away from home was assessed using two questions. The questions separately asked about after-school snacks and late night snacks but did not provide detailed instruction regarding the sources of food and drink to include. Response categories for each item were never or almost never, one to two times per week, three to four times per week, and five or more times per week. Based on previous research,[37–40] responses were dichotomized for analysis of change over time in the prevalence of eating snacks prepared away from home on three or more occasions per week.

Energy-dense, nutrient-poor snack food and sugary drinks (servings/day)—In addition to reporting the total number of times food or drinks were consumed between

meals, adolescents were asked to separately indicate how often they had consumed specific energy-dense, nutrient poor food and drink items that are commonly consumed by youth at snack occasions.[41] Snack food items were assessed as part of a section of the FFQ titled "snack foods/desserts"; however, it is possible that adolescent participants consumed these food/drink items with meals. The snack food items included potato chips; corn chips; nachos with cheese; fun fruit or fruit rollups; toaster pastries; cake; snack cakes; Danish, sweetrolls, or pastry; donuts; cookies; brownies; pie; chocolate bar or packet; other candy bars; other candy without chocolate; gelatin desserts; pudding; frozen yogurt; ice cream; milkshake or frappe; and popsicles. A serving of snack food was defined by units such as one small bag, one pack, and one slice as appropriate for the item. The sugar-sweetened drinks included were non-diet soda and fruit drinks with one serving defined as the equivalent of a glass or can. Snack intake was estimated by summing the reported consumption of the 21 food items and sugar-sweetened drink intake was estimated by summing the reported consumption of the two beverage items.

Statistical Analysis

Tests for secular trends were conducted using two-sample t-tests and chi-square tests for continuous and dichotomous measures of meal and snack behaviors respectively. Additional regression analyses tested interactions of year with sex, school level (middle school or high school), ethnicity/race, and SES. For each case where the *P* value for an interaction test was <0.10, the result for the interaction test is described along with tests comparing 1999 with 2010 that were stratified by the characteristic. Tests comparing the number of snacks adolescents consumed between 1999 and 2010 were further examined within subsamples of the population reporting specific meal patterns. Models included inverse probability weights for the 1999 sample that were calculated from a logistic regression of the year indicator on sex, age, ethnicity/race, SES, and all possible two-way interactions.[42] By weighting the 1999 samples, the secular trend tests and standard errors of the estimates were consequently controlled for demographic shifts that may have occurred over time. Proper control of the demographic shift using this weighting method was achieved, as evidenced by the nonsignificant differences observed by sex, age, ethnicity/race, and SES when comparing the weighted 1999 sample with the corresponding 2010 sample (Supplemental Table 1). All analyses were performed using the Statistical Analysis System (SAS, version 9.3, 2011, SAS Institute, Cary, NC, USA).

RESULTS

Meal Patterns

In the overall sample of adolescents, there were small to modest increases in the frequency of breakfast and lunch consumption from 1999 to 2010; however, tests for interactions with sex (lunch: $P=0.011$, dinner: $P=0.006$), school level (breakfast: $P<0.001$, lunch: $P=0.052$, dinner: $P=0.037$), ethnic/racial background (breakfast: $P<0.001$, lunch: $P=0.003$, dinner: $P=0.093$), and SES (lunch: $P=0.054$) were statistically significant or near significant ($P<0.10$) and suggested trends in meal frequency differed across sociodemographic subgroups (Table 1). Breakfast frequency increased among both boys and girls, but frequencies of lunch and dinner increased only among girls. Although consumption

frequencies were highest among adolescents in middle-school grades in both years for breakfast, lunch, and dinner, observed increases in meal frequencies occurred only among adolescents in high-school grades. In 1999, frequencies of breakfast and lunch were lowest among adolescents who reported their ethnicity/race as Black, Hispanic, or Native American. Statistically significant increases in breakfast frequency occurred only among White, Black, and Hispanic adolescents and significant increases in lunch frequency occurred only among White and Black adolescents. The observed mean changes in lunch frequency indicated that the largest increases over time mostly occurred among adolescents who reported low-to-middle SES backgrounds. The test for interaction with SES was not statistically significant for breakfast, but it is also notable breakfast frequencies were lowest among adolescents from low SES backgrounds in both 1999 and 2010.

The percentage of adolescents who reported consuming each main meal on most or all days (≥5 times in the past week) was 34.9% in 1999 and increased to 40.7% by 2010. Analogous modest improvements were observed for each of the three meals when examined separately (Table 2). The overall percentage of adolescents reporting the consumption of meals on most or all days of the week was 41.7% for breakfast, 75.9% for lunch, and 81.6% for dinner in 1999. By 2010 the percentages increased to 49.3% for breakfast, 79.0% for lunch, and 82.1% for dinner. Additional analysis of trends in the consumption of meals on most or all days of the week by sociodemographic subgroup showed patterns similar to those observed in models of mean consumption frequencies. Tests for interactions with sex (dinner: P=0.001), school level (breakfast: P=0.013), and ethnic/racial background (breakfast: P=0.008, lunch: P=0.004, dinner: P=0.050) were statistically significant or near significant.

Snack Patterns

There were small to modest decreases in the mean number of snacks consumed on school days and the mean number of snacks consumed on vacation/weekend days from 1999 to 2010 among the overall sample despite notable differences in the observed trends by school level (Table 3). Tests for interactions with school level were statistically significant for snacks consumed on school days (P<0.001) and snacks consumed on vacation/weekend days (P=0.002). Whereas the number of snacks consumed on school days and vacation/weekend days decreased notably among adolescents in middle-school grades, no changes in mean number of snacks consumed were observed among adolescents in high-school grades. Statistically significant tests for interactions were not found for ethnicity/race or SES. However, it is notable the mean number of snacks consumed on school days and vacation/weekend days was highest among adolescents who reported their race as Black or mixed/other in both years.

Similarly, the number of snacks consumed on vacation/weekend days was lowest among adolescents from high SES backgrounds in both years. Among the subsample of adolescents who reported consuming breakfast, lunch, and dinner on most or all days (≥5 times in the past week), observed overall changes in the mean number of snacks consumed on school days and vacation/weekend days were consistent with those described above; however, the decrease in snacks was statistically significant only for school days (Table 4). Further

detailed analysis showed decreases over time in the number of snacks consumed on school day afternoons and evenings among adolescents who reported consuming both lunch and dinner and dinner respectively on most or all days of the week. Examination of trends in snacks consumed on vacation/weekend days showed a statistically significant decrease only for the number of afternoon snacks consumed by adolescents who reported consuming lunch and dinner on most or all days of the week.

Snacks Prepared Away from Home

The overall percentage of adolescents who reported consuming three or more snacks per week prepared away from home was 36.1% for after school and 17.9% for late at night in 1999. No statistically significant changes occurred over time with similar proportions of the sample consuming three or more snacks per week prepared away from home in the hours after school (34.9%) and late at night (18.2%) in 2010. Tests for interactions with school level (late at night snacks: P=0.001), ethnic/racial background (after-school snacks: P=0.005), and SES (after-school snacks: P=0.007) were statistically significant; however, few trends over time in the consumption of snacks prepared away from home were observed in analyses stratified on sociodemographic characteristics (Supplemental Table 2). A decrease in the proportion of adolescents consuming three or more after-school snacks per week prepared away from home was observed only among adolescents of low-to-middle SES backgrounds (1999: 43.1%, 2010: 35.0%, P=0.008). Trends in the proportion of adolescents consuming three or more late-night snacks per week prepared away from home were suggested with an increase among those enrolled in high-school grades (from 16.5% to 20.2%, P=0.01) and decreases and among those enrolled in middle-school grades (from 19.0% to 15.6%, P=0.03) as well as those who reported their ethnicity/race as Hispanic (decrease from 18.8% to 11.5%, P=0.01).

Consumption of Energy-dense, Nutrient-poor Snack Food and Sugary Drinks

Findings regarding trends in the consumption of energy-dense, nutrient-poor snack food and sugary drinks paralleled those observed for changes over time in the overall number of daily snacks consumed (Table 5). In the overall sample, mean daily snack food intake decreased from 2.6 servings in 1999 to 2.2 servings in 2010 and mean daily sugary drink intake decreased from 1.2 servings in 1999 to 0.8 servings in 2010 (P<0.001 for both trends). Statistically significant decreases in consumption occurred among most sociodemographic subsamples; however, tests for interactions with school level (snack foods: P<0.001, sugary drinks: P=0.058), ethnic/racial background (snack foods: P=0.016, sugary drinks: P=0.004), and SES (snack foods: P=0.088, sugary drinks: P=0.079) were also statistically significant or near significant. It was notable that energy-dense, nutrient-poor snack food servings and sugary drink servings were highest among adolescents of Black, Native American, and mixed/other ethnicity/race at both time points. Similarly, the results stratified by SES showed that energy-dense, nutrient-poor snack food servings and sugary drink servings were highest among adolescents of low and low-middle SES backgrounds at both time points.

DISCUSSION

This study examined changes from 1999 to 2010 in adolescent meal and snack patterns alongside trends in the consumption of snacks prepared away from home and common energy-dense, nutrient-poor snack foods and drinks. Findings indicated the frequency of breakfast and lunch consumption increased among adolescents in the overall population, and there were small to modest decreases in the number of snacks consumed on schools days and on vacation/weekend days. The results also showed a modest decrease over time in mean daily servings of energy-dense, nutrient-poor snack foods and drinks despite heavy marketing of these foods and drinks over the past decade.[43, 44] Although observed improvements in the frequency of breakfast and lunch consumption were small to modest, these changes are encouraging and may have a large impact on the nutritional health and academic performance of adolescents at the population level.[45, 46] Numerous studies have reported that eating regular meals, and in particular eating breakfast, is linked to positive outcomes, including improved overall nutrient intake, energy regulation, weight control, memory, test grades, school attendance, psychosocial function, and mood.[45] The benefits of eating breakfast depend largely on the composition of the meal, which was not assessed as part of the current study. However, regularly eating breakfast and other meals throughout the day provides important opportunities to improve overall nutrient intake and may bring about advantageous metabolic changes.[45] The observed trends are also encouraging given what is known regarding the potential consequences of frequent meal skipping and consumption of energy-dense, nutrient-poor foods and drinks.[16, 47, 48]

The research described here importantly updates previously published data on secular changes in the snacking patterns of U.S. adolescents beyond the year 2006 and provides context for the observed trends in further describing changes in snacking according to adolescent reports of meal patterns. Most recent studies of secular trends in adolescent snacking have focused on trends over more narrow periods of time or more broadly changes between the late 1970s and 2006, and reported substantial increases in snack consumption across the three decades.[6, 7, 22, 49] The authors were unable to identify other research among adolescents documenting a halting or reversal of these trends in the last ten years with the exception of one study focusing solely on trends in intake of common sweet and salty snack foods from 2003–2006 to 2007–2010.[49] Only one previous study of 40-year trends in snacking behaviors among U.S. adults[21] was found to include a corresponding description of trends in meal behaviors and no previous studies among adolescents were identified that included similar data. In contrast to the observed decreases in meal consumption among adults and evidence that an observed increase in the contribution of snacks to 24-hour energy intake over the period 1971 to 2010 was driven in part by snacks reported by those omitting one or more meals, the results of the current study showed the mean number of snacks consumed per day to be similar among the overall sample and the subgroup of adolescents that reported consuming breakfast on 5+ days/week, lunch on 5+ days/week, and dinner on 5+ days/week. Several methodological differences between the two studies such as the use of 24-hour recalls versus survey data and the time periods of study could have contributed to the contradictory findings in addition to developmental factors.

The secular increases in the frequency of breakfast and lunch consumption and decreases in the consumption of energy-dense, nutrient-poor snacks observed as part of the current study may have been influenced by changes that have been implemented in secondary schools over the past decade. Federal and local policy changes have led to the expansion of free school breakfast programs and reduced access to energy-dense, nutrient-poor competitive foods and drinks on school grounds.[50] Both school districts enrolled in this study adopted wellness policies in 2006 addressing the nutritional quality of food and drinks offered outside the school meal program. Despite the encouraging nature of observed improvements in eating behavior, the results also provided evidence of disparities according to sex, school level, ethnicity/race, and SES that suggest additional, targeted efforts may be needed to promote further improvements and the achievement of health equity. Previous studies of secular trends in the eating behaviors of adolescents have not provided comparable data on sociodemograhic disparities; however, the results reported here were consistent across the multiple eating behaviors examined in suggesting there is a particular need for targeted health promotion efforts to address the meal and snack patterns of adolescents enrolled in high-school grades. It may be that parents have more control over the meal and snack patterns of adolescents enrolled in middle-school grades than high-school grades and have become increasingly aware of public health recommendations relating to the consumption of energy-dense, nutrient-poor snack foods/drinks. Additionally, the results suggested there is a particular need for targeted health promotion efforts to address the meal and snack patterns of adolescents who report their ethnicity/race as Black, Native American, and mixed/other, and adolescents representing lower SES households.

Strengths and limitations of this study should be considered in interpreting the findings. Strengths included the unique design, large and diverse adolescent sample, and breadth of data examined regarding different aspects of adolescent meal and snack patterns. The repeated cross-sectional design allowed for the study of secular trends during an 11-year period in which there was growing attention given to the potential consequences of meal skipping and frequent snacking for adolescent health.[16, 46] In addition, the ethnically/racially and socioeconomically diverse study population allowed for comparing trends in different sociodemographic subgroups. The combined assessment of changes in meal and snack patterns was another important contribution. Available data allowed for examination of trends in breakfast, lunch, and dinner meal frequency; the number of snacks consumed on school days and vacation/weekend days; the frequency of consuming snacks prepared away from home; and daily servings of common energy-dense, nutrient-poor snack foods and drinks.

Despite the breadth of data examined, the brief measures used to assess these multiple aspects of meal and snack patterns did not allow for investigation of changes over time in the contribution of meals and snacks to energy or nutrient intake; the number of days where breakfast, lunch, and dinner were all eaten; portion sizes of food and drinks consumed at snack occasions; use of adolescents' own income to make snack purchases; or the multiple contexts in which snacks may be consumed (e.g., watching television, spending time with friends). The questionnaire-based estimates of the number of snacks (foods or drinks) consumed on school days and vacation/weekend days reported here are not directly comparable to national population estimates of the number of daily snack occasions reported

by U.S. adolescents as part of 24-hour recalls.[6] The information collected on the consumption of snacks prepared away from home did not specifically define the sources of foods and drinks to include. Further, the information collected on consumption of common snack foods and drinks did not allow for distinguishing how often these foods were consumed along with meals versus in between meals. Caution should be used in making generalizations to youth from other areas as the data were collected in one urban area and students included in the analytic sample differed from students who were excluded on sociodemographic characteristics and, in 1999, on meal frequency. Ethnic/racial differences between the analytic sample and excluded samples are particularly noteworthy; a higher proportion of students were white in the analytic sample than among the groups who were excluded because they did not complete an FFQ or provided an FFQ but reported implausible dietary intake. Although all analyses used inverse probability weighting so that the 1999 sample was matched demographically to the 2010 sample (Supplemental Table 1), it is still possible there were unmeasured changes in the characteristics of adolescent participants over time that the weights may not have fully accounted for and that influenced their meal and snack patterns.

CONCLUSIONS

The results described here encouragingly suggest there have not been increases in meal skipping or the consumption of common energy-dense, nutrient-poor snacks over the past decade. However, in 2010 there were still only 40.7% of adolescents who reported consuming each main meal (breakfast, lunch, and dinner) on most or all days of a given week and the mean intake of energy-dense, nutrient-poor snacks (foods and drinks) was nearly three daily servings. Of further concern, disparities in meal and snack patterns persisted over time among population subgroups most vulnerable to poor nutrition and the development of obesity. For example, consumption of energy-dense, nutrient-poor snacks and sugary drinks remained highest over time among adolescents who reported their race as Black, Native American, or mixed/other. The disparities observed in the current study emphasize the need for research to inform and conduct evaluations of targeted strategies that will ensure public health messages reach low-income and ethnic/racial minority population subgroups. There is a particular need for research to pinpoint developmental, cultural, and economic factors that may be contributing to socidoemographic differences in how eating patterns have changed over time and evaluate policy interventions (e.g., federal regulation of marketing practices, price incentives to encourage healthy choices, land use regulations to limit the concentration of convenience stores) to ensure they facilitate healthy food choices for all population groups.

Future studies are also needed to address the limitations of the current study and should examine whether similar trends in meal and snack patterns continue over time in other adolescent populations following full implementation of the Healthy, Hunger-Free Kids Act of 2010 (Public Law 11-296). As linkages between snacking behaviors, dietary quality, and risk for overweight are likely contingent on the types and amounts of food and drinks consumed at snack occasions, it will be particularly important for studies to incorporate measures that allow for assessment of changes in the contribution of snacks to energy and nutrient intake along with changes in the portions consumed at snack occasions.

Additionally, it will be imperative for future research to identify contextual factors of relevance to health promotion efforts. To further support and extend the findings, it may moreover be informative to examine trends within sociodemographic subgroups in the types of snack foods and drinks available in the homes of adolescents, adolescent involvement in purchasing and preparing meals and snacks, what types of common snack foods and drinks are available at convenience stores in school neighborhoods, the consumption of meals and snacks while watching television, perceived barriers to eating meals, and other potential influences on meal and snack patterns. Finally, it will be important for future research to assess the meal and snack patterns of parents and caregivers. Information on trends among this population subgroup is of particular significance as interventions targeting their eating behaviors may have a spillover benefit in terms of reducing the availability of energy-dense, nutrient-poor snacks at home and promoting the modeling of healthy choices for consumption at meals and snacks.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Secular trends from 1999 to 2010 in adolescent meal patterns by sociodemographic characteristics: Minneapolis-St. Paul, Minnesota, Project EAT (Eating and Activity among Teens)

	1999 n[a]	2010 n	Breakfast frequency (mean days/week)			Lunch frequency (mean days/week)			Dinner frequency (mean days/week)		
Characteristic			**1999[a]**	**2010**	***P* value[b]**	**1999[a]**	**2010**	***P* value[b]**	**1999[a]**	**2010**	***P* value[b]**
Total sample	2,598	2,540	3.7	4.2	<0.001	5.6	5.8	<0.001	6.0	6.0	0.23
Sex											
Boys	1,181	1,175	4.1	4.4	0.001	5.9	5.9	0.49	6.2	6.1	0.20
Girls	1,348	1,365	3.4	4.0	<0.001	5.4	5.7	<0.001	5.8	6.0	0.008
School level[c]											
Middle school	1,148	1,136	4.1	4.3	0.20	5.9	6.0	0.25	6.1	6.1	0.47
High school	1,335	1,404	3.4	4.1	<0.001	5.4	5.7	<0.001	5.8	6.0	0.02
Ethnicity/race[d]											
White	540	499	4.3	4.7	0.005	5.6	6.0	<0.001	6.3	6.5	0.08
Black	638	706	3.5	4.3	<0.001	5.4	5.7	0.002	6.0	5.9	0.84
Hispanic	414	435	3.2	4.0	<0.001	5.5	5.8	0.07	5.3	5.7	0.05
Asian	546	520	3.8	3.8	0.94	6.0	5.9	0.32	6.0	6.0	0.59
Native American	98	92	3.5	4.1	0.10	5.2	5.7	0.05	5.9	6.2	0.16
Mixed/other	293	288	4.0	4.0	0.96	5.7	5.6	0.50	6.1	6.0	0.77
Socioeconomic status[e]											
Low	936	973	3.4	3.9	0.002	5.7	5.8	0.36	5.7	5.8	0.20
Low-middle	560	556	3.4	4.0	<0.001	5.4	5.9	<0.001	5.9	6.0	0.45
Middle	436	430	3.7	4.4	<0.001	5.5	5.8	0.03	6.1	6.0	0.67
High-middle	335	320	4.3	4.6	0.16	5.7	5.8	0.65	6.3	6.5	0.02
High	199	193	4.9	5.0	0.63	5.8	6.1	0.16	6.6	6.5	0.57

[a] The 1999 sample was weighted to allow for an examination of secular trends in meal patterns independent of demographic shifts in the population. For example, estimates of weekly breakfast frequency within the low socioeconomic status group in 1999 and 2010 are mutually controlled so that sex, school level, and ethnicity/race makeup are the same in the low socioeconomic status group in the 1999 sample as in the 2010 sample.

[b] *P* values represent testing to examine weighted mean differences in meal frequency between 1999 and 2010.

[c] Middle school represents students enrolled in 6th–8th grades and high school represents students enrolled in 9th–12th grades.

[d] Adolescents could choose more than one ethnic/racial category; those responses indicating multiple categories were coded as mixed/other. Because there were few participants who identified themselves as Hawaiians or Pacific Islanders these participants were also included in the mixed/other category.

[e] The prime determinant of socioeconomic status was the higher education level of either parent with adjustments made for student eligibility for free/reduced-price school meals, family public assistance receipt, and parent employment status.

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Table 2

Secular trends from 1999 to 2010 in adolescent consumption of meals ≥5 days/week by sociodemographic characteristics: Minneapolis-St. Paul, Minnesota, Project EAT (Eating and Activity among Teens)

	Breakfast: ≥5 days/week (%)			Lunch: ≥5 days/week (%)			Dinner: ≥5 days/week (%)			Each meal: ≥5 days/week (%)[c]		
Characteristic	**1999[a]**	**2010**	***P* value[b]**	**1999[a]**	**2010**	***P* value[b]**	**1999[a]**	**2010**	***P* value[b]**	**1999[a]**	**2010**	***P* value[b]**
Total sample	41.7	49.3	<0.001	75.9	79.0	0.006	81.6	82.1	0.65	34.9	40.7	<0.001
Sex												
Boys	48.4	54.3	0.003	80.7	81.6	0.59	87.2	83.7	0.02	41.9	46.5	0.02
Girls	36.1	45.0	<0.001	71.4	76.8	0.002	76.8	80.8	0.01	29.1	35.8	<0.001
School level[d]												
Middle school	48.3	52.2	0.07	81.7	82.4	0.63	84.7	83.2	0.35	42.1	45.0	0.17
High school	36.3	47.0	<0.001	70.8	76.2	0.001	79.0	81.2	0.14	29.1	37.3	<0.001
Ethnicity/race[e]												
White	53.0	61.2	0.003	76.6	84.6	<0.001	89.8	93.0	0.05	45.8	55.1	<0.001
Black	36.9	49.9	<0.001	70.0	76.3	0.01	80.4	79.3	0.62	30.3	39.7	<0.001
Hispanic	34.0	46.4	0.004	73.5	78.8	0.14	66.9	74.7	0.04	24.7	37.2	0.002
Asian	40.8	42.1	0.65	83.9	80.4	0.11	84.6	81.3	0.14	36.8	34.8	0.47
Native American	40.2	48.9	0.21	69.3	78.3	0.15	83.8	87.0	0.52	35.1	42.4	0.29
Mixed/other	45.8	44.8	0.85	77.5	73.8	0.41	83.9	81.5	0.55	37.3	33.9	0.50
Socioeconomic status[f]												
Low	36.7	43.4	0.01	75.8	77.4	0.47	76.2	78.4	0.32	28.6	35.4	0.006
Low-middle	37.5	46.5	0.003	71.6	79.3	0.004	79.9	81.6	0.47	31.5	37.8	0.03
Middle	42.0	52.9	<0.001	75.8	79.8	0.13	85.8	82.3	0.13	36.3	42.8	0.03
High-middle	51.4	59.1	0.04	79.2	79.4	0.96	87.9	92.2	0.05	45.9	50.9	0.17
High	61.9	63.7	0.68	79.2	85.5	0.08	93.5	91.2	0.32	55.7	57.0	0.77

[a] The 1999 sample was weighted to allow for an examination of secular trends in meal patterns independent of demographic shifts. For example, the estimates of what proportion of adolescents consume breakfast on ≥5 days/week within the low socioeconomic status group in 1999 and 2010 are mutually controlled so that sex, school level, and ethnicity/race makeup are the same in the low socioeconomic status group in the 1999 sample as in the 2010 sample.

[b] *P* values represent testing of weighted differences in the population proportion consuming a meal ≥5 days/week between 1999 and 2010.

[c] Adolescents reported consuming breakfast on 5+ days/week, lunch on 5+ days/week, and dinner on 5+ days/week but did not necessarily have 5+ days/week where breakfast, lunch, and dinner were all eaten.

[d] Middle school represents students enrolled in 6th–8th grades and high school represents students enrolled in 9th–12th grades.

[e] Adolescents could choose more than one ethnic/racial category; those responses indicating multiple categories were coded as mixed/other. Because there were few participants who identified themselves as Hawaiians or Pacific Islanders they were also included in the mixed/other category.

[f] The prime determinant of socioeconomic status was the higher education level of either parent with adjustments made for student eligibility for free/reduced-price school meals, family public assistance receipt, and parent employment status.

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Table 3

Secular trends from 1999 to 2010 in adolescent snack patterns on school days and vacation/weekend days by sociodemographic characteristics: Minneapolis-St. Paul, Minnesota, Project EAT (Eating and Activity among Teens)

	1999 n[a]	2010 n	School days (mean snacks/day)			Vacation/weekend days (mean snacks/day)		
Characteristic			**1999[a]**	**2010**	***P* value[b]**	**1999[a]**	**2010**	***P* value[b]**
Total sample	2,598	2,540	4.3	3.8	<0.001	5.2	4.9	0.003
Sex								
Boys	1,181	1,175	4.1	3.7	<0.001	5.1	4.7	0.01
Girls	1,348	1,365	4.4	3.9	<0.001	5.3	5.1	0.09
School level[c]								
Middle school	1,148	1,136	4.3	3.5	<0.001	5.3	4.6	<0.001
High school	1,335	1,404	4.2	4.0	0.17	5.1	5.1	0.88
Ethnicity/race[d]								
White	540	499	4.0	3.7	0.04	4.8	4.8	0.68
Black	638	706	4.9	4.4	0.009	5.9	5.5	0.15
Hispanic	414	435	3.7	3.3	0.07	4.9	4.4	0.09
Asian	546	520	4.0	3.4	0.001	5.0	4.5	0.02
Native American	98	92	4.2	3.5	0.08	5.0	4.9	0.85
Mixed/other	293	288	4.8	4.3	0.17	6.0	5.2	0.07
Socioeconomic status[e]								
Low	936	973	4.2	3.9	0.09	5.4	5.0	0.05
Low-middle	560	556	4.4	4.0	0.04	5.4	5.1	0.19
Middle	436	430	4.5	3.8	<0.001	5.1	4.9	0.24
High-middle	335	320	4.0	3.6	0.06	4.8	4.7	0.61
High	199	193	4.1	3.4	0.007	4.8	4.5	0.20

[a] The 1999 sample was weighted to allow for an examination of secular trends in snack patterns independent of demographic shifts in the population. For example, estimates of snack consumption on school days within the low socioeconomic status group in 1999 and 2010 are mutually controlled so that sex, school level, and ethnicity/race makeup are the same in the low socioeconomic status group in the 1999 sample as in the 2010 sample.

[b] *P* values represent testing to examine weighted mean differences in the number of snacks consumed between 1999 and 2010.

[c] Middle school represents students enrolled in 6th–8th grades and high school represents students enrolled in 9th–12th grades.

[d]Adolescents could choose more than one ethnic/racial category; those responses indicating multiple categories were coded as mixed/other. Because there were few participants who identified themselves as Hawaiians or Pacific Islanders these participants were also included in the mixed/other category.

[e]The prime determinant of socioeconomic status was the higher education level of either parent with adjustments made for student eligibility for free/reduced-price school meals, family public assistance receipt, and parent employment status.

Table 4

Secular trends from 1999 to 2010 in adolescent snack patterns on school days and vacation days by reported meal patterns: Minneapolis-St. Paul, Minnesota, Project EAT (Eating and Activity among Teens)

	1999 n[a]	2010 n	School days (mean snacks/day)			Vacation/weekend days (mean snacks/day)		
			1999[a]	2010	*P* value[b]	1999[a]	2010	*P* value[b]
Total snacks among those who consumed each main meal on ≥5 days/week[c]	876	1,034	4.2	3.8	0.006	5.1	4.9	0.44
Morning snacks among those who consumed breakfast on ≥5 days/week and lunch on ≥5 days/week	945	1,131	1.1	1.0	0.07	1.5	1.5	0.37
Afternoon snacks among those who consumed lunch on ≥5 days/week and dinner on ≥5 days/week	1,666	1,743	1.9	1.6	<0.001	2.0	1.9	<0.001
Evening snacks among those who consumed dinner on ≥5 days/week	2,034	2,083	1.5	1.4	0.02	1.8	1.8	0.33

[a] The 1999 sample was weighted to allow for an examination of secular trends in snack patterns independent of demographic shifts in the population.

[b] *P* values represent testing to examine weighted differences in the number of snacks consumed between 1999 and 2010.

[c] Adolescents reported consuming breakfast on 5+ days/week, lunch on 5+ days/week, and dinner on 5+ days/week but did not necessarily have 5+ days/week where breakfast, lunch, and dinner were all eaten.

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Table 5

Secular trends from 1999 to 2010 in adolescent daily consumption of common snack foods and sugary drinks by sociodemographic characteristics: Minneapolis-St. Paul, Minnesota, Project EAT (Eating and Activity among Teens)

	1999 n[a]	2010 n	Snack foods			Sugary drinks		
Characteristic			**1999[a]**	**2010**	***P* value[b]**	**1999[a]**	**2010**	***P* value[b]**
Total sample	2,598	2,540	2.6	2.2	<0.001	1.2	0.8	<0.001
Sex								
Boys	1,181	1,175	2.6	2.1	<0.001	1.2	0.8	<0.001
Girls	1,348	1,365	2.7	2.2	<0.001	1.2	0.8	<0.001
School level[c]								
Middle school	1,148	1,136	2.9	2.2	<0.001	1.2	0.8	<0.001
High school	1,335	1,404	2.4	2.1	0.01	1.3	0.8	<0.001
Ethnicity/race[d]								
White	540	499	2.3	1.7	<0.001	1.2	0.7	<0.001
Black	638	706	3.6	2.9	<0.001	1.6	1.0	<0.001
Hispanic	414	435	2.4	1.8	0.002	1.3	0.7	<0.001
Asian	546	520	2.1	1.5	<0.001	0.8	0.5	<0.001
Native American	98	92	2.8	2.3	0.19	1.4	1.2	0.23
Mixed/other	293	288	2.5	2.8	0.41	1.3	0.9	<0.001
Socioeconomic status[e]								
Low	936	973	2.6	2.3	0.08	1.2	0.9	<0.001
Low-middle	560	556	2.7	2.2	<0.001	1.3	0.8	<0.001
Middle	436	430	2.8	2.0	<0.001	1.3	0.7	<0.001
High-middle	335	320	2.5	2.0	0.008	1.1	0.7	<0.001
High	199	193	2.5	1.8	0.001	1.0	0.5	<0.001

[a] The 1999 sample was weighted to allow for an examination of secular trends in snack patterns independent of demographic shifts in the population. For example, estimates of daily snack food and sugary drink consumption within the low socioeconomic status group in 1999 and 2010 are mutually controlled so that sex, school level, and ethnicity/race makeup are the same in the low socioeconomic status group in the 1999 sample as in the 2010 sample.

[b] *P* values represent testing to examine weighted mean differences in daily servings of common snack foods and sugary drinks consumed between 1999 and 2010.

[c] Middle school represents students enrolled in 6th–8th grades and high school represents students enrolled in 9th–12th grades.

[d] Adolescents could choose more than one ethnic/racial category; those responses indicating multiple categories were coded as mixed/other. Because there were few participants who identified themselves as Hawaiians or Pacific Islanders these participants were also included in the mixed/other category.

[e] The prime determinant of socioeconomic status was the higher education level of either parent with adjustments made for student eligibility for free/reduced-price school meals, family public assistance receipt, and parent employment status.