Increased portion sizes from energy-dense foods affect total energy intake at eating occasions in US children and adolescents: patterns and trends by age group and sociodemographic characteristics, 1977–2006[1–3]

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ABSTRACT

Background: Larger portion sizes of foods and beverages could affect overall energy intake at meals and promote overeating.

Objective: We investigated trends in portion sizes of energy-dense foods and energy intakes at eating occasions in US children and adolescents.

Design: Four US nationally representative surveys from 1977 to 2006 were analyzed (n = 31,337). We measured trends in portion sizes (kcal, g, and mL) of selected foods [sugar-sweetened beverages (SSBs), salty snacks, desserts, French fries, burgers, pizzas, and Mexican fast foods] and energy intake (kcal) at eating occasions during which selected foods were consumed. Trends were reported by age group (2–6-, 7–12-, and 13–18-y-olds), sex, and socioeconomic status.

Results: In 2003–2006, the selected foods accounted for 38% of daily energy intake in 13–18-y-olds, 35% of the daily energy intake in 7–12-y-olds, and 28% of the daily energy intake in 2–6-y-olds. In all age groups, larger portion sizes of pizza coincided with higher energy intakes at eating occasions during which pizzas were consumed. In 7–12- and 13–18-y-olds, higher energy intakes at meals coincided with larger portion sizes of SSBs, French fries, or salty snacks. In all age groups, nonsignificant larger portions of Mexican fast foods were related to higher energy intakes at meals. Adolescent boys consumed larger portion sizes of the selected foods and had higher energy intakes at meals for all periods than did girls ($P < 0.01$). The percentage of kilocalories from pizza within a meal increased more sharply in non-Hispanic African Americans, in Hispanics, and in the group with a low household education than in the other groups.

Conclusions: Adolescents are more susceptible to increased portion sizing than are younger children. The group of non-Hispanic African Americans and Hispanics and individuals with a lower education represents key concerns for public health policies. *Am J Clin Nutr* 2011;94:1324–32.

INTRODUCTION

The "supersizing of America" in the context of the obesity epidemic is currently one of the most studied eating behaviors in the United States. Larger portion sizes of energy-dense foods are pushing energy intakes beyond requirements and are becoming a cause of concern (1–7). Bigger package-unit sizes (8–10), good-value meals (11–14), and away-from-home eating (15–17) are examples of other related environmental factors that promote overeating. Together with frequent snacking (18, 19), constant eating (20), and increased fast-food consumption (21, 22), these patterns have been linked to increased energy intakes and represent potential risk of childhood obesity.

Portion sizes have been related to excess energy intakes, particularly in older children. Physiologic signals (hunger and satiety) in older children exert less influence than do environmental cues, such as large portion sizes, compared with in younger children (23–26). Although some research suggested that children of all age groups are predisposed to overeat (27), a well-controlled, short-term study of young children reported that energy intakes in 2-y-olds were less affected by increased portion sizes than were those in 5-y-olds, who increased their intakes when offered larger portions (28). Besides age differences, another short-term design showed that larger portions promoted excess energy intakes in low-income Hispanic and African American children of 5 y of age (29).

Portion sizes in relation to energy intakes have been previously studied, but most of the research focused on overall increases of specific foods (15, 25) and ignored the effect on energy intakes at a meal. The current study focused on children in general and key child subpopulations in particular and built on earlier research (30). In terms of energy regulation and energy balance, our assumption was that a larger portion size of a certain food might be important if the energy intake at that meal increased as well. With the use of US representative surveys of dietary intakes, we explore important socioeconomic- and age-specific patterns and trends in food portion sizes (kcal and g) and energy intakes (kcal) at eating occasions in 3 age groups of children and adolescents (ie, 2–6-, 7–12-, and 13–18-y-olds) from 1977–1978 to 2003–

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2006. We analyzed the same trends by dividing each age group into sex, race, and education subpopulations.

SUBJECTS AND METHODS

Subjects, study design, and dietary data

We studied 3 age groups of children and adolescents (ie, 2–6- , 7–12-, and 13–18-y-olds) from the following 4 USDA cross-sectional surveys (n = 31,337) that were nationally representative of the US population: the USDA NFCS[4] in 1977–1978 (n = 12,231) (31), the USDA CSFII in 1989–1991 (n = 3148) (32), the USDA CSFII in 1994–1996 and 1998 (n = 8621) (33), and from 2 combined periods of NHANES from 2003–2004 and 2005–2006 (n = 7337) (34, 35). All of these surveys were based on a multistage probability sample of noninstitutionalized US households. Sampling designs, survey instruments, dietary collection methodology, and food-composition tables for the NHANES were designed to match earlier procedures of the NFCS and CSFII (36). Detailed information about each survey was published elsewhere (31–35).

The following dietary data for 3 consecutive days was included in the NFCS 1977–1978 and CSFII 1989–1991: a single interviewer-administered 24-h recall and 2 d of self-administered food records. Dietary intakes during 2 nonconsecutive days were included in the CSFII 1994–1998 and the NHANES 2003–2006, which used interviewer-administered 24-h recalls (3–10 d apart). The 5-step, computerized, multiple-pass method was used in NHANES 2003–2006. For children <12 y of age, dietary information was obtained from their caregivers. To maintain consistency across surveys, the first 2 d of dietary intakes from each survey have been included as follows: one 24-h recall and one food record from the NFCS 1977–1978 and CSFII 1989–1991 and two 24-h recalls from the CSFII 1994–1998 and NHANES 2003–2006. Dietary data from these surveys was averaged to get per-day estimates.

Portion sizes of selected foods and energy intakes at eating occasions

Eating occasions or meals were self-defined as breakfast or brunch, lunch, dinner or supper, and snack. Because people usually consume several foods during an eating occasion, we combined items consumed within a 15-min period as a single eating occasion. Self-defined snack items consumed within a meal were considered as part of that meal (eg, chips within a lunch).

The USDA surveys and the NHANES used food models to assist respondents in the identification of the portion size. Consistent with previous studies (15, 30), we defined a portion size as the amount of kilocalories and the amount of grams or milliliters from a certain food or beverage consumed at a given eating occasion. To study trends over time for portion sizes and eating occasions, the sample unit used was the eating occasion that included the selected food or beverage. When a subject consumed the same food ≥2 times during the 2-d period, those eating occasions were considered independent unless they occurred within a 15-min period. However, almost all results were based on one or 2 eating events per child. The number of eating occasions on either day 1 or 2 or both was used to calculate portion sizes of selected foods at eating occasions during which those foods were consumed. We reported the mean portion size (kcal, g, and mL) for each selected food and the mean energy intake of an eating occasion during which each selected foods was consumed. For example, we calculated the mean portion size for all pizza events and then the mean energy intake of all eating events during which pizza was consumed.

Selected foods and food grouping system

Portion sizes were determined for the following selected foods: salty snacks, desserts, soft drinks, fruit drinks, French fries, burgers, pizzas, and Mexican fast foods. Salty snacks included crackers, chips, pretzels, rice cakes, and popcorn. Desserts include ice creams, pies, cakes, and cookies. SSBs, such as soft drinks and fruit drinks, include caloric sweetened beverages and did not include diet drinks or 100% fruit juice. Burgers included hamburgers and cheeseburgers and consisted of items offered in typical menus at fast-food chains. Mexican fast foods included burritos, enchiladas, tacos, and similar items. These items have been identified in previous research as the foods with the greatest increase in kilocalories and portion sizes in Americans between 1977 and 1996 (37, 38). The food-group system developed at the University of North Carolina at Chapel Hill was used to link foods from each survey over time and to ensure comparable food compositions, Latin binomial names, and nutrient compositions. The food grouping of the University of North Carolina at Chapel Hill has been previously described (39).

Statistical analysis

Data were reported as means ± SEs. STATA 11 software (Stata Corp) (40) was used to perform all analyses together with survey commands to account for survey design and weighting. We studied the following 3 age groups: young children 2–6 y of age, middle-aged children 7–12 y of age, and adolescents 13–18 y of age. For each age group and year surveyed, we first calculated the mean total daily energy intake and the proportion of calories that came from the selected foods. We calculated portion sizes of selected foods (kcal, g, and mL) and the total energy intake (kcal) at meals during which those foods were consumed. To investigate whether larger portion sizes of the selected foods were related to greater energy intake at meals, we examined whether the percentage of kilocalories of the eating occasion that came from each selected food also increased. For snacking occasions, we studied portion sizes (kcal) of selected foods, such as salty snacks, desserts, and SSBs, and energy intakes at snacking occasions during which these snacks were consumed. Trends in portion sizes (kcal) of foods and energy intakes from eating occasions were analyzed by sex and socioeconomic variables, such as self-reported race (ie, NHW, NHAA, or Hispanic) and the household's level of education (<12 y of education was considered LE). To estimate trends over time, the mean energy intake from foods or eating occasions was calculated for each survey period. Surveys were compared with one another, and significant differences across surveys were tested by using the F test in STATA 11 software

[4]Abbreviations used: CSFII, Continuing Survey of Food Intake by Individuals; HE, high education; LE, low education; NFCS, Nationwide Food Consumption Survey; NHAA, non-Hispanic African American; NHW, non-Hispanic white; SES, socioeconomic status; SSB, sugar-sweetened beverage.

(Stata Corp) (40). A 2-sided Bonferroni-adjusted $P < 0.01$ was set for statistical significance.

RESULTS

Trends in energy intake and consumption of selected foods

The total daily energy intake increased for all age groups studied, although young children (2–6 y old) had the greatest increase from 1977 to 2006 (+232 kcal) (**Table 1**). The percentage of daily energy intake that came from the selected foods also increased in all children. In adolescents, this percentage increased from 23% to 38% from 1977–1978 to 2003–2006.

Portion sizes of foods and energy intakes at eating occasions: differences by age

Larger portion sizes of pizza (kcal and g) coincided with increased energy intakes at eating occasions in all age groups (**Table 2**; *see* supplemental Tables 1 and 2 under "Supplemental data" in the online issue). The percentage of kilocalories from pizza at an eating occasion increased ~5% in 2–6-y-olds, 8% in 7–12-y-olds, and 12% in 13–18-y-olds. In 2003–2006, a portion of pizza and an eating occasion during which pizza was consumed accounted for ≤376 and ≤559 kcal, respectively, in 2–6-y-olds, ≤492l and ≤752 kcal, respectively, in 7–12-y-olds, and ≤699 and ≤958 kcal, respectively, in 13–18-y-olds.

TABLE 1
Sample characteristics[1]

	NFCS 1977–1978	CSFII 1989–1991	CSFII 1994–1998	NHANES 2003–2006
Young children (2–6 y old)				
No. of participants	3154	1053	6017	1997
No. of eating occasions				
Day 1	12,528	5490	32,107	12,012
Day 2	12,200	4477	29,350	10,083
Socioeconomic characteristics				
Males (%)	51	51	51	51
NHW (%)	78	72	63	59
NHAA (%)	16	14	16	13
Hispanic (%)	5	10	16	20
Household education less than high school diploma (%)	69	55	42	46
Total kcal/d	1432 ± 12[2]	1433 ± 14	1595 ± 10	1664 ± 13
Energy from all selected foods (% of kcal)	19	23	27	28
Middle-aged children (7–12 y old)				
No. of participants	4309	1147	1519	2119
No. of eating occasions				
Day 1	16,292	5380	7216	10,959
Day 2	15,722	4503	6440	9358
Socioeconomic characteristics				
Males (%)	49	52	52	52
NHW (%)	79	71	66	59
NHAA (%)	15	16	16	15
Hispanic (%)	4	12	14	17
Household education less than high school diploma (%)	73	52	38	46
Total kcal/d	1879 ± 14	1826 ± 27	1955 ± 20	2051 ± 21
Energy from all selected foods (% of kcal)	21	27	32	35
Adolescents (13–18 y old)				
No. of participants	4768	948	1085	3221
No. of eating occasions				
Day 1	17,184	4216	4618	15,103
Day 2	16,755	3478	4131	12,619
Socioeconomic characteristics				
Males (%)	50	48	51	50
NHW (%)	79	75	68	66
NHAA (%)	16	15	15	15
Hispanic (%)	4	8	12	15
Household education less than high school diploma (%)	75	84	76	44
Total kcal/d	2072 ± 21	2029 ± 69	2278 ± 39	2259 ± 27
Energy from all selected foods (% of kcal)	23	32	36	38

[1] The analysis sample included respondents, 2–18 y old, from the following 4 US nationally representative surveys: the NFCS 1977–1978 (n = 12,231), CSFII 1989–1991 (n = 3148), CSFII 1994–1998 (n = 8621), and NHANES 2003–2006 (n = 7337). CSFII, Continuing Survey of Food Intake by Individuals; NFCS, Nationwide Food Consumption Survey; NHAA, non-Hispanic African American; NHW, non-Hispanic white.

[2] Mean ± SE (all such values).

TABLE 2
Changes in portion sizes (kcal) of selected foods and in eating occasion intakes in US children and adolescents, 1977–2006[1]

	Salty snacks	Desserts	Soft drinks	Fruit drinks	French fries	Burgers	Pizzas	Mexican fast foods
Young children (2–6 y old)								
Portion size of selected food (kcal)								
Change from 1977–1978 to 2003–2006	+24[2]	−4	+4	+14[2]	+23[2]	+48	+98[2]	+104[2]
Energy content of eating occasions during which selected foods were consumed (kcal)								
Change from 1977–1978 to 2003–2006	+32	−13	+77[2]	+29	−6	+102	+112[2]	+80
Percentage of total energy intake of eating occasions from selected food								
In 1977–1978	20	29	18	19	23	52	62	52
In 2003–2006	23	29	17	21	28	51	67	63
Middle-aged children (7–12 y old)								
Portion size of selected food (kcal)								
Change from 1977–1978 to 2003–2006	+51[2]	+28[2]	+23[2]	+18[2]	+21[2]	+69[2]	+124[2]	+78
Energy content of eating occasions during which selected foods were consumed (kcal)								
Change from 1977–1978 to 2003–2006	+44	−44[2]	+100[2]	+13	−7	+132[2]	+109[2]	+29
Percentage of total energy intake of eating occasions from selected food								
In 1977–1978	18	27	17	18	22	50	57	55
In 2003–2006	24	33	18	20	25	50	65	63
Adolescents (13–18 y old)								
Portion size of selected food (kcal)								
Change from 1977–1978 to 2003–2006	+60[2]	+16	+50[2]	+48[2]	+62[2]	+151[2]	+220[2]	+205[2]
Energy content of eating occasions during which selected foods were consumed (kcal)								
Change from 1977–1978 to 2003–2006	+55[2]	−72[2]	+157[2]	+74[2]	+72[2]	+283[2]	+177[2]	+130
Percentage of total energy intake of eating occasions from selected food								
In 1977–1978	19	29	19	17	23	53	61	50
In 2003–2006	25	34	21	21	27	53	73	65

[1] Analysis sample included respondents, 2–18 y old, from the following US nationally representative surveys: the Nationwide Food Consumption Survey 1977–1978 and NHANES 2003–2006. The percentage of kilocalories was calculated as follows: (kcal from selected foods) ÷ (kcal of eating occasions during which selected foods were consumed) × 100.

[2] Energy intake (kcal) from selected foods or eating occasions was significantly different from 1977 to 1978 by using an F test with $P < 0.01$ (Bonferroni adjusted).

Over the period studied, larger portion sizes (kcal, g, and mL) of other foods, such as soft drinks and salty snacks, were associated with significantly higher energy intake at meals in children aged 7–12 y old. Adolescent energy intake at eating occasions was related to larger portion sizes (kcal, g, and mL) of all of the selected foods (except desserts) and increased the percentage of kilocalories from selected foods that accounted for the total energy intake of an eating occasion: pizzas (+12%), soft drinks (+2%), French fries (+4%), fruit drinks (+4%), and salty snacks (+6%). These results indicated that larger portions of these items contributed to increase the total energy intake at meals for adolescents. Portion sizes of French fries in terms of grams did not increase for any of the age groups studied from 1977–1978 to 2003–2006, which indicated that the energy density of French fries increased over that time period (*see* supplemental Table 2 under "Supplemental data" in the online issue).

Portion sizes of burgers increased in terms of kilocalories, as did the total energy intake at eating occasions in all age groups from 1977–1978 to 2003–2006 (Table 2). In terms of grams, portion sizes of burgers increased for all age groups but increased significantly only in adolescents over this period (*see* supplemental Table 2 under "Supplemental data" in the online issue). The percentage of kilocalories from burgers that accounted for the total energy intake at meals remained stable. Larger portion sizes of burgers and eating occasions during which burgers were consumed were shown in all age groups in the last period (322 and 627 kcal, respectively, in 2–6-y-olds, 422 and 841 kcal, respectively, in 7–12-y-olds, and 547 and 1029 kcal, respectively, in 13–18-y-olds (*see* supplemental Table 1 under "Supplemental data" in the online issue).

Although the energy intake from eating occasions during which salty snacks and Mexican fast food were consumed increased nonsignificantly in young and middle-aged children from 1977–1978 to 2003–206, the percentage of kilocalories from those foods that accounted for the total energy intake of an eating occasion increased markedly in both age groups. In terms of grams, portion sizes of salty snacks increased significantly in all age groups. Portion sizes (kcal and g) of Mexican fast-foods in adolescents increased significantly (+205 kcal/portion in 2003–2006), although the energy content of eating occasions with Mexican fast foods increased nonsignificantly over the same period.

Portion sizes of foods and energy intakes at eating occasions: differences by sex

Significant differences in energy intakes and portion sizes of foods between boys and girls were shown only for adolescents in

2003–2006 (**Figure 1**). For both sexes, portion sizes of pizza, burgers, and SSBs and energy intakes at eating occasions increased significantly. Portion sizes of French fries and intakes at meals increased significantly only in boys.

Compared with adolescent girls, adolescent boys showed significantly greater portion sizes of the selected foods and greater energy intakes of eating occasions during which those foods were consumed ($P < 0.01$). Pizzas increased the percentage of kilocalories 13% in boys compared with 9% in girls, French fries increased the percentage of kilocalories 5% in boys compared with 4% in girls, and SSBs increased the percentage of kilocalories 4% in boys compared with 3% in girls. The total energy intake at meals coincided with larger portion sizes of pizzas and soft drinks in both sexes, whereas larger portions of French fries coincided with increased energy intakes at meals in boys only. However, compared with adolescent girls, boys appeared to increase their meal energy intakes to a greater extent by the consumption of these food items, particularly of pizzas.

Sociodemographic differences in portion sizes of selected foods and eating occasions

Among all of the foods studied, significantly different trends in SES groups by age were shown only for pizza and eating occasions during which pizza was consumed.

NHWs compared with NHAAs or Hispanics

Portion sizes of pizzas and energy intakes at eating occasions during which pizzas were consumed were not significantly different in NHWs than in NHAAs or Hispanics in 2003–2006 (**Figure 2**). From 1977–1978 to 2003–2006, the portion size of pizzas increased in all children of all ethnicities. In all age groups, the percentage of kilocalories from pizzas in an eating occasion increased more sharply in NHAAs or Hispanics than in NHWs.

Low (less than high school) compared with high (at least high school) household education

Portion sizes of pizza and energy intakes at eating occasions with pizza were not significantly different between LE and HE groups in 2003–2006 (**Figure 3**). Over the period studied, portion sizes of pizza and eating occasions with pizza increased significantly only in the low-education (LE) group in young children and adolescents. For middle-aged children, portion sizes of pizza and eating occasions with pizza increased significantly only in the high-education (HE) group.

In the comparison of LE and HE groups in the 3 age groups studied, the percentage of kilocalories from pizzas that accounted for the total kilocalories of the eating event increased more rapidly in the LE group from 1977–1978 to 2003–2006 except in adolescents.

Trends in portion sizes of snacks and snacking occasions

Salty snacks and snacking events during which salty snacks were consumed increased significantly only in 2–6-y-olds during the time period studied, whereas the percentage of kilocalories of the snacking occasion that came from salty snacks increased from 52% to 59%. Desserts remained stable in all age groups, whereas SSBs increased significantly in 2–6-s and 7–12-y-olds without any increase in the percentage of kilocalories from SSBs that accounted for the total energy intake of the snacking event (C Piernas and BM Popkin, unpublished data, November 2010).

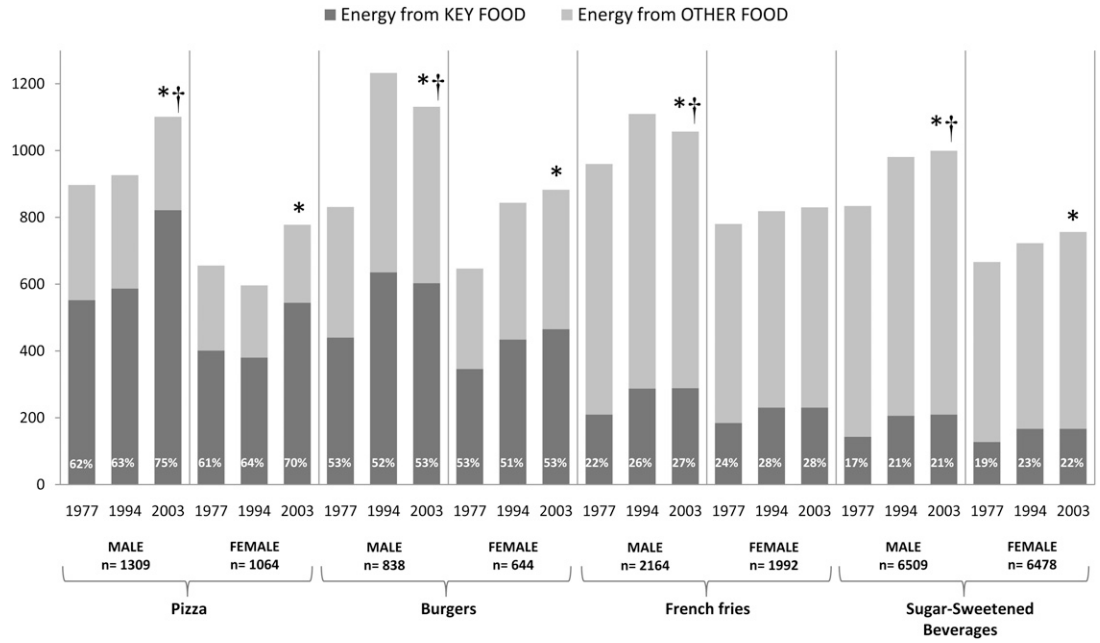

FIGURE 1. Trends in food portion sizes and eating occasion intakes for pizzas, burgers, French fries, and soft drinks by sex in US adolescents 13–18 y of age (1977–2006). The analysis sample included male and female respondents, 13–18 y old, from the following US nationally representative surveys: the Nationwide Food Consumption Survey 1977–1978, Continuing Survey of Food Intake by Individuals 1994–1998, and NHANES 2003–2006. The percentage of kilocalories was calculated as follows: (kcal from selected foods) ÷ (kcal of eating occasions during which selected foods were consumed) × 100. The sugar-sweetened beverage group included soft drinks and fruit drinks. *Portion size of food and intakes at eating occasion were significantly different from 1977 to 1978, $P < 0.01$ (F test, Bonferroni adjusted); †portion size of food and intakes at eating occasion in 2003–2006 were significantly different between boys and girls, $P < 0.01$ (F test, Bonferroni adjusted).

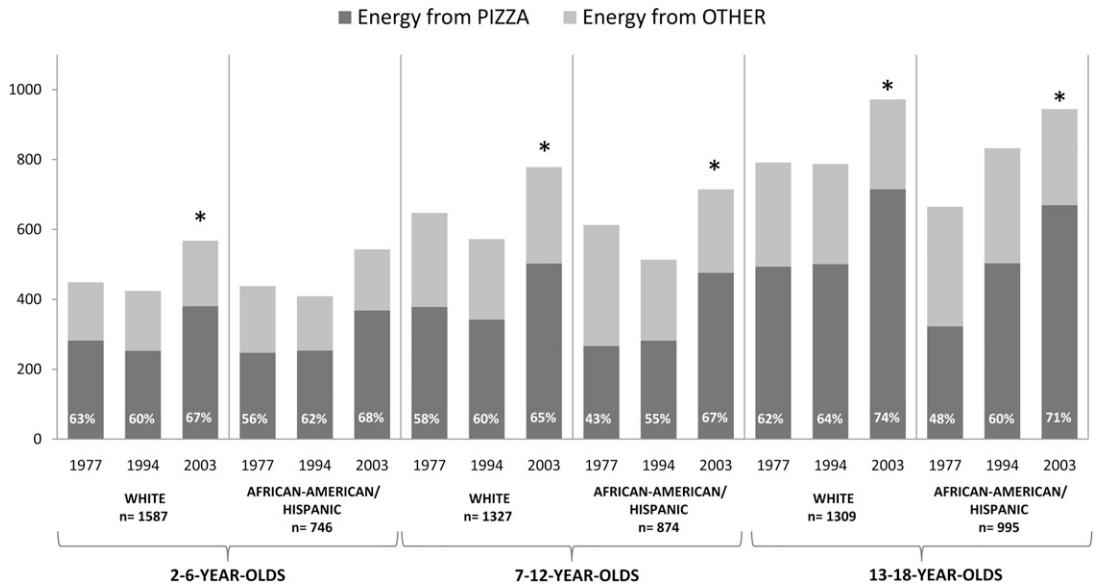

FIGURE 2. Trends in portion sizes of pizzas and intakes at eating occasion during which pizzas were consumed by race-ethnicity and age group in US children and adolescents 2–18 y of age (1977–2006). The analysis sample included respondents, 2–18 y old, from the following US nationally representative surveys: the Nationwide Food Consumption Survey 1977–1978, Continuing Survey of Food Intake by Individuals 1994–1998, and NHANES 2003–2006. The percentage of kilocalories was calculated as follows: (kcal from selected foods) ÷ (kcal of eating occasions during which selected foods were consumed) × 100. *Portion size of pizza and intakes at eating occasion were significantly different from 1977 to 1978, $P < 0.01$ (F test, Bonferroni adjusted).

DISCUSSION

With the use of nationally representative data on children and adolescents in the United States, we provided, to our knowledge, new trends in portion sizes (kcal, g, and mL) of selected foods and energy intakes at eating occasions during which those foods were consumed from 1977–1978 to 2003–2006. We showed that energy-dense, nutrient-poor foods, such as pizzas, French fries, and SSBs, became increasingly popular in children and adolescents of all age groups and represented an important percentage of their total daily energy intake in 2003–2006. In particular, larger portion sizes of pizzas coincide with higher energy intakes at eating occasions in all age groups. In older children, other foods

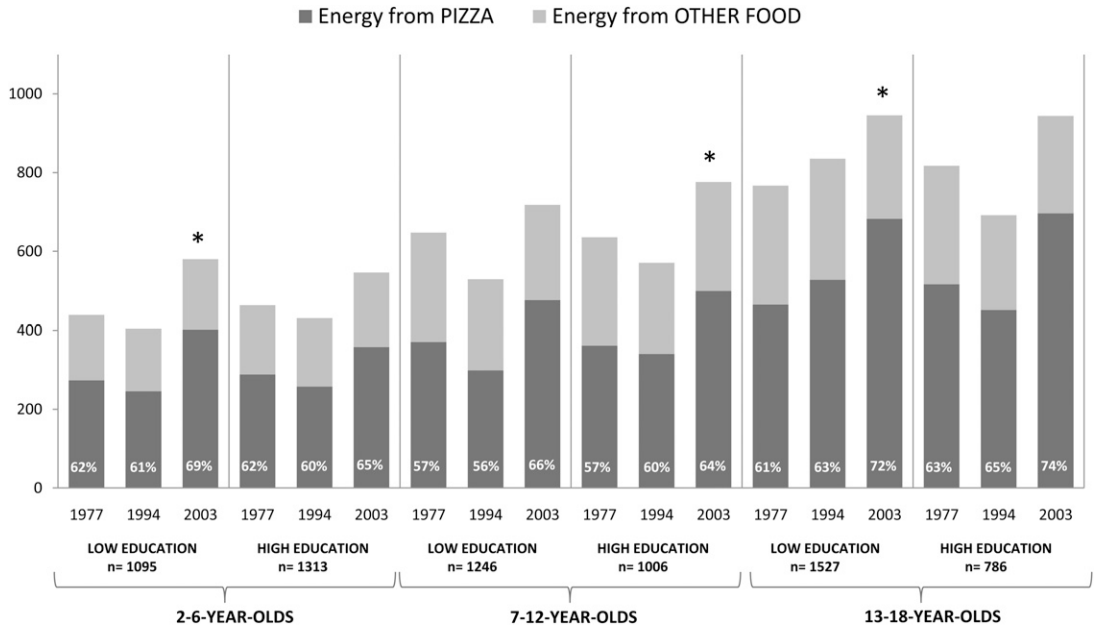

FIGURE 3. Trends in portion sizes of pizzas and intakes at eating occasion during which pizzas were consumed by household education and age group in US children and adolescents 2–18 y of age (1977–2006). The analysis sample included respondents, 2–18 y old, from the following US nationally representative surveys: the Nationwide Food Consumption Survey 1977–1978, Continuing Survey of Food Intake by Individuals 1994–1998, and NHANES 2003–2006. The percentage of kilocalories was calculated as follows: (kcal from selected foods) ÷ (kcal of eating occasions during which selected foods were consumed) × 100. *Portion size of pizza and intakes at eating occasion were significantly different from 1977 to 1978, $P < 0.01$ (F test, Bonferroni adjusted).

were also important contributors to excess energy intakes at an eating event. Energy intakes at meals in middle-aged children (7–12 y old) and, in particular, in adolescents (13–18 y old) increased in parallel with energy intakes from SSBs, French fries, and salty snacks, among other foods. Larger portion sizes of Mexican fast foods were associated with increased energy intakes at meals in all age groups, although these increases were not significant. Portion sizes of burgers did not coincide with increased energy intakes at eating occasions, which suggested that other foods typically consumed in the same fast food meal (eg, French fries or SSBs) could increase the energy intake at that eating occasion more dramatically. Although the exact age at which children become susceptible to environmental exposures, such as larger portions of foods, remains unclear, our findings supported previous findings that suggested that young children might be better able to self-regulate their energy intakes than are older children (23, 28).

Sex differences were significant only in adolescents. Energy intakes at a meal were related to larger portion sizes of pizzas, burgers, and SSBs in boys and girls and of French fries in boys only. As in previous studies (10, 41, 42), boys had greater energy intakes and larger portion sizes than did girls.

Trends studied for the different SES groups showed that the percentage of kilocalories from pizzas that accounted for the total energy intake at a meal increased more sharply in NHAAs or Hispanics and in the LE group than in NHWs and the HE group over the 30-y period in children and adolescents. Another within-subject crossover study that compared standard and large portion sizes in low-income Hispanic and African American children and mothers reported that large portion sizes contributed to increased energy intakes for children and mothers over a 24-h period. In agreement with that study, our results suggested that these SES groups in 1977–1978 had smaller portion sizes of pizzas and lower energy intakes but were catching up with the other groups very rapidly and might become high-risk groups in the next decade.

The effect of portion sizes on energy intakes (3, 10, 8, 41, 43–46) has been studied in laboratory conditions (10, 42, 43, 47, 48) and more naturalistic conditions (5) in children and adults (10, 25, 29, 49). Other related research has focused on trends in portion sizes and caloric intakes from selected foods for earlier time periods (1977–1998). These studies reported actual food consumption in all Americans >2 y old and in several age groups of children and adults (15, 16). Our approach extended this work by examining the effect of the portion size of a food on the total meal size to account for the total nutritional consequences of larger portion sizes. In contrast, the physiologic and biological processes of hunger, satiety, and self-regulation are important mediators of the total daily energy intake and the eating occasion intake and must be taken into account (44, 50–52). We identified larger portion sizes of selected foods and increased energy intakes at meals during which these foods were consumed, especially in adolescents (13–18 y old). An increased energy intake at an eating occasion has been linked with an increased total daily energy intake (13, 42, 46), and in this context, larger portion sizes may predispose people to overeat and increase their risk of overweight or obesity (6, 53).

There are limitations to this research. For Mexican fast foods, we showed increases in portion sizes and meal sizes in all age groups in 1977–1978; however, small sample sizes limited the power of these results. This lack of a difference because of underpower could also be present in the sex and SES trend analyses. Other foods, such as burgers purchased from fast-food places, were directly self-reported as complete recipes by respondents, whereas burgers consumed at home or at restaurants were reported as separate components (eg, bread, meat, and vegetables). Our analysis was limited mainly to burgers purchased at fast-food places. Burgers reported as separate components were not included in this analysis because it was not clear how many individual portions were consumed at a single eating event. In other research, we showed that portion sizes at fast-food establishments have increased more than portion sizes at restaurants or prepared at home (15). We also know that about one-half of the food currently purchased at fast-food establishments is eaten at home (17).

Potentially important methodologic changes occurred from the 1970s to the 1980s (36, 54), and the multiple pass method was implemented in the NHANES and USDA surveys in the 1990s with the goal of improving recall and decreasing respondent bias. We still do not know the consequences that these changes might have on the total energy intake and selected foods in the current study, although decreased underreporting in the last period could potentially explain some of our results (55). Other limitations inherent to the use of 1 or 2 d of self-reported 24-h intakes most likely affected our results through underreporting (56). People also tend to underreport the consumption of unhealthy foods, particularly when those foods relate to obesity (57). Moreover, the accuracy of the estimation of large portions decreases not only systematically (58) but also when food models are used to assist people (59).

In the context of the growing obesity in the United States, larger portion sizes of selected energy-dense, nutrient-poor foods have increased in parallel with energy intakes at meals, especially in adolescents and middle-aged children. To our knowledge, our study provided new insights about the behavioral and nutritional changes that have occurred over the past 3 decades in the United States, which may have contributed to increased daily energy intakes during a period of reduced activity (60) and increased risk of childhood obesity. Larger portions of pizzas were identified as the main contributor to an increased energy intake at an eating occasion in all age groups. Other foods, such as Mexican fast foods, soft drinks, and French fries, are also important contributors of the excess energy intake as children get older. This study allowed the selective targeting of those foods that were identified as potential contributors of increased energy intakes at critical stages of childhood and adolescence or in key SES and sex groups. We believe that portion sizing needs to be placed in the context of the eating occasion, and when this is done, larger portions of some popular foods could potentially promote overeating.

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