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Trends in dietary intake among US 2-6 year old children, 1989 2008

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Abstract

Background—Between 1989 and 2008, obesity increased markedly in children of all ages. We examine changes in the diets of children ages 2-6 in the US between 1989 and 2008. Our study provides new insight into diet changes that may have contributed to the sharp rise in obesity during this period.

Objectives—Describe changes in diet among 2-6 year olds from 1989 to 2008 related to sharp rises in obesity during this period.

Methods—This analysis included 10,647 children ages 2-6 from five nationally representative surveys of dietary intake in the U.S.: Continuing Survey of Food Intake in Individuals (CSFII) 1989-1991; CSFII 1994-1998; and the What We Eat In America, National Health and Nutrition Examination Surveys (WWEIA, NHANES) 2003-2004, 2005-2006 and 2007-2008. Diet data were categorized into groupings using the UNC-CH approach. Analyses were carried out using a single 24-h dietary recall with appropriate survey weighting. T-tests were used to compare means across survey years with $P < .05$ considered significant.

Results—Over the 20-year period, there were increases in per capita intake of savory snacks (+51 kcal, $P < .01$), pizza/calzones (+32 kcal, $P < .01$), sweet snacks and candy (+25 kcal, $P < .01$), mixed Mexican dishes (+22 kcal, $P < .01$) and fruit juice (+18 kcal, $P < .01$), whereas total daily energy intake increased by 109 kcal (from 1475 to 1584) ($P < .05$). Fruit intake increased marginally (+24 kcal, $P < .01$). Six of the 10 greatest absolute changes in per capita intake between sequential survey years occurred between CSFII 1994-1998 and NHANES 2003-2004 ($P < .05$).

Conclusions—Foods high in added sugars and solid fats such as savory snacks, pizza/calzones, mixed Mexican dishes, sweet snacks and candy, and fruit juice, predominated the top changes in per capita consumption between 1989 and 2008.

Keywords

energy intake; eating location; food source; food away-from-home

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Introduction

The prevalence of obesity in 2-5 year olds more than doubled between 1976-1980 and 2009-2010 (from 5% to 12.1%)(1-3), prompting increased attention on the early prevention of childhood obesity. While a host of individual and environmental factors influence early childhood obesity, diet and physical activity play a fundamental role (4-7). A large body of literature has shown that food preferences and dietary behaviors are established during early childhood (8-15), thereby making the diets of 2-6 year old children a key focus for obesity prevention researchers.

During the previous decade, a handful of nationally representative studies have examined the dietary intakes of young children in the U.S. (16-23). The Feeding Infants and Toddlers Study (FITS), a nationally representative dietary survey of children four to 23.9 months of age has been critical in highlighting several key dietary behaviors in young children that contribute to obesity, particularly related to excessive intake of saturated fats, sodium, and high-calorie, low-nutrient foods such as sweets, sweetened beverages, and french fries (17, 20, 21). Other work has highlighted excessive empty calorie intake among preschoolers (23).

Few studies have examined how the diets of young children have changed over time (24-26). Others have reported significant increases in caloric intake among 2-6 year old children, which was attributed to increases in snacking, particularly low-nutrient, high-calorie foods like sweetened beverages and desserts. Poti and Popkin (2011), who examined trends in energy intake in US children by location and source, noted a significant increase in daily caloric intake among 2-6 year old children (+160 kcal) between 1977-1978 and 2003-2006(25). These findings provide evidence of a decrease in diet quality among 2-6 year olds since the 1980's.

Still, greater detail is needed to elucidate other dietary changes in 2-6 year old children that may have contributed to the surge in obesity over the past 20 years. Accordingly, this study investigates dietary changes in 2-6 year old children between 1989 and 2008 utilizing five nationally representative US dietary surveys. To examine dietary changes that may have contributed to the sharp rise in obesity among young children, the current analysis aims to: 1) identify major changes in per capita consumption between 1989 and 2008 by food group; 2) examine how consumption patterns for these foods have changed over time; and 3) identify the top absolute changes in per capita consumption between sequential survey intervals.

Methods

Datasets and sample sizes

This analysis included 10,647 children ages 2-6 years from five nationally representative surveys of dietary intake in the United States. The Continuing Survey of Food Intake by Individuals (CSFII) was conducted by the USDA from 1989 to 1991 (n=1,370 children ages 2-6) and from 1994 to 1998 (n=6,285 children ages 2-6) (27). CSFII sampling was based on US Census tracks, and participants were enrolled at the household level. What We Eat in America (WWEIA) is the dietary intake interview component of the National Health and Nutrition Examination Survey (NHANES). WWEIA, NHANES is conducted as a partnership between the U.S. Department of Health and Human Services (DHHS) and the U.S. Department of Agriculture (USDA). This study used data for 907 children ages 2-6 from WWEIA, NHANES 2003-2004, 1,085 children ages 2-6 from WWEIA, NHANES 2005-2006, and 1,000 children ages 2-6 from WWEIA, NHANES 2007- 2008. The sampling design was based on US Census data, and participants were enrolled at the

household level (28). Further details on the sampling strategy for each survey have been reported previously³⁶⁻³⁸.

Dietary collection methods

For CSFII surveys, each subject completed an in-person interview using a 24-hour dietary recall survey, in which all foods consumed over the previous 24 hours were reported. Dietary recall surveys were completed by the primary caregiver for children under the age of 12. For WWEIA, NHANES surveys, participants completed two interviewer-administered 24-hour dietary recall surveys on nonconsecutive days: day one interviews were conducted in-person at the Mobile Exam Center; day two interviews were administered via telephone. The 5-step, computerized, multiple-pass method was implemented in WWEIA, NHANES from 2003 onwards. Primary caregivers completed proxy surveys for children younger than 12 years of age (32-34). To ensure comparability across surveys, all data analyses were carried out using a single 24-hour dietary recall for participants between the ages of two and six years with reliable dietary data.

Food grouping system

Dietary data from each of the five surveys were categorized into groupings that allow for meaningful characterization of changes in dietary behaviors over time, using the UNC-CH approach (35). Appendix Table 1 provides a brief description of the food groups used for this analysis.

For CSFII 1989-91 and 1994-98, data was used from the Survey Nutrient Database which was maintained for use with nationwide food surveys (36). The Survey Nutrient Database is based on nutrient values in the Primary Data Set of nutrient values maintained in the Agricultural Research Service (ARS) Nutrient Data Laboratory. For WWEIA, NHANES 2003-2004, 2005-2006 and 2007-2008, data was used from the USDA's Food and Nutrient Database for Dietary Studies (FNDDS) which is used to code, process and analyze WWEIA⁴³⁻⁴⁵. The FNDDS is based on nutrient values in the USDA National Nutrient Database for Standard Reference. Of note, the nutrient databases from which nutrient values were derived were each developed by the USDA with nutrient values corresponding to the diets of individuals at the time of data processing.

Statistical Analysis

Data were analyzed using STATA (version 12, 2011, StataCorp, College Station, TX). Appropriate weighting factors were applied to adjust for differential probabilities of selection and various sources of nonresponse. Mean intakes of total energy obtained from each food and beverage grouping were estimated for each survey year. Food groups in the WWEIA, NHANES 2007-2008 data set were sorted in descending order of kilocalories consumed per capita and compared to corresponding food groups in the CSFII 1989-1991 data set. Differences in per capita consumption between survey years were computed to identify the top 10 foods with the greatest absolute changes in per capita consumption between 1989 and 2008. Using this subset of food groups, changes in per capita consumption, percent consuming, and consumption among reported consumers, as well as differences between sequential survey years were examined using student's t-tests. P values <0.05 were considered statistically significant. Finally, among the subset of foods with significant changes in per capita consumption between 1989 and 2008, we sorted by absolute changes in per capita between sequential survey years to identify the intervals in which the top 10 absolute changes in per capita consumption occurred.

Results

Sociodemographic characteristics and total daily energy intake are reported in Table 1. For preschoolers ages 2 -6, total daily energy intake increased by 109 kcal between 1989 and 2008 ($P<.05$). There were minor differences in the distributions of race-ethnicity and income over the surveys, the greatest of which was a nearly eight percent decrease in the proportion of non-Hispanic Whites between 1989-1991 and 1994-1998. The proportion of poor increased between 1989-1991 and 2003-2004, but declined again in 2005-2006. The proportion of non-Hispanic Whites decreased marginally between 1989-1991 and 1994-1998, and the proportion of Mexican Americans increased between 1994-1998 and 2003-2004.

Top 10 20-year changes in per capita consumption between 1989-1991 and 2007-2008

Figure 1 shows the top 10 changes in per capita consumption from 1989-1991 to 2007-2008. Per capita consumption increased for savory snacks (+51 kcal, $P<.01$), pizza/calzones (+32 kcal, $P<.01$), sweet snacks and candy (+25 kcal, $P<.01$), fruit (+24 kcal, $P<.01$), mixed Mexican dishes (+22 kcal, $P<.01$), cheese (+21 kcal, $P<.01$), and fruit juice (+18 kcal, $P<.01$). Per capita consumption decreased for RTE cereals (-25 kcal, $P<.01$), starchy vegetable dishes (-22 kcal, $P<.01$), and nuts and seeds (-19 kcal, $P<.01$) between 1989-1999 and 2007-2008.

For these foods, the percent of reported consumers increased significantly for savory snacks, pizza/calzones, sweet snacks and candy, fruit, mixed Mexican dishes, cheese and fruit juice (**Table 2**). Conversely, the percent of reported consumers decreased significantly for RTE cereals and starchy vegetable dishes between 1989-1991 and 2007-2008. Among reported consumers, caloric intake from RTE cereals, starchy vegetable dishes, and nuts and seeds decreased significantly during the same period, while large increases in calories among reported consumers were found for pizza/calzones (+35 kcal) and mixed Mexican dishes (+43 kcal).

Table 3 shows trends in per capita consumption of foods with the greatest absolute changes in per capita consumption among 2-6 year olds from CSFII 1989-1991 to NHANES 2007-2008. Per capita consumption increased sharply between 1989 and 2004 for savory snacks, pizza/calzones, mixed Mexican dishes, cheese, and fruit juice (range: 27, 52 kcal). Conversely, per capita consumption decreased sharply between 2003 and 2008 for pizza/calzones, RTE cereals, starchy vegetable dishes, and fruit juice (range: -20, -12 kcal), whereas per capita consumption of fruit increased sharply during this interval (+23 kcal).

Top 10 greatest changes in per capita consumption for all intervals

Changes in per capita consumption, percent consuming, and caloric intake among reported consumers between sequential surveys are summarized in Appendix Table 2. The top 10 absolute changes in per capita intake by food group between sequential survey years are also noted here. Six of these changes occurred between 1994-1998 and 2003-2004: pizzas and calzones (+29 kcal); mixed Mexican dishes (+22 kcal); savory snacks (+20 kcal); fruit juice (+19 kcal); cheese (+17 kcal); and nuts and seeds (-18 kcal). Two of the top 10 changes in per capita consumption between sequential surveys occurred between 1989-1991 and 1994-1998 (savory snacks: +33 kcal; fruit juice: +19 kcal), and two occurred between 2005-2006 and 2007-2008 (fruit: +21 kcal; RTE cereals: -21 kcal). For those foods for which per capita consumption increased, the percent of reported consumers also increased during the same interval, whereas only five of these foods saw increases in mean consumption among reported consumers.

Discussion

To our knowledge, this is the first study to examine 20-year changes in food consumption patterns among 2-6 year old children in the U.S. using nationally representative samples. Over a 20-year period, there is a marked increase in foods high in added sugars, solid fats and sodium in the preschooler diet. Per capita consumption of savory snacks, pizza/calzones, sweet snacks and candy, mixed Mexican dishes, and fruit juice, increased by a combined 148 kcal/day. In contrast, consumption of fruits from any source increased by only 24 kcal. Overall during this 20-year period, total daily energy intake increased by 109 kcal (from 1475 to 1584).

Our findings are compatible with increasing prevalence of overweight and obesity among young children across the same time period except for a recent leveling off (1-3). Moreover, foods that tend to negatively impact diet quality, and contribute excess calories, such as savory and sweet snacks, pizza/calzones, mixed Mexican dishes, sweet snacks and candy, and fruit juice (40-48), predominated the top changes in per capita consumption between 1989 and 2008.

Our results are consistent with other studies on diets of preschoolers during the last decade. Results from the Feeding Infants and Toddlers Study (FITS) showed that, on average, young children were consuming excessive amounts of saturated fats, higher than recommended amounts of salt, and too many calories from high-calorie, low-nutrient foods such as sweets, sweetened beverages, and french fries (17, 20, 21). Furthermore, approximately 85% of children ages 2-3 consumed at least one serving of salty snack foods, sweetened beverages, desserts, or sweets on the survey day (18). Recent data from the WWEIA, NHANES (2003-2004; 2005-2006) have yielded additional insight into the diets of young children. Reedy & Krebs-Smith (2010) reported that the top five sources of calories per capita, among 2-3 year olds, were whole milk, fruit juice, reduced-fat milk, and pasta and pasta dishes(23). Among 4-8 year olds, the top five sources of calories were grain-based desserts, yeast breads, pasta, reduced-fat milk and pizza (23). Fruit drinks, soda, grain desserts, dairy desserts and candy comprised the leading sources of added sugars, whereas whole milk, fatty meats, pizza, grain desserts and regular cheese were the leading sources of solid fats, among children ages 2-8 (23).

The current research also echoes previous studies examining trends in dietary patterns among U.S. children. Others have shown reported sharp increases in snacking and caloric intake among U.S children across a similar time period (26). Piernas and Popkin (2011) reported that salty snacks, which are included in the savory snacks food group, accounted for the greatest change in caloric intake between 1977 and 2006 among children ages 2-18 (26). Nielsen et al (2002), who looked at dietary changes among 2-18 year olds, found that salty snacks, soft drinks and pizza underwent the largest increases in consumption among the foods examined between 1977 and 1996 (49). Consumption of desserts, candy, soft drinks, fruit drinks and pizza also increased among 2-18 year olds during the same period(49). Wang et al (2008) reported that per capita fruit juice consumption also increased in both 2-5 year old children, as well as among 6-11 year old children during the same period between 1988 and 2004 (50). We also found that fruit consumption increased between 1989 and 2008, with a significant change occurring between 1989 and 1998, which is consistent with Kranz et al. (2004), who reported that total consumption of fruits increased in 2-5 year old U.S. children between 1977 and 1998 (51).

Across surveys, there were minor differences in the distributions of race/ethnicity, to which some of the observed changes may be attributable. In **Appendix Table 3**, we compared changes in consumption between 1989-1991 and 2007-2008 by standardizing to the race/

ethnicity distribution in the 1989-1991 survey. Adjusting for race/ethnicity had a marginal effect, which thereby suggests that differences in consumption among preschool children occurring between 1989 and 2008 are attributable mainly to factors other than race/ethnicity.

This study has several limitations. One is our use of surveys with different methods of dietary assessment. Starting in 1994, the USDA began using the multi-pass approach, which employs several steps to enhance the accuracy of recall (52). Accordingly, prior survey years conducted without this method may be more prone to issues of recall bias. There is no bridging survey as there was in earlier decades to allow us to understand the impact of this methodological change(53). These surveys, however, are the only ones which allow us to use consistent food composition tables, all developed by USDA to fit the food supply at the time of the survey.

Dietary data for each of the five surveys used was based on self-report, which may be prone to reporting bias and there is limited evidence that these reporting errors have increased over time, at least in Europe (54-56). Moreover, subjects tend to underreport consumption of foods perceived to be unhealthy or related to obesity (54). To the extent that these biases exist, our results reporting increases of food considered less healthful would represent a conservative assessment of these changes.

This study highlights an increase in the proportion of foods that are key sources of added sugars and solid fats and high in sodium in the diets of US preschool children in the past two decades. The large increases in savory snacks, pizzas, sweets, fruit juice and mixed Mexican dishes are patterns that are likely to affect future diets of these preschoolers as they age. The only positive change was a small increase in fruit intake. The dietary trends among US preschoolers reflected in this paper reinforce calls to improve the diets of young children in an effort to prevent obesity in children.

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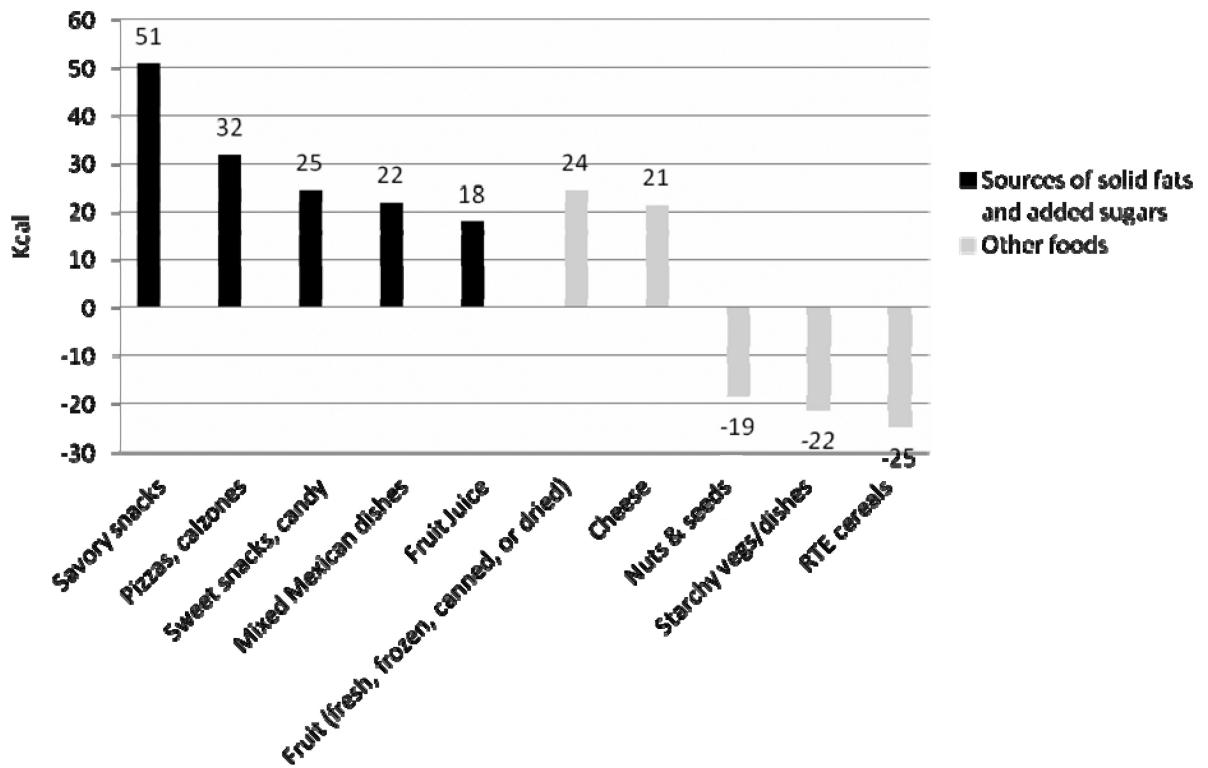


Figure 1. Top changes in per capita intake among U.S. children ages 2-6 from 1989 to 2008, based on data from the Continuing Survey of Food Intakes by Individuals (CSFII) 1989-1991 and National Health and Nutrition Examination Survey (NHANES) 2007-2008. Changes in mean energy intake per capita were significantly different between CSFII 1989-1991 and NHANES 2007-2008, $P < 0.01$.

Table 1
Sociodemographic characteristics of children ages 2 to 6 years from five nationally representative surveys of dietary intake

Characteristic	Survey				
	Continuing Survey of Food Intakes by Individuals 1989-1991 (n=1,370)	Continuing Survey of Food Intakes by Individuals 1994-1998 (n=6,285)	National Health and Nutrition Examination Survey 2003-2004 (n=907)	National Health and Nutrition Examination Survey 2005-2006 (n=1,085)	National Health and Nutrition Examination Survey 2007-2008 (n=1,000)
Boys (%) ^a	50.2%	49.3%	49.6%	49.7%	48.8%
Non-Hispanic Whites (%) ^a	69.8%	62.2%**	61.3%	57.9%	56.8%
Non-Hispanic African American (%) ^a	15.6%	16.5%	14.0%	14.0%	14.7%
Mexican American (%) ^a	11.2% ^b	8.4%**	14.0%**	15.1%	15.0%
Other (%) ^a	3.4%	5.8%**	10.7%**	13.0%	13.4%
185% Federal Poverty Level (%) ^a	39.9%	44.4%**	51.2%**	44.8%*	45.2%
Daily energy intake (mean kcal/d ± standard error)	1475 ± 24	1631 ± 12*	1735 ± 27*	1614 ± 21*	1584 ± 25

^a Percentages have been adjusted to be nationally representative.

^b Percentage reflects Hispanics as Hispanics were sampled indiscriminately in the Continuing Survey of Intakes of Individuals 1989-1991 survey

* Daily energy intake was significantly different from the previous survey, $P < 0.05$ (t -test).

** Adjusted percentage was significantly different from the previous survey, $P < 0.05$ (two-proportion z -test).

Table 2

Top 10 changes in mean caloric intake among U.S. children ages 2-6 from 1989 to 2008, based on data from the Continuing Survey of Food Intakes by Individuals (CSFII) 1989-1991 and National Health and Nutrition Examination Survey (NHANES) 2007-2008

Food	CSFII 1989-1991				NHANES 2007-2008			
	Mean caloric intake	Percent consuming	Caloric intake among consumers	Mean caloric intake	Percent consuming	Caloric intake among consumers		
Savory snacks	44	30	147	95**	60**	158		
Pizza/calzones	27	10	278	59**	19**	313		
RTE cereals	77	54	144	52**	46*	115**		
Sweet snacks, candy	27	22	127	52**	41*	127		
Fruit (fresh, frozen, canned or dried)	47	43	109	72**	62**	116		
Mixed Mexican dishes	10	4	253	32**	11**	296		
Starchy vegetable dishes	43	32	135	34**	22**	98**		
Cheese	27	16	169	48**	32**	150		
Nuts and seeds	48	19	251	29**	15	197*		
Fruit juice	52	42	122	70**	52*	134		

* Value was significantly different from the CSFII 1989-1991 survey, $P < 0.05$

** Value was significantly different from CSFII 1989-1991 survey, $P < 0.01$

Table 3

Trends in per capita consumption of top 10 foods consumed per capita in 2007-2008 among 2-6 year olds, based on data from the Continuing Survey of Food Intakes by Individuals (CSFII) 1989-1991; CSFII 1994-1998; National Health and Nutrition Examination Survey (NHANES) 2003-2004; NHANES 2005-2006; and NHANES 2007-2008

Food	CSFII 1989-1991	CSFII 1994-1998	NHANES 2003-2004	NHANES 2005-2006	NHANES 2007-2008
	Mean caloric intake				
Savory snacks	44	77 ^{**}	96 [*]	90	95
Pizza/calzones	27	34	73 ^{**}	70	59
RTE cereals	77	79	70	73	52 ^{**}
Sweet snacks, candy	27	43 ^{**}	49	53	52
Fruit (fresh, frozen, canned or dried)	47	58 [*]	49	51	72 [*]
Mixed Mexican dishes	10	14	36 ^{**}	37	32
Starchy vegetable dishes	43	43	33 ^{**}	23	21
Cheese	27	37	54 [*]	48	48
Nuts and seeds	48	48	30 [*]	36	29
Fruit juice	52	71 [*]	90 [*]	79	70

* Daily caloric intake was significantly different from the previous survey, $P < 0.05$

** Daily caloric intake was significantly different from the previous survey, $P < 0.01$

Table 4

Top 10 absolute changes in per capita consumption, 1989-1991 to 2007-2008

Food	Interval	Change in kcal consumed per capita	Change in percent consuming	Change in kcal among consumers
Savory snacks	1989-1991 to 1994-1998	+33 **	+18 **	+ 14
Fruit juice	1989-1991 to 1994-1998	+ 19 **	+4	+29 **
Pizzas, calzones	1994-1998 to 2003-2004	+39 **	+4	+173 **
Mixed Mexican dishes	1994-1998 to 2003-2004	+22 **	+7 *	-16
Savory snacks	1994-1998 to 2003-2004	+20 *	+14 **	-4
Fruit juice	1994-1998 to 2003-2004	+19 *	+12 **	+3
Cheese	1994-1998 to 2003-2004	+17 *	+11 **	-1
Nuts & seeds	1994-1998 to 2003-2004	-18 **	+3	-65 **
Fruit (fresh, frozen, canned, or dried)	2005-2006 to 2007-2008	+21 *	+8	+21 **
RTE cereals	2005-2006 to 2007-2008	-21 **	-11 **	-14 *

Means indicated with asterisks were significantly different from the preceding survey year:

*
P<.05**
P<.01