School Meal Program Participation and Its Association with Dietary Patterns and Childhood Obesity

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Abstract

This study used data from the School Nutrition Dietary Assessment III Study to examine the dietary patterns of school meal program participants and nonparticipants and the relationship between school meal participation and children's Body Mass Index (BMI). School Breakfast Program (SBP) participants ate more low-nutrient energy-dense (LNED) baked goods and more calories at breakfast than did nonparticipants. National School Lunch Program (NSLP) participants had lower intake of sugar-sweetened beverages and a lower percentage of calories from LNED foods and beverages than did nonparticipants. Overall, NSLP participation was not significantly related to students' BMI, although participants were less likely to be overweight or obese than nonparticipants among Black students but more likely to be so among "other race" students. SBP participants had significantly lower BMI than did nonparticipants, possibly because SBP participants are more likely to eat breakfast and eat more at breakfast, spreading calorie intake more evenly over the course of the day.

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EXECUTIVE SUMMARY

Understanding the role of eating behaviors and school meal program participation in children's food consumption patterns and weight status is critical to understanding and addressing the high prevalence of obesity among children. Children from low-income families, who are eligible for free or reduced-price school meals and are more likely than other children to eat school meals, are also more likely to be overweight or obese. School meal programs, including the National School Lunch Program (NSLP) and the School Breakfast Program (SBP), play an important role in children's diets and can thus influence their weight status.

What is the Issue?

This study examines the dietary patterns of school meal program participants and nonparticipants, including the location of meals and snacks and the extent to which children consume low-nutrient, energy-dense (LNED) foods and beverages. Given that some of these differences in dietary patterns may ultimately influence children's weight status, we then estimated the relationship between SBP and NSLP participation and children's BMI and risk of overweight or obesity, and explored possible explanations for the observed relationship.

What did the Study Find?

In terms of specific dietary patterns, four clear findings emerge from regression-adjusted comparisons of participants and nonparticipants. First, participation in the SBP is associated with a significant increase in students' calorie intake at breakfast, so that participants' energy intake appears to be spread out a bit more evenly over the course of the day than that of nonparticipants. Second, NSLP participation is associated with reduced intake of Sugar Sweetened Beverages (SSBs), for both elementary and secondary school students.

Third, at the elementary school level, NSLP participants consume a lower percentage of their calories from LNED foods and beverages than do nonparticipants (22 versus 25 percent). Fourth, school meal program participants consume some subcategories of LNED foods more frequently than do nonparticipants. In the case of the SBP, participants' regression-adjusted mean intake of calories from baked goods and desserts is significantly greater than that of nonparticipants. At both the elementary and secondary school level, this translates into a significantly higher mean of overall calories from LNED foods among SBP participants as compared with nonparticipants. In the case of the NSLP, participants' intake of calories from french fries is greater than that of nonparticipants at school, but this difference is not statistically significant across all locations. On the other hand, NSLP participation is associated with a lower mean intake of calories from chips or salty snacks at both levels, and of candy at the elementary school level.

We found no evidence that NSLP participation is related to students' body mass index or risk of obesity. In all specifications, the estimated effect of NSLP participation on weight-related

outcomes was small and not statistically significant. There was not strong evidence of positive or negative effects of NSLP participation on students' weight for most of the key subgroups we examined. However, there were some suggestions of a modest negative effect of participation on the likelihood of being overweight or obese among black, non-Hispanic students and a positive effect on the likelihood of obesity among students in the "other race" category (that is, those not classified as Hispanic, non-Hispanic white, or non-Hispanic black).

Participation in the SBP was associated with significantly lower BMI. Across the full sample, the size of this effect was modest, implying that students who participate in the SBP every day would have a mean BMI 0.75 points lower than those who never participate in the SBP, all else being equal. This result was robust across a number of different specifications, and was driven largely by the negative effect of SBP participation on BMI among non-Hispanic white students. There was no evidence of systematic differences in the effect of SBP participation across the other subgroups we examined, including age/gender and household income.

In exploring potential explanations for the negative association between SBP participation and BMI, we examined the differences in participants' and nonparticipants' dietary intakes and dietary patterns. Previous research using the same data found some evidence that SBP participation was associated with higher food energy intake. Thus, one potential explanation could be dismissed—that SBP participation leads to lower BMI by causing participants to eat less and have lower energy intake overall. Nor did we find evidence that SBP participants consume fewer calories (or a lower percentage of their calories) from LNED foods and beverages than do nonparticipants, so consumption of LNEDs does not appear to be a likely explanation for the SBP-BMI result either.

The one large difference in the dietary patterns of SBP participants and nonparticipants is that participants are more likely to eat breakfast and have a greater intake of calories at breakfast than nonparticipants. Thus, we examined the hypothesis that SBP participation leads to lower BMI by promoting the consumption of substantial breakfasts and leading to participants' energy intake being spread more evenly over the course of the day than that of nonparticipants. We found some evidence in support of this hypothesis. Breakfast consumption itself was associated with significantly lower BMI, and after we accounted for this relationship, the remaining association between SBP participation and BMI was substantially diminished.

Our findings suggest that school meals and school food practices can influence risk of childhood obesity based on the quality and portion sizes of the school meals offered, the availability of certain types of foods and beverages in the school food environment (à la carte, meals, snack bars, vending machines, and so on), and promoting eating breakfast.

How was the Study Conducted?

We analyzed data from the third School Nutrition Dietary Assessment (SNDA-III) Study. The sample used in the analysis included 2,314 1st through 12th graders in public schools offering the SBP and/or NSLP. The design of this sample was stratified, with the students in the sample distributed among 287 schools from a smaller number of school food authorities, and was

representative of the national population of students in public schools offering school meals in school year 2004-2005. Data collection for the study included 24-hour dietary recalls, heights and weights, child and parent surveys, and a variety of information collected about the students' schools and districts as well as the meal service and competitive foods available at these schools.

I. INTRODUCTION

Understanding the role of eating behaviors and school meal program participation in children's food consumption patterns and weight status is critical to understanding and addressing the issue of the high prevalence of obesity among children (Institute of Medicine (IOM) 2005; Story et al. 2006, 2008). During the period between 2003 and 2006, one in three school-aged children in the United States was overweight or obese, accounting for 25 million American children (Ogden et al. 2008). Children from low-income or minority families, who are eligible for free or reduced-price school meals and are more likely than other children to eat school meals, are also more likely to be overweight or obese (Gordon-Larsen et al. 2003; Meich et al. 2006).

School meal programs, including the National School Lunch Program (NSLP) and the School Breakfast Program (SBP), play an important role in children's diets and can thus influence their weight status. On school days, children obtain a substantial proportion of their calories while at school, largely from the meal programs (Gleason and Suitor 2001, 2003; Gordon et al. 2007). According to data from the third School Nutrition Dietary Assessment (SNDA-III) study, more than one-fourth (26 percent) of calories consumed by the average child on a school day were both obtained and consumed at school (Briefel et al. 2009a). The proportion of calories consumed at school was higher among school meal participants, with NSLP participants getting 35 percent of their daily food energy from foods obtained and consumed at school and those who participated in both the NSLP and SBP getting 47 percent of their energy from these foods.

Aside from simply contributing calories to children's diets, the school meal programs may also influence the types of foods that children eat. Obviously, this influence arises from the types

of foods offered in school meals, but participation in the programs likely also has an effect on the extent to which students eat the "competitive foods" that are available in school vending machines or served à la carte as alternatives to school meals. These competitive foods are often low-nutrient, energy-dense (LNED) foods, and thus they provide excess energy relative to their nutrient value (Cullen et al. 2004; O'Toole et al. 2007; Wiecha et al. 2006). Examples include sugar-sweetened beverages (SSBs), high-fat baked goods, and desserts. Some LNED foods, such as breakfast pastries, brownies, cookies, and french fries, may also be available to children as part of a school meal. Access to such foods has been related to increased energy intake at school and higher body mass index (BMI) among middle school children (Kubik et al. 2005).

Beyond school campuses, energy-dense diets associated with consumption of "fast foods", higher-fat snack foods, sweets, desserts, and sugar-sweetened beverages, as well as increased portion sizes, meal-skipping, and snacking have been implicated in a higher risk of childhood obesity (American Dietetic Association (ADA) 2009a, 2009b, 2009c, 2009d, 2000e; Drewnowski and Darmon 2005; Newby 2007; Nicklas et al. 2001). However, little data exist on how these specific dietary patterns vary among school meal program participants and nonparticipants. Given the large role of the school meal programs in children's diets, it is reasonable to think that they may influence children's weight status and likelihood of obesity (IOM 2005; Story et al. 2006). Several commentators have suggested that participation in the meal programs may have contributed to rising levels of childhood obesity (Besharov 2002; Forman 2000; Haskins 2005; Yeoman 2003). As discussed in Chapter II, the current research evidence about this claim is inconclusive. And even if the school meal programs have not contributed to childhood obesity, the SBP and NSLP constitute two major avenues through which federal policy may influence—for better or worse—what children eat and their resulting weight status.

Thus, this report has two main objectives. First, we wish to provide new evidence on the relationship between school meal participation and children's weight status. In particular, does participation in the SBP and/or NSLP lead to rising BMI and/or a greater likelihood of overweight/obesity? Second, we want to provide policy makers with information about possible mechanisms through which participation could influence weight status in particular, or children's health status in general. To do so, we focus on the association between school meal program participation and children's dietary patterns, with particular attention paid to the timing[1] and location of eating occasions and to consumption of LNED foods and beverages. Past research has suggested that increases in foods and beverages consumed away from home, accompanied by increases in portion sizes may have contributed to increases in childhood obesity (Anderson and Butcher 2006; Drewnowski and Darmon 2005; Newby 2007; Nicklas et al. 2001). Our research can shed light on children's patterns of consumption across locations on an average school day, especially those foods and beverages that are high in energy and low in nutrient value.

This focus on dietary patterns involving the questions of if, where, and when children consume specific foods and beverages is designed to increase the policy relevance of the research. While children's weight and health status may ultimately be driven by their calorie and nutrient intake, children and their parents do not typically select calories and nutrients. Instead, they decide what foods they would like to eat (or serve their children, in the case of parents) and what beverages they would like to drink. Thus, understanding the ways in which school meal program participation is related to food and beverage consumption behaviors should make it easier for policy-makers to develop programs and policies that will ultimately have beneficial effects on their nutrient levels, weight status, and health.

[1] By timing, we mean the meals (breakfast, lunch, and dinner/supper) and snacks reported across the day, and not the actual time of day of the meal/snack or the amount of time between meals.

To address the objectives listed above, we analyzed data from the third School Nutrition Dietary Assessment Study (SNDA-III study). The sample used in the analysis included 2,314 1st through 12th graders in public schools offering the SBP and/or NSLP. The design of this sample was stratified, with the students in the sample distributed among 287 schools from a smaller number of school food authorities, and was representative of the national population of students in public schools offering school meals in school year 2004-2005. Data collection for the study included 24-hour dietary recalls, heights and weights, child and parent surveys, and a variety of information collected about the students' schools and districts as well as the meal service and competitive foods available at these schools.

The remainder of the report is organized as follows. To provide a context for the analysis, chapter II reviews the existing research evidence on the relationships between school meal program participation, dietary patterns, and children's weight status. Chapter III examines the dietary patterns of school meal program participants and nonparticipants, including the location of meal and snacks occasions and the extent to which children consume LNED foods and beverages at certain meals and snacks. Given that some of these differences in dietary patterns may ultimately influence children's weight status, chapter IV presents estimates of the relationship between participating in the SBP and NSLP and children's BMI and risk of overweight or obesity. Finally, a brief summary, including the policy implications of the findings, is provided in chapter V.

II. PREVIOUS RESEARCH

This chapter provides the background and motivation for our research that aims to describe the complex linkages between school meal program participation, dietary patterns, and childhood obesity. We first provide an overview of the dietary topics addressed in the project (section II.A), and then summarize the pertinent literature on: the effects of school meal program participation on dietary patterns (section II.B), the effects of dietary patterns on BMI and obesity (section II.C), and the effects of school meal program participation on BMI and obesity (section II.D).

A. BACKGROUND

A growing body of research on the determinants and consequences of children's eating patterns suggests that certain behaviors, such as when children eat and what types of foods and beverages are eaten, are associated with body mass index (BMI) and/or increased risk of overweight or obesity (Newby 2007). National cross-sectional studies such as the National Health and Nutrition Examination Survey (NHANES), the Continuing Survey of Food Intakes by Individuals (CSFII), SNDA-I, and SNDA-II, and several smaller studies, have been used to look at NSLP and SBP participation and children's outcomes – most have focused on dietary outcomes, but some have also looked at nutritional status and weight outcomes (Fox et al. 2004). Longitudinal studies have shown that selected dietary patterns and BMI track from early childhood to adolescence and young adulthood (Dodd et al. 2008).

The focus of this project is on the relationship between school meal program participation and obesity with attention to the mediating variable of children's dietary patterns. The dietary patterns of interest include:

- **When** do children eat? The focus here is especially on whether children eat breakfast and on the number of eating occasions or eating frequency, since both have been

associated with BMI. Snacking is also of interest since it relates to eating frequency and may be associated with the consumption of low-nutrient, energy-dense (LNED)[1] foods such as soft drinks and higher-fat chips (IOM 2005).

- **Where** do children eat? We distinguish between eating occasions that occur at school, at home, and away from school and home. Children eating away from home and school may be less likely under an adult's supervision and more likely to LNED foods from fast food restaurants (Keystone Center 2006). Foods and beverages consumed at school are related to school meal participation and to the availability of competitive foods (Briefel et al. 2009a; Gordon et al. 2007).
- **What** do children eat? In particular, do they consume sugar-sweetened beverages and other LNED items that are associated with BMI or obesity (IOM 2005; ADA 2009a, 2009c)? What is their overall consumption of LNED foods and beverages and what is the energy density of their diets across the day or at certain eating occasions and location?

B. EFFECTS OF SCHOOL MEAL PROGRAM PARTICIPATION ON DIETARY PATTERNS

Participation in school meal programs can affect whether and when children eat meals (especially breakfast) and snacks, where they eat, and what foods (and nutrients) they eat. We summarize the research on school meals and dietary patterns, with particular attention to dietary patterns that have been associated with BMI or increased risk of obesity.

1. Do School Meals Influence When Children Eat?

There is a documented decline in eating breakfast among boys and girls, especially among adolescents (Siega-Riz et al. 1998). Other research has shown that youth of all ages snack frequently and derive a large portion of daily calories form energy-dense snacks (Jahns et al. 2001). The number and timing of eating occasions, including snacking, has been studied among school-age children but few studies have reported findings by school meal program

[1] LNED items are defined as low in nutrients but high in energy or caloric density per unit volume or mass (Robert Wood Johnson Foundation 2008). For example, soft drinks and fried foods are considered LNED items whereas fresh fruits and vegetables are considered high in nutrients and low in energy.

participation.[2] Devaney and Stuart (1998) found that having the SBP available in school made students more likely to eat breakfast, particularly if breakfast was defined as something more than having "any" calories during breakfast hours (SNDA-I data). Additional evidence in support of this finding was presented by Gleason and Suitor (2001) using data from the CSFII; thirty-six percent of students at SBP schools ate breakfast compared with 31 percent elsewhere. On the other hand, Bhattacharya et al. (2004) found no significant relationship between SBP availability and breakfast consumption.

Snacking at school has been studied mostly from the perspective of competitive food policies and the availability of less healthy or LNED foods at school (Cullen et al. 2004, 2007; Probart et al. 2005). Neumark-Sztainer et al. (2005) found that snacking among high school students was significantly associated with the number of snack machines in high schools.[3] Children who eat school meals are less likely to consume competitive foods at schools (Fox et al. 2009; Gordon et al. 2007). A study of Texas school children found that secondary school students were more likely to report snacking than elementary school students, but snacking was not studied in relationship to school meals or school meal program participation (Perez et al. 2007).

[2] In the SNDA-1 study, Burghardt et al. (1993) looked at the number of eating occasions and the percentage of students getting breakfast, lunch, dinner, and snacks, but didn't do so separately for participants versus nonparticipants.

[3] They also found that found that a closed school campus policy was related to fewer lunch purchases from fast food restaurants (Neumark-Sztainer et al. 2005).

2. Do School Meals Influence Where Children Eat?

Obviously, students who eat a school meal are eating at school and can't also eat that particular meal at home or another location.[4] So, to that extent, school meal program participation influences eating location. But is there evidence of any effects beyond this?

As of 1992, whereas all SBP participants ate their breakfast at school, 76 percent of nonparticipants ate at home, 8 percent ate at school, and 5 percent ate elsewhere (with the remaining nonparticipants eating no breakfast) (SNDA-I data; Burghardt et al. 1993). Among NSLP nonparticipants, 70 percent ate lunch at school, 9 percent ate at home, and 9 percent ate away from home or school (12 percent ate no lunch).

Gleason and Suitor (2001) examined the relationship between school meal program participation and calories consumed at school (and obtained from the school cafeteria) versus elsewhere, though they did not distinguish between home and away, or foods obtained elsewhere in school. They found that NSLP participants obtained just over a third of their food energy from the school cafeteria and just under two-thirds from other sources (CSFII 1994-96/98 data). Though the authors didn't directly examine the percentage of food energy from the school cafeteria among nonparticipants, presumably it was a small percentage. Among SBP participants (who almost always participate in the NSLP as well), nearly half of their food energy came from foods obtained in the cafeteria.

Other dietary studies of school children have focused on the school food environment, school food policies or practices, and the source of the foods consumed *at school* rather than the eating location of other meals and snacks throughout the day and their association with eating a school meal (for example, a school meal from the cafeteria, a bag lunch from home, a snack or

[4] However, students may eat a second meal of the same name at home or at another location. The most likely scenario is eating two breakfasts – one at home and one at school.

meal from the school vending machine, and items from a fast food restaurant brought into school) (Briefel et al. 2009a; Cullen et al. 2008; Greves et al. 2006; Neumark-Sztainer et al. 2005). Research has shown that limiting access to low-nutrient, energy-dense foods at school reduces the consumption of these items (Neumark-Sztainer et al. 2005). However, we don't know much about the relationship between what children eat at school and what they eat outside of school. For example, there is little information about whether children's dietary practices outside of school are modified by the availability of LNED-type foods at school.

3. Do School Meals Influence What Children Eat?

As stated previously, students who participate in the school meal program are less likely to consume competitive foods at school. "Competitive" foods are foods that are available in schools but are not part of the US Department of Agriculture (USDA) school meals. These include foods and beverages sold through vending machines, à la carte purchase in cafeteria lines, school stores, snack bars, and fund-raising and other school activities, or provided by teachers (IOM 2005; O'Toole et al. 2007; Story et al. 2008). Such foods are usually "low-nutrient, energy-dense" (LNED) and may be consumed for breakfast, lunch, or snacks at school (Fox et al. 2009; Templeton et al. 2005). Most school meal studies report the consumption of competitive foods, many—but not all—of which are LNEDs. LNED items may be obtained from any source, including school meals or competitive foods at school or brought from home or other source outside of school.

Previous SNDA studies have not looked specifically at the category of LNED foods, but SNDA-I and SNDA-III examined (unadjusted) intakes of specific foods by participants and nonparticipants (Burghardt et al. 1993; Gordon et al. 2007). Gordon et al. (2007) compared the dietary intake of participants and nonparticipants and found that participants were significantly

less likely to consume both soda and fruit drinks at lunch (and fruit drinks over 24 hours).[5] NSLP participants were:

- more likely to consume fries
- equally likely to have cookies/cakes/brownies
- less likely to have candy
- equally likely to have dairy-based desserts
- equally likely to have chips

Clark and Gleason (2006) found that NSLP participation was associated with a significant decrease in the consumption of sugar-sweetened beverages. In a longitudinal study of fourth graders, Cullen and Zakari (2004) found that when fourth graders had access to snack bars in fifth grade they consumed fewer fruits and nonfried vegetables, less milk, and more sugar-sweetened beverages than in the previous grade when they only had access to school lunch. Fifth-grade students who selected only the NSLP meal consumed more fruits and vegetables and 100% juice than students who brought lunch from home or ate from the snack bar (Cullen et al. 2007).

In an analysis of NHANES III data, the weekly frequency of eating a school lunch was a significant independent negative predictor of the reported number of low-nutrient-density foods (desserts, sweeteners, salty snacks, and fats) consumed (Kant and Graubard 2003). Using data from NHANES 1999-2004, Cole and Fox (2008) found that low-income and higher income NSLP participants consumed less salty snacks and beverages other than milk or 100% juice (and more milk, meat, and beans). Low-income NSLP participants also consumed more fruit.

[5] Both soft drinks and fruit drinks are examples of sugar-sweetened beverages (and one category of LNED items).

A review of the literature on NSLP and nutrient outcomes found that NSLP participation was associated with students' diets that were higher in intakes of fiber, selected vitamins and minerals, total and saturated fat, and a lower intake of 'added sugars' at lunch and over 24 hours (Fox et al. 2004). The strongest evidence of a beneficial effect comes from an analysis of CSFII 1994-96/98 data by Gleason and Suitor (2003) showing that NSLP participation led to a significantly lower intake of added sugars. Devaney et al. (1993), Gordon et al. (1995), and Gleason and Suitor (2003) found, however, that the estimated impact of NSLP participation on 24-hour food energy intake was not statistically significant. Studies examining the impacts of NSLP participation on dietary outcomes using NHANES III data (Bhattacharya et al. 2004; Gleason et al. 2003) have been less conclusive, in part because these studies have not been able to control for differences in the characteristics of participants and nonparticipants as effectively as the other studies.

Studies based on SNDA-I data from the early 1990s found that NSLP participation led students to consume increased amounts of fat and saturated fat, both at lunchtime and over 24 hours, and that SBP participation increased students' 24-hour caloric intake (Devaney et al. 1993; Gordon et al. 1995). Across several studies, there is strong evidence that SBP participants consume more energy, protein, and carbohydrates at breakfast than nonparticipants, but that the effects are diminished over the course of the total day's intake (Fox et al. 2004). An analysis of NHANES III found that children in the SBP consumed a better overall diet, as evidenced by a lower percentage of calories from fat, and were less likely to have low serum levels of vitamin C and folate (Bhattacharya et al. 2004). Based on an analysis of NHANES 1999-2000 dietary data, Gleason, Briefel and others (2003) found that SBP participants consumed higher breakfast intakes of energy, a number of vitamins and minerals, along with fat, cholesterol, and sodium, and less added sugar.

As noted above, studies of school meal programs have generally focused on energy intake and nutrient density rather than on energy density.[6] Energy-dense foods are generally lower in cost yet provide the high palatability of fat and sugar that appeals to children (Drewnowki 2007; Drewnowki and Specter 2004). Energy density has not been reported in previous studies of the diets of school meal participants and non-participants, although it may be possible to calculate this characteristic from dietary data shown in some of the reports' tables.

C. EFFECTS OF DIETARY PATTERNS ON BMI/OBESITY

Strong evidence does exist linking children's particular dietary behaviors to the risk of overweight or obesity (ADA 2009a; IOM 2005; Newby 2007). These behaviors include, but are not limited to 1) the timing of consumption (e.g., eating breakfast vs. skipping breakfast; number of meals and snacks; eating frequency), 2) the location of consumption (e.g., home vs. away from home), and 3) the consumption of LNED foods and beverages. These behaviors are often correlated. For example, eating away from home at fast food locations is associated with increased risk of consuming LNED items such as soft drinks and fried foods (Keystone Center 2006). The research on these topics is summarized below.

1. Effects of Timing of Consumption

Studies of breakfast and obesity have found varying results across age and gender subgroups (ADA 2009b; Andersen et al. 2005; Newby 2007). Skipping breakfast may be a risk factor for increased adiposity among older children or adolescents and appears to be more important for

[6] Energy density is defined as the amount of energy stored in a given food per unit volume or mass. Foods that are almost entirely composed of fat with minimal water (e.g., butter) are more energy-dense than foods that consist largely of water, fiber and carbohydrates (e.g., fruits and vegetables).

girls than for boys (ADA 2009b). Longitudinal studies of US adolescents have found that skipping breakfast was associated with increased weight gain from adolescence to adulthood, while eating breakfast was associated with lower BMI (Niemeier et al. 2006; Timlin et al. 2008).

Cross-sectional studies have found no significant relationship between children's frequency of eating and overweight (ADA 2009c; Huang et al. 2004). One cross-sectional study using CSFII 1994-96/98 data found that meal portion sizes, but not snack patterns, were associated with BMI percentile among school-age boys and girls (Huang et al. 2004). One longitudinal study found that meal frequency was inversely related to BMI among girls ages nine to 19 years (Franko et al. 2009). Black girls that ate three or more meals a day were less likely to be overweight (Franko et al. 2009).

Snacking frequency does not appear to be related to childhood adiposity, but the evidence is clouded by the lack of consistent definition of *snack* across research studies (ADA 2009d; Gatenby 1997). However, LNED items are often the choice of foods and beverages consumed by children as snacks (Briefel 2007; Jahns et al. 2001; Nicklas et al. 2001). Snacking at home has been related to families' fast food purchases and consumption of SSBs (with salty snacks) (ADA 2009d; Boutelle et al. 2007), and energy intake and meal patterns appear to be more related to children's BMI than snacking (Huang et al. 2004). Thus, the frequency of snacking may matter less than what foods and beverages are consumed in these snacks as well as in other meals consumed during the day.

2. Effects of Location of Consumption

Increases in children's BMI and overweight in the 1980s and 1990s have been accompanied by increases in the frequency of eating away from home and by shifts in the types of foods and beverages and portion sizes consumed (Briefel 2007; Keystone Center 2006; Nicklas et al. 2001). Children eat about one-third of their meals away from home, and schools and fast food

restaurants are an important source of these meals, together providing more than two-thirds of meals (and calories) consumed away from home (Lin, Guthrie and Blaylock 1996; Lin, Guthrie, and Frazao 1999). Fried foods consumed away from home are associated with higher energy intakes and body weight and lower consumption of fruits and vegetables among older children and adolescents (Traveras et al. 2005). Away-from-home foods from fast food and takeout restaurants have increased and are often associated with consumption of energy-dense meals and snacks (Briefel 2007; Keystone Center 2006).

Eating 'fast food' has been associated with consumption of LNED items as well as with BMI and overweight (Duerkson et al. 2007; IOM 2005; Keystone Center 2006). Currie et al. (2008) found that the presence of fast food restaurants located within a tenth of a mile of schools was associated with an increase in the prevalence of obesity among 9th grade students at the school, while fast food restaurants located farther away had no effect on the obesity rate. Thus, there is some suggestive evidence that eating away from home and school (especially in fast food restaurants) is associated with increases in BMI and obesity among children, but little evidence that this relationship is causal. Again, the link may be driven by the types and portion sizes of foods and beverages—LNEDs—consumed at these locations.

3. Effects of Sugar-Sweetened Beverages and LNED Foods

There is a growing body of research on the relationship between the consumption of LNED foods or beverages (e.g., sugar-sweetened beverages, fried foods, candy) and childhood overweight. The greatest amount of evidence is for sugar-sweetened beverages and other items with added sugar such as candy (ADA 2009e; Dodd et al. 2008). Systematic reviews and meta-analysis have found a positive association between the consumption of SSBs and BMI, overweight/obesity, and/or weight gain (Ludwig et al. 2001; Malik et al. 2006). A separate meta-analysis of 88 studies of the effects of soft drinks concluded that consumption was linked to

increased calorie intake, lower nutrient intake, and higher body weight among children (Vartanian et al. 2007). Studies also suggest that consumption of soft drinks tracked over time and that fast food consumption increased from early childhood to adolescence (Dodd et al. 2008; Traveras et al. 2007). A prospective study that followed more than 2,300 girls aged 9-10 for 10 years found that soda consumption predicted the greatest increase in BMI (Striegel-Moore et al. 2006).

Consumption of LNED foods, also common among children, is also adversely associated with BMI (Drewnowski and Bellisle 2007; Kant 2003). Anderson and Butcher (2005) estimated that the increase in the availability of foods high in calories and low in nutrients in schools accounted for one-fifth of the increase in BMI observed in adolescents over the past 10 years. Research has shown that limiting access to LNED foods at school reduces the consumption of these items in schools (Cullen et al. 2008; Story et al. 2006, 2008). Further, access to such LNED items has been related to increased calorie intake at school and higher BMI among middle school children (Kubik et al. 2005).

Research on childhood overweight has typically found that reported energy intake is unrelated to overweight, but that consumption of energy-dense foods, or LNED foods, may be associated with overweight, depending on energy expenditure (IOM 2005). A comprehensive review of evidence on diet and childhood obesity by Newby (2007) stated that no studies had been published on the relationship between energy density and obesity among children, although studies in adults have shown a positive relationship.

D. EFFECTS OF SCHOOL MEAL PROGRAM PARTICIPATION ON BMI AND OBESITY

The existing evidence on whether the school meal programs affect the prevalence of overweight among children is far from definitive. None of the studies reviewed by Fox et al.

(2004) found definitive evidence linking SBP or NSLP participation and overweight. A second literature review conducted at about the same time (Linz et al. 2004), also concluded that there was not solid evidence of a relationship between school meal participation and children's weight status. These literature reviews each pointed out that the studies that had been completed up to that time suffered from a number of methodological problems, including incomplete measures of program participation, lack of information on measured heights and weights, and the difficulty of adequately dealing with selection bias.

Three more recent studies have focused particular attention on the selection bias issue in analyzing the school meal participation-BMI relationship. Schanzenbach (2005) found that among very young students—those in kindergarten and first grade—participation in the NSLP leads to higher obesity rates, even after controlling for children's likelihood of obesity upon entering kindergarten using a fixed effects model. She found that whereas children who became NSLP participants and those who did not enter kindergarten with similar obesity rates (thus suggesting no selection into participation), the participants were 2 percentage points more likely to be obese by the end of first grade. Using a similar methodology and the same data set (though a longer follow-up period), Milmet et al. (2008) initially found no relationship between NSLP participation and children's weight gain between kindergarten and third grade, but a positive relationship between SBP participation and weight gain over this period. However, they also found evidence of positive selection into the SBP—those who participate in the SBP appear to be predisposed to weight gain, and that this selection likely wipes out the positive relationship between SBP participation and weight gain.

A third study (Hofferth and Curtin 2005) used a different data set—the Panel Study of Income Dynamics—and different approach to addressing selection bias, and finds no evidence that NSLP or SBP participation leads to an increased risk of obesity among low-income 6- to 12-

year-old children. In particular, before adjusting for selection, they found that NSLP participation was positively related to BMI and risk of obesity. However, when they accounted for selection by estimating an instrumental variables model (with attendance at a school that offers the SBP as the identifying variable), neither SBP nor NSLP participation was significantly related to participation.

Finally, another recent study did not directly examine the school meal programs, but did look at the role of schools in explaining childhood overweight and obesity (von Hippel et al. 2007). Their approach was to examine children's weight gain over the course of the year, and found that kids were more likely to gain weight during the summer months than they were during the school year. This evidence is merely suggestive, but is consistent with the notion that school meal program participation does not lead to great weight gain, since the effect of participation would be seen during the school year and not the summer.

In summary, there is a lack of a clear consensus from the research on the relationship between school meal participation and children's weight status. Many of the studies failed to use good measures of children's school meal participation status and/or relied on measures of height and weight that were not measured appropriately. The early studies, in particular, struggled to deal adequately with the issue of selection bias. This suggests the need for research that carefully measures children's school meal program participation status and their BMI and overweight/obesity indicators and seriously addresses the possible selection of children into these programs. This research project uses data collected in SNDA-III to overcome previous data limitations in assessing the relationship between school meal program participation, diet, and obesity.

III. DIETARY PATTERNS AMONG SCHOOL MEAL PARTICIPANTS AND NONPARTICIPANTS

The previous chapter summarizes the literature on the relationship between school-age children's dietary patterns and obesity, between school meal participation and diet, and between school meal participation and obesity outcomes. This chapter addresses the question of how school meal participation may affect children's dietary patterns, focusing on those dietary patterns shown to be associated with an increased risk of obesity. Based on a set of basic individual characteristics and dietary outcomes available in the SNDA-III data, we present the results of multivariate regression analysis to explore this relationship. After describing how the key dietary variables in the analysis are defined and summarizing the methodology, we present the results of the main regression analysis to compare the eating patterns of public school meal program participants and nonparticipants.

The chapter focuses on three components of children's diets: (1) meal and snack patterns; (2) consumption of low-nutrient, energy-dense (LNED) foods, including sugar-sweetened beverages (SSBs); and (3) eating location (school, home, away from school and home, referred to as "away"). In particular, it focuses on the following primary research questions. Is participation in the NSLP and/or SBP associated with the consumption of LNED solid foods and SSBs away from school? Are children who participate in the school meal programs, and are therefore less likely to consume SSBs or certain LNED foods at school, more likely to consume these items at home or other locations? And do school meal participants' energy intake and energy density differ by location across the day from those of nonparticipants? Addressing these questions allows us to obtain a better understanding of the two groups' consumption patterns in

different food environments and the school meal programs' potential association with risk of obesity.

A DATA AND METHODS

Data from the SNDA-III study were used to estimate the relationship between school meal participation and children's dietary patterns. The key measures from the data set for this analysis were measures of diet (meals and snacks; total energy; energy density; calories from SSBs and LNED foods; and location of consumption) and NSLP and SBP participation on the target recall day. School lunch and breakfast participation were the key independent variables, and a basic set of individual student and household characteristics, drawn from the student and parent surveys with each SNDA-III sample member, were used in the analysis to control for possible differences between participants and nonparticipants.

1. Measuring Dietary Patterns and Food and Energy Intake

A single, 24-hour dietary recall was taken from each child (or with the help of a proxy, usually a parent, for elementary school children). Dietary recalls were conducted in person by trained interviewers. These recalls obtained the necessary dietary data to provide an estimate of students' intakes of SSBs, LNED foods, and food energy on a typical school day. No recalls were conducted for intake on weekends or holidays. Information was obtained on the specific location in which sample members obtained each food, whether or not the food was consumed at school, the meal or snack during which the student reported consuming each food, and the time each food was consumed.

Data were collected using the USDA Automated Multiple Pass Method software (AMPM, version 2.3, 2003, USDA, Agricultural Research Service, Bethesda, MD) and processed with the Survey Net coding system (version 3.14, 2004, USDA, Agricultural Research Service, Bethesda,

MD) and the Food Nutrients Database for Dietary Studies (FNDDS, version 1.0, 2004). The five steps (or passes) of the AMPM are designed to help students remember the specifics of all foods consumed (Raper et al. 2004). The steps are:

1. *Quick List.* Collects an uninterrupted listing of all foods and beverages consumed in a 24-hour period.
2. *Forgotten Foods*. Probes for any foods that may have been forgotten during the Quick List.
3. *Time and Eating Occasions.* Collects the time the student began consuming each reported food item and what the student called that eating occasion (breakfast, lunch supper/dinner, or snack).
4. *Detail Cycle*. Through a set of standardized questions, probes for descriptions of each item, including the quantity consumed, where the food was obtained, whether the food was eaten at school, plus any additions made to the food.
5. *Review Cycle.* Collects detailed information for any additional foods not previously mentioned.

Interviews for the elementary school children were done in two stages. An after lunch interview was conducted on the target day to record foods consumed in the morning, and a follow-up interview on the next day was used to records foods consumed in the afternoon and night. For example, if the target day was Monday, the student was interviewed at school after lunch on Monday to record Monday morning's consumption, and the student and his/her parent were interviewed on Tuesday to record foods consumed Monday afternoon and evening. Secondary school students were interviewed alone the day following the target day (e.g., interviews were conducted on Tuesday to record foods consumed on the target day of Monday).

a. Defining Eating Occasion and Location

To describe eating patterns, we used child- (or respondent-) defined eating occasions. Breakfasts, lunches, and suppers/dinners were reported as such. Snacks included foods reported as: snacks, drinks, and extended consumption (i.e., an item or items consumed over a long period

of time, most commonly a drink). Some children reported more than one breakfast, lunch, or supper/dinner (e.g., a breakfast at home *and* a breakfast at school). Children were allowed multiple meals of the same meal name. If a child consumed a school meal, they were counted as a school meal participant.

The 24-hour dietary recall interviews captured the time and name of each eating occasion, the foods and beverages reported at each eating occasion, where the items were consumed (school or nonschool), and the source of items consumed. We used this information to deduce where each eating occasion occurred and to assign eating occasions to a location of school, home, or away from school or home in the following hierarchical manner:

- **School.** For each food or beverage reported in the 24-hour recall, the child was asked if the item was consumed at school. All foods reported to have been consumed at school by the child and all other items consumed at the same eating occasion and time as a food reported to be consumed at school by that child were considered to be consumed at "school".
- **Home.** Foods that were not eaten at school and were obtained from home, a friend/classmate or neighbor (excluding entire classes), or a relative were considered to be consumed at "home".[1] Additionally, any food consumed at the same eating occasion time as a food obtained from one of these sources was also considered to be eaten in the home environment.
- **Away.** All other foods were considered to be consumed "away from the home and school" environments. These included foods obtained from restaurants, non-school vending machines, churches, YMCAs, Boys & Girls clubs, other community sites, sporting events, and ice cream trucks, among others.

Across all students, 54 percent of reported foods were consumed at home, 39 percent at school, and 7 percent away.

[1] Our definition includes foods eaten at home and at friends' and relatives' homes, but it also includes foods taken from home and consumed at other non-school locations.

b. Classifying SSBs and LNEDs

We classified foods and beverages as LNED items if they were low in nutrients but high in energy or caloric density per unit volume or mass (Robert Wood Johnson Foundation 2008) or were defined as foods of minimal nutritional value by USDA school meal regulations (U.S. Congress 2004; Gordon et al. 2007).[2] Energy density is determined by the amount of energy in a given food per unit volume or mass (Keystone Center 2006).[3] Nutrient density is determined by the amount of nutrients that a food contains per unit volume or mass. Foods that are almost entirely composed of fat with minimal water (e.g., butter) are more energy-dense than foods that consist largely of water, fiber, and carbohydrates (e.g., fruits and vegetables). Nutrient density and energy density are independent characteristics, but in practice the nutrient density of a food is often described in relationship to the food's energy density. Compared to foods with high fat content, carbonated soft drinks are not particularly energy-dense because they primarily are made up of water and carbohydrates; however, because they are otherwise low in nutrients, their energy density is high relative to their nutrient content.

All beverages reported in the study were grouped into seven mutually exclusive categories; only one category--sugar-sweetened beverages (SSBs)--met our criteria for LNED items. The SSBs included non-diet soft drinks, fruit-flavored sweetened beverages, "energy" and sports drinks, and sweetened iced teas. LNED solid foods were classified into five mutually exclusive categories: (1) higher-fat baked goods, including muffins and desserts such as cakes, cookies, and brownies; (2) dairy-based desserts (e.g., ice cream); (3) candy (all types) and sweetened

[2] Foods of minimal nutrition value include soft drinks, chewing gum, candy, and water ices (Food and Nutrition Service 2008; U.S. Congress 2004).

[3] Fat stores 9 kilocalories/gram (gm), alcohol stores 7 kilocalories/gm, carbohydrate and protein each store 4 kilocalories/gm, fiber stores 1.5 to 2.5 kilocalories/gm and water has no calories.

gum; (4) french fries and similar potato products; and (5) higher-fat chips and other salty snacks (e.g., potato chips, corn chips). All five groups were included as LNEDs items for this analysis. Together, the SSBs and the LNED solid foods comprise estimates of 'all LNEDs' for this analysis.

c. Calculating Energy Density and Population Ratios

To better understand the contribution of LNED items and other food choices to NSLP participants' and nonparticipants' diets, we estimated energy density by meal/snack and location. Energy density was calculated by summing the total number of calories consumed at a particular location and/or eating occasion and dividing by the total number of grams consumed at that location/eating occasion. Energy density can be assessed either including or excluding some or all types of beverages (Ledikwe et al. 2005). Because we were specifically interested in energy density in relation to SSBs and total energy intake, *all* foods and beverages consumed—including bottled water—were included in the primary energy density calculations. [4]

In calculating mean energy density across a group of individuals, we faced a choice between a population-level estimate and a mean of individual-level estimates. To estimate mean energy density, we chose the population-level approach. We first calculated the mean number of calories in the relevant set of foods consumed across all individuals in the group. Next, we calculated the mean gram weight of foods consumed by these individuals. Finally, we divided the mean calorie intake by the mean gram weight to generate the population-level estimate of mean energy density. The individual-level approach would have been to reverse the order of the calculation—

[4] Since beverages include a significant amount of water, including beverages in the calculation of energy density results in a lower energy density value than calculating energy density solely on the basis of solid foods. We also calculated unadjusted mean energy density from solid foods alone for comparison to energy density from solid foods and beverages combined (see section III.B. below).

first calculating each individual's ratio of calorie intake to gram weight and then calculating the mean of this ratio across individuals. Both the population-level and individual-level approaches are defensible, but they have different analytical meanings (Krebs-Smith et al. 1989). We chose the population-level approach because we felt that the individual-level approach would have produced estimates of mean energy density that were unduly influenced by extreme energy density ratio values among individuals who consumed relatively few foods at a given eating occasion/location.[5]

2. Measuring School Meal Program Participation on the Target Day

This analysis compares children who participate in the NSLP and/or SBP to those who do not. Participation was defined using target day, as opposed to usual, participation. This definition was used in the main SNDA-III study (Gordon et al. 2007) and is based primarily on the foods sample members reported consuming for the appropriate meal on the target day from the school cafeteria. In particular, children in food-based menu-planning schools were counted as participating in NSLP if either: the child consumed at least three of the required five food groups (one grain, one mean/meat alternate, two fruits and/or vegetables, and one milk) and all three were on the school menu for the target day, or if the child reported consuming at least one of the required five groups and reported consuming a school lunch on the target day. Children in nutrient standard menu-planning schools were counted as participating in NSLP if either: the child consumed at least one entrée and one side, both of which were on the school menu for the target day, or the child reported consuming one entrée or one side that was on the school menu for the target day and also reported consuming a school lunch for that day (Gordon et al. 2009).

[5] We also used a population-level approach in calculating the mean percentage of calories coming from LNED items among groups of individuals in the sample.

Participation in the SBP was determined in a similar manner. Children in food-based menu-planning schools were counted as SBP participants if the student consumed at least one of the four required food items (two grains and/or meat/meat alternates, one fruit or vegetable, and one milk) and that item appeared on the school menu for the target day. Children in nutrient-based menu-planning schools were counted as SBP participants if the student reported consuming at least one item that was on the school breakfast menu for the target day (Gordon et al. 2009).

3. Analytic Methods for Estimating Participation-Diet Relationship

The analysis of dietary patterns included 2,314 students for which a complete 24-hour recall and parent interview were obtained. The analysis presented in this chapter (and related appendix tables) is based on both weighted mean values of dietary outcomes and regression-adjusted weighted mean values of these outcomes. The benefit of the regression adjustment is that it allows us to control for some differences in the basic individual and household characteristics of participants and nonparticipants that be related to their dietary patterns. SBP participants tend to come from lower-income households than nonparticipants, for example. In comparing the two groups' dietary patterns, we wanted to account for any differences that arise only because of the difference in the household income of participants and nonparticipants, and that have nothing to do with their participation in the SBP itself.

The specific regression model we estimated depended on the nature of the outcome variable. Regression-adjusted estimates for binary outcomes, such as consuming a meal or not, we based on a logistic regression model. All other outcomes were estimated using a linear regression

model. The main variables included in the model were the following basic demographic and socioeconomic characteristics of the individuals and their households[6]:

- Target day participation in the NSLP
- Target day participation in the SBP
- Age
- Gender
- Race/ethnicity
- Family income
- Family receives public assistance[7]
- Parents' employment status/family structure (number of parents)
- Parents' highest level of education
- Whether English is the primary language spoken at home

The models included variables representing participation in both the SBP and NSLP. Thus, comparisons between participants and nonparticipant in either program control for participation in the other program. However, the comparisons between participants and nonparticipants should not be interpreted as estimations of the impact of participation on dietary patterns, since the two groups may have also differed in characteristics that we did not include as controls in the model.[8] In other words, in the equations representing the factors influencing children's dietary intakes,

[6] See Table IV.2 in Chapter IV for additional description and descriptive statistics of these (and other) characteristics of sample members and their families.

[7] The food assistance category includes receipt of Temporary Assistance for Needy Families (TANF), Medicaid, or food stamps. Receipt of certain forms of public assistance results in automatic qualification for free school meals through the policy of direct certification.

[8] The analysis for this chapter builds on earlier analysis to describe the unadjusted dietary patterns among NSLP participants and nonparticipants (Briefel et al. 2009b). Since the objective of the analysis conducted for this chapter was to describe participants' and nonparticipants' dietary patterns rather than estimate the causal effect of participation, we did not include the full set of control variables that were included in the chapter IV analysis. In addition, we did not include fixed school effects in the analysis for this chapter.

participation in the SBP and NSLP may be endogenous, or related to factors not included in the model that influence dietary intakes.

The variance estimates and tests of statistical significance conducted here were computed using SUDAAN, release 9 (2005, Research Triangle Institute, Research Triangle Park, NC) to account for the complex sampling design used to collect the SNDA-III data, which resulted in clustering of the data within schools and districts. However, to estimate the variance of the regression-adjusted outcomes based on ratios (energy density and the percentage of calories from LNEDs) that were generated using the population-level approach, we had to use an alternative strategy because separate regressions needed to be conducted to generate the numerator and denominator. To calculate these variances and standard errors (for purposes of conducting significance tests), we used a bootstrapping approach, based on 1,000 bootstrapped samples.

B. GENERAL DIETARY PATTERNS OF SCHOOL-AGE CHILDREN

Concerns about high rates of childhood obesity have raised interest in the general meal and snack patterns of school children. Understanding how often and how much food and beverages are consumed across the day is important to developing interventions and implementing school policies and practices to improve children's diet and achieve healthy weight. In this section, we briefly discuss children's overall dietary patterns, without focusing on participant-nonparticipant differences. Thus, the results presented in this section are not regression-adjusted, and are summarized primarily in the tables presented in Appendix A.

SNDA-III data show that on an average school day in spring 2005, nearly all school-age children reported eating lunch, supper/dinner, and at least two snacks (see Appendix A for unadjusted population data, Table A.1). Nearly all children (91 percent) consumed lunch at school, while 23 percent consumed breakfast, and 40 percent reported at least one snack at school (Table A.1). Breakfast was the meal most commonly skipped by children in both

elementary and secondary school. The majority of children reported eating breakfast, supper/dinner, and at least one snack at home, and the most common eating occasion away from school or home was a snack (17 percent), followed by supper/dinner (13 percent) (Table A.1). Mean unadjusted calories at lunch at school and total daily calories were significantly higher among NSLP participants than nonparticipants in secondary school, but not elementary school (Table A.2).

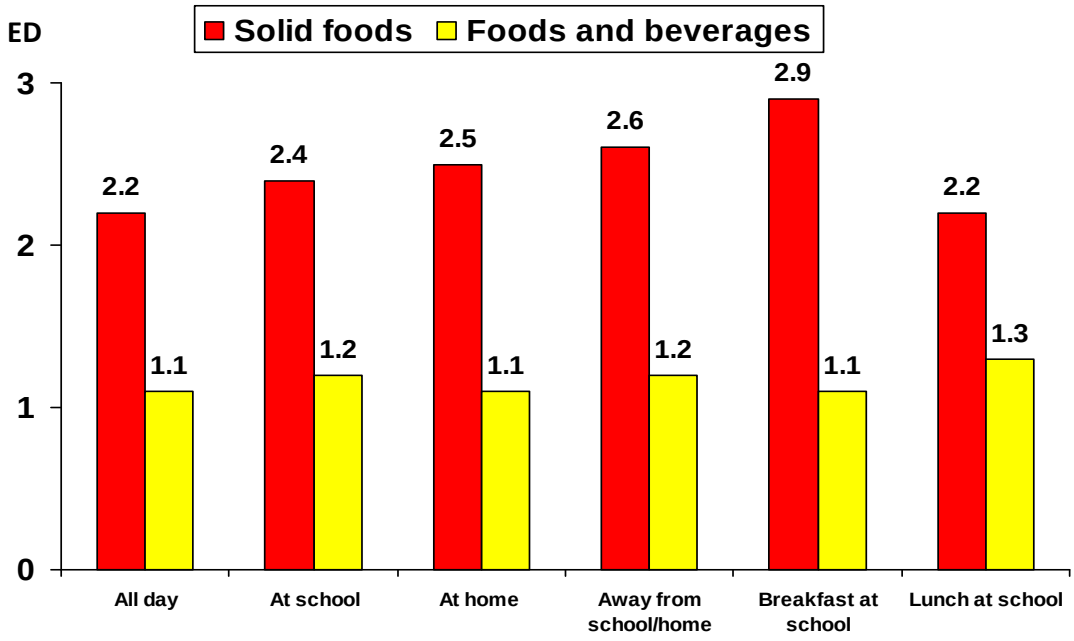
Mean energy density from foods and beverages varied by meal and location, and was higher for consumption at school and at locations away from school and home (means of 1.20 across all students) than for consumption at school (mean of 1.05). Mean energy density of lunches consumed at school was significantly lower for NSLP participants compared to NSLP nonparticipants in elementary schools (Table A.3). We also compared the mean energy density from foods and beverages to that calculated from foods alone, and found that energy density from foods and beverages was lower (typically half or less) than that calculated from solid foods alone. For example, across all children, the daily energy density from foods *and* beverages was 1.11 (Table A.3) compared to 2.21 for solid foods alone. At school, the respective numbers were 1.20 and 2.35 among all children (see Figure III.1 for other examples). [9]

We were also interested in studying the proportion of children consuming SSBs, LNED solid foods, and any LNED solid food or SSB, by location consumed, and the calories provided by these types of foods. Overall, 68 percent of children consumed SSBs at some location during the day, about half (50 percent) consumed SSBs at home, and one-fourth (25 percent) at school

[9] General participant-nonparticipant differences were in the same general direction using either method of calculating energy density for elementary school students. At the secondary school level, the participant-nonparticipant comparisons of the energy density of solid foods alone were more favorable for participants than the comparisons of the energy density of foods and beverages combined.

FIGURE III.1

COMPARISON OF ENERGY DENSITY (ED)
INCLUDING AND EXCLUDING BEVERAGES,
ALL STUDENTS, GRADES 1-12



Note: ED is calculated as total calories divided by grams at the specific meal and location.

(See Figure III.2, derived from Briefel et al. 2009b).[10] Most children (88 percent) consumed some amount of an LNED solid food, and nearly all (95 percent) consumed less nutrient dense calories from an LNED item over the course of a 24-hour period (on a Monday through Friday) (Figure III.2, Briefel et al. 2009b).

On average, public school children consumed 159 calories from SSBs and 368 calories from LNED solid foods (for a total of 527 LNED calories over the course of the day), representing 25 percent of total daily calories (Table A.3). The relative proportion of SSB and LNED calories consumed varied by meal and location and school meal participation (Tables A.4 and A.5). School meal participants consumed fewer calories from SSBs at school, but more calories from LNED items at school, especially baked goods and french fries, at the secondary school level.

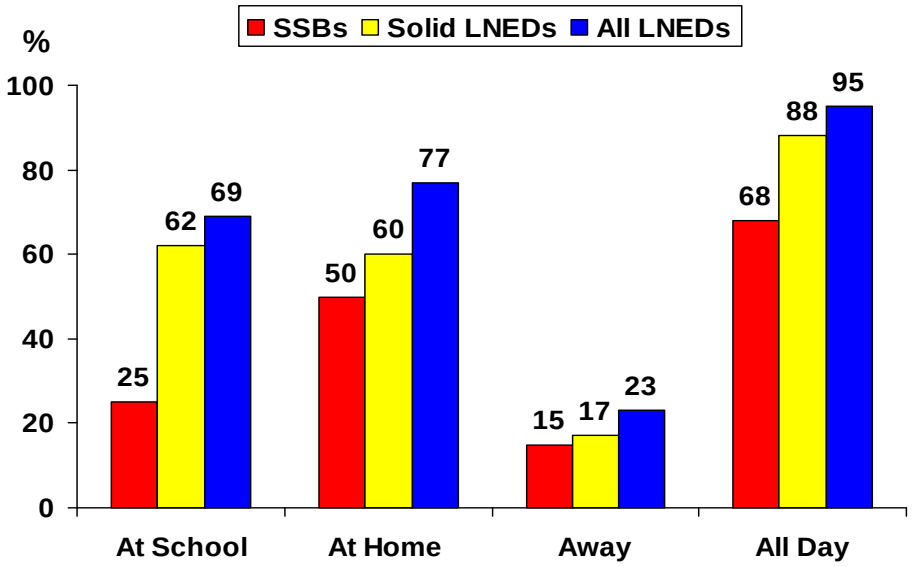
C. RELATIONSHIP OF SCHOOL MEAL PROGRAM PARTICIPATION AND EATING OCCASION/LOCATION

Tables III.1 through III.5 show the meal and snack patterns, total calories, and calories from LNED foods and beverages consumed by participants and nonparticipants of the NSLP, after a regression adjustment for differences in the characteristics of participants and nonparticipants (see Appendix A, Tables A.1 through A.5 for unadjusted data for NSLP participants and nonparticipants). Tables III.6 through III.10 follow the same table format for SBP participants and nonparticipants, and Tables III.11 through III.15 compare students who participated in both

[10] Across *all* elementary school students, the proportion of calories from all LNED items was lowest for consumption at school (20 percent), intermediate for consumption at home (22 percent) and highest for consumption away from school and home (37 percent) (data not shown in tables). Across *all* secondary school students, about 29 percent of calories consumed at school were from LNED items compared to 25 percent at home and 39 percent away from school and home (data not shown in tables). Elementary school students consumed 22 percent of their daily calories from LNED items; this increased to 28 percent among secondary school students (data not shown in tables).

FIGURE III.2

PERCENTAGE OF ALL CHILDREN CONSUMING LOW-NUTRIENT, ENERGY-DENSE (LNED) ITEMS BY LOCATION



Source: Unadjusted SNDA-III data (Briefel et al. 2009a).

SSBs = sugar-sweetened beverages.

TABLE III.1

REGRESSION-ADJUSTED MEAL AND SNACK PATTERNS OF NATIONAL SCHOOL LUNCH PROGRAM (NSLP) PARTICIPANTS AND NONPARTICIPANTS (PROPORTION CONSUMING)

	Elementary School		Secondary School		
	NSLP Participants[a]	NSLP Nonparticipants	NSLP Participants[a]	NSLP Nonparticipants	All Students
Total Daily					
Breakfast	88.4	92.4	74.7	77.6	83.2
Lunch	100.0**	93.3	100.0**	84.2	95.7
Supper/dinner	95.3	94.6	92.9	92.8	93.8
Snacks	95.0	92.6	93.1	93.0	93.8
Mean no. of snacks[b]	2.4	2.3	2.3	2.3	2.3
At School					
Breakfast	27.0	28.3	17.8	18.6	22.7
Lunch	100.0**	91.3	100.0**	66.0	90.1
Supper/dinner	2.7	3.8	1.2	1.4	2.1
Snacks	42.4	48.0	33.7	35.7	38.5
Mean no. of snacks[b]	0.5	0.6	0.5	0.5	0.5
At Home					
Breakfast	62.0	66.9	56.9	57.4	60.6
Lunch	0.7*	5.0	1.4**	9.8	3.7
Supper/dinner	81.7	82.4	78.6	77.8	80.1
Snacks	85.1*	78.4	84.5	81.7	83.4
Mean no. of snacks[b]	1.7*	1.4	1.6	1.6	1.6
At Locations Away from School/Home					
Breakfast	1.6	1.2	1.5*	3.2	1.9
Lunch	0.2*	3.9	0.7**	9.2	3.2
Supper/dinner	11.2	10.8	13.8	13.8	12.3
Snacks	15.0	18.1	19.6	18.4	17.2
Mean no. of snacks[b]	0.2	0.2	0.3	0.3	0.2
Sample Size	**531**	**201**	**855**	**727**	**2,314**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]NSLP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.2

REGRESSION-ADJUSTED MEAN ENERGY INTAKE BY LOCATION FOR NATIONAL SCHOOL LUNCH PROGRAM (NSLP) PARTICIPANTS AND NONPARTICIPANTS (IN KCAL)

	Elementary School		Secondary School		
	NSLP Participants[a]	NSLP Nonparticipants	NSLP Participants[a]	NSLP Nonparticipants	All Students
Total Daily	**2,008**	**2,076**	**2,199**	**2,109**	**2,084**
Breakfast	331	366	313	324	330
Lunch	562	562	635**	518	569
Supper/dinner	611	628	691	691	650
Snacks[b]	504	519	559	576	535
Total at School	**759**	**744**	**762****	**553**	**706**
Breakfast	98	100	71	76	86
Lunch	559	505	618**	381	523
Supper/dinner	16	18	5	9	11
Snacks[b]	86	120	68	87	86
Total at Home	**1,105**	**1,156**	**1,211**	**1,276**	**1,179**
Breakfast	227	256	232	233	235
Lunch	4	13	8**	60	20
Supper/dinner	506	544	565	570	540
Snacks[b]	368	342	407	413	384
Total Away from School/Home	**144**	**175**	**225***	**280**	**199**
Breakfast	6	10	10	16	10
Lunch	0*	43	9**	77	25
Supper/dinner	90	66	122	112	99
Snacks[b]	50	57	84	76	65
Sample Size	**531**	**201**	**855**	**727**	**2,314**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]NSLP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.3

REGRESSION-ADJUSTED MEAN ENERGY DENSITY BY LOCATION FOR NATIONAL SCHOOL LUNCH PROGRAM (NSLP) PARTICIPANTS AND NONPARTICIPANTS

	Elementary School		Secondary School		
	NSLP Participants[a]	NSLP Nonparticipants	NSLP Participants[a]	NSLP Nonparticipants	All Students
Total Daily	**1.17**	**1.21**	**1.08**	**1.05**	**1.12**
Breakfast	1.10	0.98	1.05	1.03	1.05
Lunch	1.28**	1.50	1.24	1.26	1.28
Supper/dinner	1.21	1.18	1.16	1.12	1.17
Snacks[b]	1.07*	1.21	0.88	0.85	0.97
Total at School	**1.25****	**1.42**	**1.14**	**1.10**	**1.21**
Breakfast	1.09	---[c]	1.16	1.16	1.12
Lunch	1.28**	1.53	1.25	1.28	1.29
Supper/dinner	---[c]	---[c]	---[c]	---[c]	1.19
Snacks[b]	1.28	1.46	0.64	0.66	0.91
Total at Home	**1.10**	**1.11**	**1.04**	**1.01**	**1.06**
Breakfast	1.10	0.94	1.02	0.98	1.02
Lunch	---[c]	---[c]	---[c]	1.14	1.12
Supper/dinner	1.18	1.18	1.14	1.12	1.15
Snacks[b]	1.00	1.13	0.93	0.90	0.97
Total Away from School/Home	**1.38**	**1.25**	**1.15**	**1.08**	**1.18**
Breakfast	---[c]	---[c]	---[c]	---[c]	1.28
Lunch	---[c]	---[c]	---[c]	1.28	1.26
Supper/dinner	1.39	---[c]	1.33**	1.09	1.26
Snacks[b]	1.35	1.34	0.96	0.89	1.03
Sample Size	**531**	**201**	**855**	**727**	**2,314**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

Note: Energy density was calculated using solid foods and beverages.

[a]NSLP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.
[c]Sample sizes were too small to compute a reliable statistic.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.4

REGRESSION-ADJUSTED MEAN ENERGY FROM SUGAR-SWEETENED BEVERAGES (SSBS) AND LOW-NUTRIENT, ENERGY-DENSE (LNED) FOODS AMONG PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL LUNCH PROGRAM (NSLP)
(IN KCAL)

	Elementary School		Secondary School		
	NSLP Participants[a]	NSLP Nonpartici-pants	NSLP Participants[a]	NSLP Nonpartici-pants	All Students
All Locations					
SSBs – total	101*	127	197*	225	160
-- at breakfast	4**	14	12	13	9
-- at lunch	3**	36	27**	58	27
-- at dinner/supper	48	45	73	71	60
-- at snacks[b]	47*	32	84	83	64
LNED solid foods-total	336	391	397	383	370
-- at breakfast	51	45	47	40	46
-- at lunch	67*	107	97	99	88
-- at dinner/supper	56	46	51	67	56
-- at snacks[b]	162	192	202	177	180
All LNED items - total	437*	518	593	608	530
% kcal from all LNEDs	21.8*	24.9	27.0	28.8	25.4
At School					
SSBs – total	10**	35	45**	59	35
-- at breakfast	1	1	4	3	2
-- at lunch	3**	28	26**	40	22
-- at dinner/supper	1	1	1	1	1
-- at snacks[b]	6	6	14	17	11
LNED solid foods-total	118**	182	154*	133	139
-- at breakfast	15	14	20	14	16
-- at lunch	67*	100	96*	77	81
-- at dinner/supper	0	1	<0.5	<0.5	<0.5
-- at snacks[b]	36*	67	39	42	42
All LNED items - total	129**	217	199	192	174
% kcal from all LNEDs	17.0**	29.2	26.2**	34.7	24.7
At Home					
SSBs – total	72	70	113	117	94
-- at breakfast	3**	11	6	9	6
-- at lunch	<0.5	2	1**	6	2
-- at dinner/supper	34	35	54	52	44
-- at snacks[b]	35**	21	52	51	41
LNED solid foods-total	183	167	195	189	185
-- at breakfast	33	30	26	23	29
-- at lunch	<0.5	1	<0.5**	6	2
-- at dinner/supper	39	33	32	44	37
-- at snacks[b]	111	103	136	116	118
All LNED items - total	255	237	308	306	279
% kcal from all LNEDs	23.1	20.5	25.4	24.0	23.7

TABLE III.4 *(continued)*

	Elementary School		Secondary School		
	NSLP Participants[a]	NSLP Nonparticipants	NSLP Participants[a]	NSLP Nonparticipants	All Students
At Locations Away from School/Home					
SSBs – total	19	22	39	48	31
-- at breakfast	<0.5	2	2	1	1
-- at lunch	0*	6	1**	13	4
--at dinner/supper	13	9	18	18	14
-- at snacks[b]	6	5	18	16	12
LNED solid foods-total	35	42	48	62	46
-- at breakfast	2	1	1	3	2
-- at lunch	0	7	1**	17	5
--at dinner/supper	17	12	19	23	19
-- at snacks[b]	15	22	27	20	20
All LNED items - total	53	64	86	110	77
% kcal from all LNEDs	37.0	36.2	38.4	39.3	38.7
Sample Size	**531**	**201**	**855**	**727**	**2,314**

Source: School Nutrition Dietary Assessment Study-III, 24-hour Dietary Recall Interview, school year 2004-2005. Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]NSLP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.5

REGRESSION-ADJUSTED MEAN ENERGY FROM LOW-NUTRIENT, ENERGY-DENSE (LNED) FOODS AMONG PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL LUNCH PROGRAM (NSLP) (IN KCAL)

	Elementary School		Secondary School		
	NSLP Participants[a]	NSLP Nonparticipants	NSLP Participants[a]	NSLP Nonparticipants	All Students
All Locations					
Baked goods/desserts	142	171	156	137	148
Dairy-based desserts	52	35	38	34	42
Candy	34*	53	62	63	50
French fries	51	45	73	65	59
Chips/salty snacks	56**	86	66*	83	70
At School					
Baked goods/desserts	48	81	51	40	51
Dairy-based desserts	15	10	7	4	10
Candy	10**	25	26	29	21
French fries	21*	9	45**	15	24
Chips/salty snacks	23**	57	25**	44	34
At Home					
Baked goods/desserts	87	78	97	85	88
Dairy-based desserts	33	23	29	27	29
Candy	18	22	27	29	23
French fries	16	19	8*	18	14
Chips/salty snacks	30	25	33	29	30
At Locations Away from School/Home					
Baked goods/desserts	7	12	8	11	9
Dairy-based desserts	4	2	2	4	3
Candy	7	6	9	6	6
French fries	14	17	19*	33	21
Chips/salty snacks	3	4	8	9	6
Sample Size	**531**	**201**	**855**	**727**	**2,314**

Source: School Nutrition Dietary Assessment Study-III, 24-hour Dietary Recall Interview, school year 2004-2005. Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]NSLP participation is participation on the target recall day.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

the NSLP and the SBP versus those who participated in neither program on the target day (unadjusted data are found in Appendix Tables A.6-A.10 and Tables A.11-A.15, respectively).

1. NSLP Participants and Nonparticipants

a. Elementary school

Not surprisingly, NSLP participants were significantly more likely than nonparticipants to consume *any* lunch, as well as being more likely to consume lunch at school versus home or other locations (Table III.1).[11] NSLP participants were also more likely to consume one or more snacks at home compared to nonparticipants. However, these meal and snack pattern differences did not translate to significant differences between participants and nonparticipants in mean calorie intakes at any location, at any individual meal or snacks, or in total daily calories (except that, on average, no calories were consumed at lunch at locations away from school/home among participants) (Table III.2) On the other hand, energy density at school (and for lunches at school) was significantly lower for NSLP participants than for nonparticipants, but this did not translate into a significant difference over the course of the full day (Table III.3).

We explored energy density in greater detail by analyzing students' consumption patterns of sugar-sweetened beverages and LNED solid foods. NSLP participants in elementary schools consumed significantly fewer calories from both SSBs and LNED solid foods at school, with participants consuming LNED foods and SSBs totaling 129 calories at school (17 percent of all at school calories) compared with 217 calories (29 percent of all school calories) among nonparticipants. This difference translated into significantly fewer total daily calories from LNED items (437 versus 518 kcal) and a significantly lower average percentage of calories from LNED items (22 versus 25 percent) (Table III.4).

[11] Breakfast and lunch include all meals, not only reimbursable school meals.

As noted above, NSLP participants consumed fewer calories from LNED solid foods at school, particularly at lunch and as snacks, as well as over the full day (Table III.4). Tables III.5 and Figure III.3 show the individual categories of LNED foods consumed by participants and nonparticipants. Compared to nonparticipants, NSLP participants consumed fewer mean calories from candy and chips/salty snacks at-school and over the course of the day. On the other hand, NSLP participants consumed more calories from french fries at school compared to nonparticipants (mean of 21 versus 9 kcal), though this difference evened out somewhat over the course of the day and was no longer statistically significant.

b. Secondary school

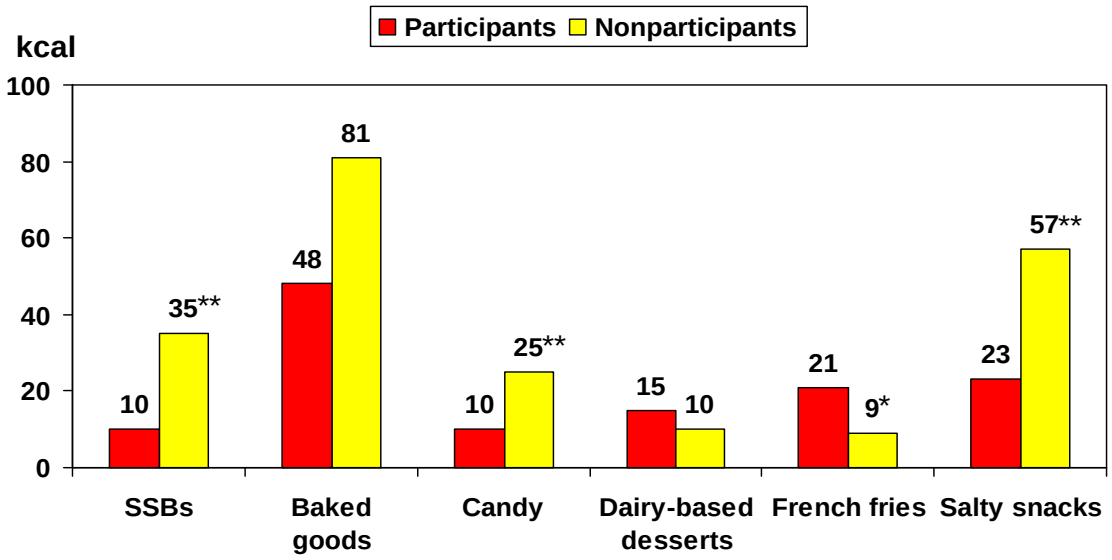
While all NSLP participants consumed lunch at school in secondary schools, only about two-thirds of nonparticipants did so (Table III.1). NSLP nonparticipants were more likely to have consumed lunch at home (10 percent) or at other locations away from school or home (9 percent) compared to NSLP participants. Overall, participants were more likely to have consumed lunch (at any location), and their mean lunchtime calorie intake was significantly higher than that of nonparticipants (635 versus 518 calories) (Table III.2). However, while participants were estimated to have consumed 90 more calories than nonparticipants consumed over the course of the day, on average, this difference was not statistically significant.

At the secondary school level, participants and nonparticipants had similar mean energy density levels over the course of the day and at nearly every meal and location. One exception involved suppers/dinners consumed away from school and home, where the energy density of NSLP participants was significantly higher than that of nonparticipants (Table III.3).

Overall, NSLP participants and nonparticipants at the secondary school level consumed similar amounts of LNED items and a similar percentage of total calories from LNED items over

FIGURE III.3

CONSUMPTION OF LOW-NUTRIENT, ENERGY-DENSE ITEMS AT SCHOOL, BY NSLP PARTICIPATION STATUS (ELEMENTARY SCHOOLS)



Note: Regression-adjusted SNDA-III data. SSBs= sugar-sweetened beverages.
*significantly different from participants at *P*<0.05 level.
**significantly different from participants at *P*<0.01 level.

the course of the day. This overall similarity masks some interesting differences in patterns of LNED consumption by meal and location, however. NSLP participants in secondary schools consumed significantly fewer calories from sugar-sweetened beverages at school (45 versus 59 kcal) and across the full day (27 versus 58 kcal) than did nonparticipants (Table III.4). And while participants' absolute calorie intake from LNED solid foods was significantly higher than that of nonparticipants (154 versus 133 kcal), participants actually consumed a *lower* percentage of calories from all LNED items at school (26 versus 35 percent). However, these significant differences at school were not sufficiently large to translate into significant differences in the percentage of calories from LNED items across all locations.

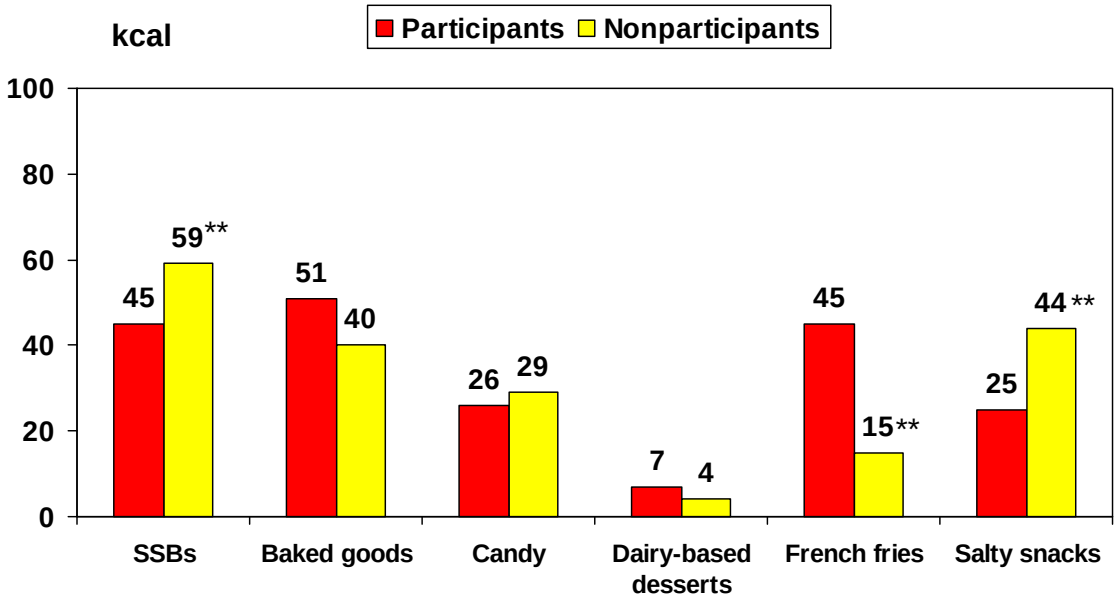
At the secondary school level, there were no significant differences in LNED solid food calories overall or for any meal type, but NSLP participants consumed significantly more calories from french fries at school (45 versus 15 kcal) and significantly fewer calories from chips/salty snacks (25 versus 44 kcal) (Table III.5, Figure III.4). However, the at-school difference in french fries was offset by lower calories from french fries at both home and away locations, resulting in no significant difference in calories from french fries over the course of the day (Table III.5). Overall, higher-fat baked goods/desserts were the largest contributor to LNED calories for both participant groups.

c. NSLP summary

NSLP participation was associated with participants consuming a higher share of daily calories at school, but no significant difference in total daily calories. Mean energy density at school was lower among NSLP participants than nonparticipants for elementary school only, but there were no significant differences at either school level in participants' and nonparticipants' mean 24-hour energy density. Calories from sugar-sweetened beverages were significantly lower

FIGURE III.4

CONSUMPTION OF LOW-NUTRIENT, ENERGY-DENSE ITEMS AT SCHOOL, BY NSLP PARTICIPATION STATUS (SECONDARY SCHOOLS)



Note: Regression-adjusted SNDA-III data. SSBs= sugar-sweetened beverages.
**significantly different from participants at *P*<0.01 level.

at school (and overall) among NSLP participants compared to nonparticipants at both the elementary and secondary school levels. Over all students, an average of 160 calories were consumed from SSBs on an average school day (Table III.4), the equivalent of one 12-fluid ounce soft drink. SSB consumption was higher among secondary school students than elementary school students.

The percentage of calories from all LNED items was significantly lower at school for NSLP participants than nonparticipants at both school levels. However, only at elementary schools did this translate into participants having a lower percentage of calories from LNEDs over the full day across locations. At-school differences in LNED calories were driven by NSLP participants consuming fewer SSBs at lunch and more french fries at lunch compared with nonparticipants at both school levels. On the other hand, calories from chips/salty snacks at-school and overall were significantly lower among NSLP participants in both school levels.

2. SBP Participants and Nonparticipants

a. Elementary School

Whereas all SBP participants (by definition) consumed breakfast at school, most SBP nonparticipants (77 percent) consumed breakfast at home (Table III.6). Overall, participants were significantly more likely to eat breakfast (at any location), and this contributed to significantly higher calorie intakes among elementary school SBP participants compared to nonparticipants. Over the full day, participants consumed 2,163 kcal compared with 2,004 among nonparticipants. This difference was driven mostly by the difference in intake at breakfast, across locations (414 versus 327 kcal) (Table III.7).

While SBP participants energy density was significantly lower than that of nonparticipants at school (across all meals and snacks at school), no other energy density differences were noted for other locations or for the total daily consumption (Table III.8). In fact, both SBP participants

TABLE III.6

REGRESSION-ADJUSTED MEAL AND SNACK PATTERNS OF SCHOOL BREAKFAST PROGRAM (SBP) PARTICIPANTS AND NONPARTICIPANTS (PROPORTION CONSUMING)

	Elementary School		Secondary School		
	SBP Participants[a]	SBP Nonpartici-pants	SBP Participants[a]	SBP Nonpartici-pants	All Students
Total Daily					
Breakfast	100.0**	85.2	100.0**	71.2	83.2
Lunch	98.6	97.3	88.9	92.9	95.7
Supper/dinner	91.6	95.7	95.1	92.5	93.8
Snacks	96.9*	92.3	90.7	93.0	93.8
Mean no. of snacks[b]	2.4	2.3	2.2	2.3	2.3
At School					
Breakfast	100.0**	7.2	100.0**	7.1	22.7
Lunch	100.0**	95.9	78.8	83.2	90.1
Supper/dinner	4.4	2.9	1.3	1.3	2.1
Snacks	46.0	39.3	33.2	35.5	38.5
Mean no. of snacks[b]	0.6	0.5	0.4	0.5	0.5
At Home					
Breakfast	14.3**	76.7	17.0**	61.8	60.6
Lunch	0.5**	1.6	4.9	5.7	3.7
Supper/dinner	79.0	82.8	84.9**	76.9	80.1
Snacks	82.9	82.9	80.3	83.0	83.4
Mean no. of snacks[b]	1.6	1.6	1.5	1.6	1.6
At Locations Away From School/Home					
Breakfast	1.0	1.7	0.6	2.6	1.9
Lunch	0.0**	1.6	3.5	5.6	3.2
Supper/dinner	8.9	10.8	9.6*	14.8	12.3
Snacks	17.1	14.5	18.6	19.0	17.2
Mean no. of snacks[b]	0.2	0.2	0.2	0.2	0.2
Sample Size	**160**	**572**	**221**	**1,361**	**2,314**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]SBP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.7

REGRESSION-ADJUSTED MEAN ENERGY INTAKE BY LOCATION FOR SCHOOL BREAKFAST PROGRAM (SBP) PARTICIPANTS AND NONPARTICIPANTS (IN KCAL)

	Elementary School		Secondary School		
	SBP Participants[a]	SBP Nonparticipants	SBP Participants[a]	SBP Nonparticipants	All Students
Total Daily	**2,163***	**2,004**	**2,399****	**2,112**	**2,084**
Breakfast	414**	327	469**	298	330
Lunch	572	565	584	577	569
Supper/dinner	619	614	739	678	650
Snacks[b]	559	498	607	560	535
Total at School	**1,046****	**672**	**996****	**611**	**706**
Breakfast	355**	24	388**	30	86
Lunch	567	545	515	496	523
Supper/dinner	31	15	7	7	11
Snacks[b]	93	88	87	78	86
Total at Home	**966****	**1,184**	**1,185**	**1,240**	**1,179**
Breakfast	56**	294	77**	253	234
Lunch	4	5	37	35	20
Supper/dinner	517	522	645**	546	540
Snacks[b]	390	363	426	406	384
Total Away from School/Home	**152**	**148**	**217**	**262**	**199**
Breakfast	3	10	4**	15	10
Lunch	2	15	31	45	25
Supper/dinner	71	77	87	125	99
Snacks[b]	77	46	94	77	65
Sample Size	**160**	**572**	**221**	**1,361**	**2,314**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]NSLP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.8

REGRESSION-ADJUSTED MEAN ENERGY DENSITY BY LOCATION FOR NATIONAL SCHOOL BREAKFAST PROGRAM (SBP) PARTICIPANTS AND NONPARTICIPANTS

	Elementary School		Secondary School		
	SBP Participants[a]	SBP Nonparticipants	SBP Participants[a]	SBP Nonparticipants	All Students
Total Daily	**1.18**	**1.18**	**1.12****	**1.06**	**1.12**
Breakfast	1.04	1.06	1.11	1.03	1.05
Lunch	1.33	1.32	1.28	1.24	1.28
Supper/dinner	1.21	1.20	1.13	1.14	1.17
Snacks[b]	1.12	1.12	0.99	0.86	0.97
Total At School	**1.22****	**1.32**	**1.18**	**1.12**	**1.21**
Breakfast	1.07	1.23	1.14	1.19	1.12
Lunch	1.33	1.33	1.28	1.25	1.29
Supper/dinner	---[c]	---[c]	---[c]	---[c]	1.19
Snacks[b]	1.16	1.38	0.89	0.65	0.91
Total at Home	**1.12**	**1.10**	**1.06**	**1.02**	**1.06**
Breakfast	0.92	1.04	1.01	1.00	1.02
Lunch	---[c]	---[c]	---[c]	1.09	1.12
Supper/dinner	1.19	1.18	1.11	1.12	1.15
Snacks[b]	1.07	1.05	0.99	0.90	0.97
Total Away from School/Home	**1.26**	**1.32**	**1.15**	**1.11**	**1.18**
Breakfast	---[c]	---[c]	---[c]	1.27	1.28
Lunch	---[c]	---[c]	---[c]	1.27	1.26
Supper/dinner	---[c]	1.38	---[c]	1.19	1.26
Snacks[b]	---[c]	1.27	1.07	0.92	1.03
Sample Size	**160**	**572**	**221**	**1,361**	**2,314**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

Note: Energy density was calculated using solid foods and beverages.

[a]NSLP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.
[c]Sample sizes were too small to compute a reliable statistic.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

and nonparticipants had a mean energy density of 1.18 among foods and beverages consumed across the full day and all locations.

Among elementary school children, there were no significant differences in the amount of daily calories from sugar-sweetened beverages by SBP participation status, either overall or at any location or meal. However, SBP participants mean calorie intake from LNED solid foods were significantly higher than that of nonparticipants at breakfast, lunch, and overall at school compared to SBP nonparticipants (Table III.9). This finding translated to a significantly higher LNED calorie intake from LNED solid foods over the day (405 kcal versus 337 kcal) among SBP participants versus nonparticipants. However, the proportion of calories from LNED items (beverages or solids) for the two groups was not significantly different at school or over the full day.

At the elementary school level, SBP participants' higher mean calorie intake from LNED solid foods was driven by greater consumption of higher-fat baked goods/desserts at school (Table III.10). These items included sweet rolls, donuts, pastries, cookies, brownies, and other desserts (Gordon et al. 2007). No other differences between SBP participants and nonparticipants in consumption of types of LNED solid foods were noted by location or LNED food category.

b. Secondary school

As with elementary school students, secondary school SBP participants were more likely to consume breakfast (Table III.6). This translated into a large difference in the likelihood of eating breakfast at any location, with all SBP participants consuming breakfast compared with 71

TABLE III.9

REGRESSION-ADJUSTED MEAN ENERGY FROM SUGAR-SWEETENED BEVERAGES (SSBS) AND LOW-NUTRIENT, ENERGY-DENSE (LNED) FOODS AMONG PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL BREAKFAST PROGRAM (SBP)
(IN KCAL)

	Elementary School		Secondary School		
	SBP Participants[a]	SBP Nonparticipants	SBP Participants[a]	SBP Nonparticipants	All Students
All Locations					
SSBs - total	105	110	197	212	160
-- at breakfast	3	8	11	13	10
-- at lunch	11	12	39	47	27
-- at dinner/supper	49	46	74	71	60
-- at snacks[b]	42	43	72	85	64
LNED solid foods-total	405*	337	478**	377	370
-- at breakfast	63	49	91**	36	47
-- at lunch	94	75	99	98	88
-- at dinner/supper	48	52	68	57	56
-- at snacks[b]	201	162	220	187	180
All LNED items - total	509	447	674*	589	530
% kcal from all LNEDs	23.5	22.3	28.1	27.9	25.4
At School					
SSBs - total	19	19	48	53	35
-- at breakfast	1	1	7	3	2
-- at lunch	10	10	30	34	22
-- at dinner/supper	2	1	1	1	1
-- at snacks[b]	6	7	10	16	11
LNED solid foods-total	191**	115	212**	133	139
-- at breakfast	46**	6	80**	7	16
-- at lunch	94*	73	85	85	81
-- at dinner/supper	0	0	0	0	0
-- at snacks[b]	51	36	47	40	42
All LNED items - total	210**	134	260**	186	174
% kcal from all LNEDs	20.1	19.9	26.1	30.4	24.7
At Home					
SSBs - total	65	73	115	114	94
-- at breakfast	1*	7	4	8	6
-- at lunch	0	1	3	3	2
-- at dinner/supper	36	35	61	50	44
-- at snacks[b]	29	30	46	53	42

TABLE III.9 *(continued)*

	Elementary School		Secondary School		
	SBP Participants[a]	SBP Nonparticipants	SBP Participants[a]	SBP Nonparticipants	All Students
LNED solid foods-total	178	187	219	188	185
-- at breakfast	32**	40	11**	27	29
-- at lunch	0	0	6	3	2
-- at dinner/supper	37	37	53	34	37
-- at snacks[b]	109	111	149	124	118
All LNED items - total	246	260	334	302	279
% kcal from all LNEDs	25.5	22.0	28.2	24.4	23.7
At Locations Away from School/Home					
SSBs - total	20	19	35	45	31
-- at breakfast	1	1	0**	3	1
-- at lunch	1	2	6	7	4
-- at dinner/supper	11	10	12*	20	15
-- at snacks[b]	7	6	17	16	12
LNED solid foods-total	37	34	46	56	46
-- at breakfast	2	2	0	2	2
-- at lunch	2	2	8	9	5
-- at dinner/supper	16	15	15	23	19
-- at snacks[b]	17	16	24	23	20
All LNED items - total	53	53	81	101	77
% kcal from all LNEDs	35.1	35.8	37.1	38.7	38.7
Sample Size	**160**	**572**	**221**	**1,361**	**2,314**

Source: School Nutrition Dietary Assessment Study-III, 24-hour Dietary Recall Interview, school year 2004-2005. Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]SBP participation is participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.10

REGRESSION-ADJUSTED MEAN ENERGY FROM LOW-NUTRIENT, ENERGY-DENSE (LNED) FOODS AMONG PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL BREAKFAST PROGRAM (SBP) (IN KCAL)

	Elementary School		Secondary School		
	SBP Participants[a]	SBP Nonparticipants	SBP Participants[a]	SBP Nonparticipants	All Students
All Locations					
Baked goods/desserts	199**	140	189*	138	148
Dairy-based desserts	41	50	44	35	42
Candy	41	33	89	61	50
French fries	52	51	76	67	59
Chips/salty snacks	70	62	79	73	70
At School					
Baked goods/desserts	107**	43	102**	38	51
Dairy-based desserts	9	12	6	5	10
Candy	17	12	31	27	21
French fries	24	17	35	28	24
Chips/salty snacks	33	31	38	34	34
At Home					
Baked goods/desserts	87	85	81	90	88
Dairy-based desserts	27	36	36	27	29
Candy	16	18	49*	27	23
French fries	15	20	18	12	14
Chips/salty snacks	35	29	33	31	30
At Locations Away from School/Home					
Baked goods/desserts	6	12	5*	10	9
Dairy-based desserts	5	2	1	3	3
Candy	9	3	9	7	6
French fries	13	15	23	26	21
Chips/salty snacks	2	2	7	9	6
Sample Size	**160**	**572**	**221**	**1,361**	**2,314**

Source: School Nutrition Dietary Assessment Study-III, 24-hour Dietary Recall Interview, school year 2004-2005. Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]SBP participation is participation on the target recall day.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

percent among nonparticipants. This led to substantial differences in calorie intake at breakfast and over the full day. SBP participants consumed 171 more calories at breakfast and 287 more calories over the entire day compared to SBP nonparticipants; participants also consumed 385 more calories at school (Table III.7). Mean energy consumed at home and away from school and home was not different between secondary school participant groups (Table III.8). However, mean energy density was slightly higher over the course of the day for SBP participants.

Consumption of calories from LNED solid foods was 101 calories higher among SBP participants than nonparticipants at the secondary school level. This difference was driven primarily (but not entirely) by calories from LNED solid foods consumed at breakfast (Table III.9). SBP participants consumed significantly more calories from baked goods and desserts at school (and over the course of the day), as well as more calories from candy at home compared to SBP nonparticipants (Table III.10).

c. SBP Summary

SBP participants consumed significantly more calories from baked goods/desserts at school (and over the course of the day) in both school levels. There were few significant differences in SBP participants' and nonparticipants' consumption of LNED items at home or away from home and school. Therefore, most of the observed differences at the total daily level were driven by at-school differences related to SBP participation and at-home consumption. SBP participants were more likely to eat breakfast at school and therefore more calories at school than SBP nonparticipants. This translates to a higher calorie intake among SBP participants over the course of the day at both school levels. Unlike the finding for NSLP participation, consumption of SSB calories did not differ by SBP participation and relates to SSBs being primarily consumed at lunch (in other words, controlling for NSLP participation removed SSB differences since most

NSLP participants consumed milk or 100% juice as part of the school lunch rather than purchasing a sugar-sweetened beverage for lunch).

Energy density at school was significantly lower among SBP participants compared with nonparticipants in elementary school, but not significantly different in secondary school. In fact, secondary school students who participated in the SBP had a slightly higher energy density over the course of the day. This most likely reflects both higher calorie and higher LNED solid food consumption across the day.

3. Participants in Both or Neither the NSLP and SBP

Students who participated in both the NSLP and the SBP, and those who participated in neither program represent unique groups within the student population. By definition, students who participated in both programs consumed both a breakfast and a lunch at school. In this section, we compare them to students who consumed neither school meal. Students who consumed one school meal, but not the other, are excluded from this analysis.

a. Elementary School

NSLP/SBP participants consumed both breakfast and lunch at school, whereas nonparticipants were more likely to consume breakfast at home (82 versus 13 percent)[12] or to skip breakfast or lunch (Table III.11). There were no significant differences in snack patterns between NSLP/SBP participants and nonparticipants.

Not surprisingly, mean energy intake was significantly higher for NSLP/SBP participants at school, and significantly lower at home, translating to no significant differences between the two participation groups over the course of the day (Table III.12). Mean energy density was

[12] Students that consumed a school breakfast were counted as SBP participants; some of these students also consumed a second breakfast at home.

TABLE III.11

REGRESSION-ADJUSTED MEAL AND SNACK PATTERNS OF PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL LUNCH PROGRAM (NSLP) AND SCHOOL BREAKFAST PROGRAM (SBP) (PROPORTION CONSUMING)

	Elementary School		Secondary School	
	NSLP/SBP Participants[a]	NSLP/SBP Nonparticipants	NLSP/SBP Participants[a]	NSLP/SBP Nonparticipants
Total Daily				
Breakfast	100.0**	89.5	100.0**	73.8
Lunch	100.0**	92.5	100.0**	85.3
Supper/dinner	92.5	95.6	95.1	92.4
Snacks	97.5*	90.8	91.2	93.3
Mean no. of snacks[b]	2.5	2.2	2.2	2.3
At School				
Breakfast	100.0**	8.4	100.0**	7.8
Lunch	100.0**	88.3	100.0**	67.1
Supper/dinner	3.5	3.3	1.2	1.4
Snacks	47.5	46.4	31.7	36.0
Mean no. of snacks[b]	0.6	0.6	0.4	0.5
At Home				
Breakfast	13.4**	81.5	17.3**	62.6
Lunch	0.2**	6.3	1.2**	10.0
Supper/dinner	78.7	83.3	85.5**	76.8
Snacks	85.2	78.4	82.3	82.0
Mean no. of snacks[b]	1.7	1.4	1.6	1.6
At Locations Away from School/Home				
Breakfast	1.0	1.3	0.4*	3.5
Lunch	0.0**	5.5	0.4**	9.6
Supper/dinner	9.7	11.2	9.3	14.3
Snacks	17.0	17.4	19.2	18.5
Mean no. of snacks[b]	0.2	0.2	0.2	0.2
Sample Size	**150**	**191**	**173**	**679**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a] NSLP and SBP participation on the target recall day.
[b] Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.12

REGRESSION-ADJUSTED MEAN ENERGY INTAKE BY LOCATION FOR PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL LUNCH PROGRAM (NSLP) AND SCHOOL BREAKFAST PROGRAM (SBP) (IN KCAL)

	Elementary School		Secondary School	
	NSLP/SBP Participants[a]	NSLP/SBP Nonparticipants	NSLP/SBP participants[a]	NSLP/SBP Nonparticipants
Total Daily	**2,130**	**2,038**	**2,450****	**2,074**
Breakfast	398*	346	464**	304
Lunch	568	560	641**	517
Supper/dinner	614	627	745	684
Snacks[b]	551	505	601	570
Total At School	**1,046****	**657**	**1,101****	**506**
Breakfast	353**	23	385**	32
Lunch	576	500	635**	379
Supper/dinner	28	15	4	10
Snacks[b]	89	119	77	86
Total at Home	**937****	**1,207**	**1,164**	**1,283**
Breakfast	44**	311	77**	254
Lunch	3	14	10**	60
Supper/dinner	502	545	652*	558
Snacks[b]	388	336	424	411
Total Away from School/Home	**148**	**174**	**186**	**286**
Breakfast	1	11	1**	17
Lunch	0*	46	0**	79
Supper/dinner	85	67	89	117
Snacks[b]	73	50	100	74
Sample Size	**150**	**191**	**173**	**679**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]NSLP and SBP participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

significantly lower at school for NSLP/SBP participants compared to nonparticipants, but similar at other locations, and mean energy density across the full day was not significantly different for the two groups (Table III.13).

NSLP/SBP participants were less likely to consume calories from sugar-sweetened beverages both at school and across all locations over the course of the day (Table III.14). There was no significant difference between participants and nonparticipants in the intake of calories from LNED foods over the course of the day, though participants were more likely to consume calories from LNED solid foods for breakfast at school compared to nonparticipants. Overall, NSLP/SBP participants consumed a lower proportion of calories from LNED items at school (18 percent versus 30 percent), but the reverse at home (26 versus 20 percent, respectively) (Table III.14). These differences balanced out so that there were no significant differences in the percent of calories from LNED items between NSLP/SBP participants and nonparticipants over the course of the day. Looking at the types of LNED items consumed by location, elementary students who participated in the NSLP and the SBP consumed more calories from french fries at school and fewer calories from chips/salty snacks at school (Table III.15); LNED calories for other food categories and locations did not differ by NSLP/SBP participation.

b. Secondary School

At the secondary school level, we observed somewhat different patterns than those at the elementary school level. In addition to NSLP/SBP participants being more likely to eat breakfast and lunch at school, they were also more likely to eat dinner/supper at home than nonparticipants (Table III.11). Unlike the elementary school students, NSLP/SBP participants and nonparticipants at the secondary school level did not differ in their calories consumed at home,

TABLE III.13

REGRESSION-ADJUSTED MEAN ENERGY DENSITY BY LOCATION FOR NATIONAL SCHOOL LUNCH PROGRAM (NSLP) AND NATIONAL SCHOOL BREAKFAST PROGRAM (SBP) PARTICIPANTS AND NONPARTICIPANTS

	Elementary School		Secondary School	
	NLSP/SBP Participants[a]	NLSP/SBP Nonparticipants	NLSP/SBP Participants[a]	NLSP/SBP Nonparticipants
Total Daily	**1.17**	**1.22**	**1.13****	**1.04**
Breakfast	1.08	0.98	1.12*	1.01
Lunch	1.28	1.50	1.27	1.26
Supper/dinner	1.22	1.18	1.15	1.12
Snacks[b]	1.08	1.21	1.00*	0.84
Total at School	**1.20****	**1.49**	**1.18**	**1.09**
Breakfast	1.07	---[c]	1.14	1.20
Lunch	1.28	1.54	1.27	1.28
Supper/dinner	---[c]	---[c]	---[c]	---[c]
Snacks[b]	1.13	1.51	0.87	0.64
Total at Home	**1.12**	**1.10**	**1.08**	**1.01**
Breakfast	1.22	0.96	---[c]	0.98
Lunch	---[c]	---[c]	---[c]	1.12
Supper/dinner	1.19	1.18	1.12	1.12
Snacks[b]	1.02	1.13	1.01	0.89
Total Away from School/Home	**1.32**	**1.26**	**1.20**	**1.08**
Breakfast	---[c]	---[c]	---[c]	---[c]
Lunch	---[c]	---[c]	---[c]	1.28
Supper/dinner	---[c]	---[c]	---[c]	1.09
Snacks[b]	---[c]	1.29	1.08	0.87
Sample Size	**150**	**191**	**173**	**679**

Source: Third School Nutrition Dietary Assessment Study (SNDA-III, 2004-2005). Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

Note: Energy density was calculated using solid foods and beverages.

[a]NSLP and SBP participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.
[c]Sample sizes were too small to compute a reliable statistic.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.14

REGRESSION-ADJUSTED MEAN ENERGY FROM SUGAR-SWEETENED BEVERAGES (SSBS) AND LOW-NUTRIENT, ENERGY-DENSE (LNED) FOODS AMONG PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL LUNCH PROGRAM (NSLP) AND THE NATIONAL SCHOOL BREAKFAST PROGRAM (SBP) (IN KCAL)

	Elementary School		Secondary School	
	NLSP/SBP Participants[a]	NLSP/SBP Nonparticipants	NLSP/SBP Participants[a]	NLSP/SBP Nonparticipants
All Locations				
SSBs - total	97*	128	183*	227
-- at breakfast	0**	15	11	13
-- at lunch	1**	36	23**	58
-- at dinner/supper	50	44	76	71
-- at snacks[b]	47	33	73	85
LNED solid foods-total	388	375	486**	371
-- at breakfast	62	42	95**	33
-- at lunch	82	104	99	99
-- at dinner/supper	53	47	60	65
-- at snacks[b]	191	183	231**	173
All LNED items - total	485	503	669	598
% kcal from all LNEDs	22.8	24.7	27.3	28.8
At School				
SSBs - total	11**	35	40*	60
-- at breakfast	1	1	7*	2
-- at lunch	3**	28	23**	40
-- at dinner/supper	2	0	1	1
-- at snacks[b]	5	6	9	17
LNED solid foods-total	176	164	224**	123
-- at breakfast	46**	5	83**	5
-- at lunch	84	95	96	77
-- at dinner/supper	0	1	0	0
-- at snacks[b]	47	64	46	41
All LNED items - total	187	199	265**	183
% kcal from all LNEDs	17.9**	30.3	24.0**	36.2
At Home				
SSBs - total	67	72	113	117
-- at breakfast	0**	13	3	9
-- at lunch	0	2	1	6
-- at dinner/supper	35	35	64	50
-- at snacks[b]	34	22	45	52
LNED solid foods-total	177	169	223	185
-- at breakfast	15	36	12*	25
-- at lunch	<0.5	1	3	5
-- at dinner/supper	39	33	49	41
-- at snacks[b]	124	99	158*	113
All LNED items - total	244	240	336	302

TABLE III.14 *(continued)*

	Elementary School		Secondary School	
	NLSP/SBP Participants[a]	NLSP/SBP Nonparticipants	NLSP/SBP Participants[a]	NLSP/SBP Nonparticipants
% kcal from all LNEDs	26.1*	19.9	28.9**	23.6
SSBs - total	20	21	30*	49
-- at breakfast	0	2	0	2
-- at lunch	0**	7	0**	13
-- at dinner/supper	13	9	11	19
-- at snacks[b]	8	5	19	15
LNED solid foods-total	34	42	39	63
-- at breakfast	1	2	0	3
-- at lunch	0	7	0**	17
-- at dinner/supper	15	13	12	24
-- at snacks[b]	20	20	27	19
All LNED items - total	54	63	68	113
% kcal from all LNEDs	36.4	36.4	36.7	39.5
Sample Size	**150**	**191**	**173**	**679**

Source: School Nutrition Dietary Assessment Study-III, 24-hour Dietary Recall Interview, school year 2004-2005. Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]NSLP and SBP participation on the target recall day.
[b]Includes eating occasions reported by the child (or respondent) as a snack or drink.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

TABLE III.15

REGRESSION-ADJUSTED MEAN ENERGY FROM LOW-NUTRIENT, ENERGY-DENSE (LNED) FOODS AMONG PARTICIPANTS AND NONPARTICIPANTS IN THE NATIONAL SCHOOL LUNCH PROGRAM (NSLP) AND THE NATIONAL SCHOOL BREAKFAST PROGRAM (SBP) (IN KCAL)

	Elementary School		Secondary School	
	NSLP/SBP Participants[a]	NSLP/SBP Nonparticipants	NSLP/SBP Participants[a]	NSLP/SBP Nonparticipants
All Locations				
Baked goods/desserts	187	157	201**	131
Dairy-based desserts	45	37	45	33
Candy	41	51	87	60
French fries	51	45	80	64
Chips/salty snacks	62	84	70	82
At School				
Baked goods/desserts	97	66	107**	32
Dairy-based desserts	13	11	8	4
Candy	14	24	30	29
French fries	26**	7	51**	14
Chips/salty snacks	25**	56	28*	44
At Home				
Baked goods/desserts	88	77	90	86
Dairy-based desserts	27	25	37	26
Candy	16	23	46	26
French fries	12	20	13	17
Chips/salty snacks	34	24	35	29
Baked goods/desserts	2	14	3*	12
Dairy-based desserts	6	1	1	4
Candy	11	5	11	5
French fries	13	18	16	33
Chips/salty snacks	3	4	7	9
Sample Size	**150**	**191**	**173**	**679**

Source: School Nutrition Dietary Assessment Study-III, 24-hour Dietary Recall Interview, school year 2004-2005. Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a]Participation in both the NSLP and the SBP on the target recall day.

*Significantly different from nonparticipants at 0.05 level.
**Significantly different from nonparticipants at 0.01 level.

but participants consumed significantly more calories over the course of the day (2,450 versus 2,074 kcal; Table III.12). , This result is driven by more calories consumed for breakfast and lunch at-school by students who participated in both school meal programs compared to those who participated in neither (382 versus 32 kcal, and 657 versus 384 kcal, respectively).

Energy density was significantly higher at snacks and over the course of the day for the NSLP/SBP participants (Table III.13). Further investigation into the meal/location findings shows that NSLP/SBP participants consumed more LNED solid food calories at breakfast at school and as snacks at home compared to nonparticipants (Table III.14). At school, baked goods and french fries contributed more LNED calories among NSLP/SBP participants compared to nonparticipants (Table III.15).

c. Summary

Children who participated in both the SBP and the NSLP consumed more of their daily calories at school. This translated to a significantly higher total daily caloric intake only at the secondary school level (18 percent more calories among secondary students in both programs versus those in neither program).

In elementary school, energy density was significantly lower for NSLP/SBP participants at school, but in secondary school, energy density was significantly higher across the day (Table III.13). Contributing factors for this finding are: higher consumption of calories from LNED solid foods coupled with substantial intake from SSBs outside of school and total calories consumed. Over the course of the day any small meal-location differences balanced out to no significant differences in the percentage of calories from all LNED items between NSLP/SBP

participants and nonparticipants.[13] Main contributors to LNED calories were more french fries at school among NSLP/SBP participants (but fewer chips/salty snacks, presumably due to fewer competitive foods) in both school levels.

[13] Secondary school students consumed a higher proportion of their daily calories from LNED items compared to elementary school students (28 versus 22 percent).

IV. RELATIONSHIP BETWEEN SCHOOL MEAL PROGRAM PARTICIPATION AND OBESITY

The previous chapter described the relationship between participation in the National School Lunch Program (NSLP) and/or School Breakfast Program (SBP) and patterns of dietary intake, including consumption of low-nutrient, energy-dense (LNED) foods and beverages, calorie intake by meal/snack over the course of the day, and intake by location. Key findings from that analysis included that SBP participants consume a greater proportion of their calories at breakfast, NSLP participation is associated with reduced consumption of sugar-sweetened beverages, and that NSLP participants consume a lower overall proportion of their calories from LNED foods and beverages than do nonparticipants. Other research has examined whether participants' intakes of particular nutrients differ from those of nonparticipants over the course of a day (for example, Clark and Fox 2009). The results of these analyses suggest further questions concerning the effects of school meal participation. In particular, does participating in the SBP and/or NSLP affect children's body mass index (BMI) and risk of obesity? Are participants more likely (or less likely) than nonparticipants to be overweight or obese?

This chapter addresses the question of how school meal participation may be related to children's BMI and risk of obesity. Based on a rich set of individual characteristics available in the SNDA-III data and controlling for the particular school that a sample member attends, the chapter presents the results of multivariate regression analysis with school fixed effects to explore this relationship. After describing how the key variables in the analysis are defined and summarizing the methodology, the results of the main regression analysis are shown, along with various alternative specifications, including a set of models that explore a set of factors that may mediate the relationship between school meal participation and body mass index.

A. DATA AND METHODS

As with the analysis in the previous chapter, data from the SNDA-III study were used to estimate the relationship between school meal participation and children's BMI and obesity. The key measures from the data set for this analysis were measures of height and weight and children's usual frequency of SBP and NSLP participation. In addition, a set of individual and household characteristics were used in the analysis to control for possible differences between participants and nonparticipants. These characteristics were drawn from the student and parent surveys completed for each SNDA-III sample member. Data from the twenty-four hour dietary recalls were used to create a set of potential mediating factors.

1. Measuring Body Mass Index and Obesity

The primary outcome measures reported in this chapter are based on students' BMI—the ratio of weight (in kilograms) to the square of height (in meters). From the original sample of 2,314 first- through twelfth-graders, the SNDA-III data include valid height and weight measures for a total of 2,228 sample members (96 percent of the main SNDA-III analysis sample). Those without valid data included a small number of children for whom height and weight measurements were never completed and a few others excluded because they had biologically implausible values. We used standards for implausible values as defined by the World Health Organization (1995). The height and weight measurements were taken by trained interviewers using standardized procedures and a common set of equipment across schools. Standing height was measured with a portable stadiometer or height measuring board (Seca model 214) using a slightly modified version of a procedure developed for the National Health and Nutrition Examination Survey (NHANES) and other national and international surveys (Schorr 1998). The child was asked to remove his or her shoes, hats, hair ornaments, or other items that might affect the accuracy of the height measurement, and to remove heavy outer clothing, heavy jewelry, and

anything else that might interfere with the weight measurement. At least two measures were taken of both height and weight for each child, with a third measure taken if the first two differed by more than a prespecified amount.

Four outcome variables were based on students' measured BMI, including BMI itself (the first outcome measure). The child's BMI was compared to the 2000 Centers for Disease Control and Prevention (CDC 2000) age- and sex-specific growth charts to determine the BMI-for-age percentile. Two outcome measures other than BMI were based on the recommendations of the Expert Committee on the Assessment, Prevention, and Treatment of Child and Adolescent Overweight and Obesity (Barlow 2007). A child was classified as overweight if his or her BMI was greater than or equal to the 85th but less than the 95th percentile for age and sex. A child with a BMI greater than or equal to the 95th percentile was classified as obese. The second outcome measure was a binary variable for whether BMI was at or above the 85th percentile of the BMI-for-age/sex distribution, indicating that the student was overweight or obese. The third outcome measure was a binary variable for whether BMI was at or above the 95th percentile of the BMI-for-age/sex distribution, indicating that the student was obese.

The fourth outcome variable was a standardized version of the BMI variable, the BMI z-score. This variable reflects the number of standard deviations that the student's BMI was from the mean of the CDC growth chart reference population. It was calculated by taking each child's BMI, and then subtracting the mean BMI and dividing by the BMI standard deviation among all children of that child's age and sex. For a given sample member, the BMI z-score represents the student's BMI relative to other children of the same age and sex in the reference population. This measure of BMI is comparable for students of different ages and sexes.

2. Measuring School Meal Program Participation

The key independent variables in the model are measures of students' school meal participation. SNDA-III data include both measures of SBP and NSLP participation on a single target day—the day on which children's 24-hour recalls were measured—and measures of their usual SBP and NSLP participation. Since the focus of this chapter is on the relationship between participation and a long-term outcome—children's weight status—the model used the long-term measure of their usual school meal program participation as opposed to the short-term measure of their participation on a single day. In particular, children were asked the number of times per week (0 to 5) they "usually eat a school breakfast" as well as the number of times they "usually eat a school lunch." Their parents were also asked to similar questions about the number of times per week the child usually eats a school breakfast and the number of times he/she usually eats a school lunch. The SBP participation variable we used in the analysis was the number of school breakfasts normally consumed by sample members, as reported by the children themselves for those who were older (in grades 4 through 12) and by the parents of younger children (those in grades 1 through 3). The NSLP participation variable was constructed analogously.

While the usual participation measure for older children was based on the child's report, parents' reports of these children's usual participation was also available, and was generally consistent with that reported by the children. We also compared the usual participation measure used here with the target day participation measure described in the previous chapter. One would expect some consistency between these measures—for example, among the group that reports usually participating three days a week, one would expect that roughly 60 percent participated on the target day. Table IV.1 shows the relationship between usual participation and target day participation. For both programs, it is the case that sample members who reported higher levels of usual participation had higher participation rates on the intake day. For the SBP, for example,

TABLE IV.1

CORRESPONDENCE BETWEEN REPORTED USUAL SCHOOL MEAL PARTICIPATION AND PARTICIPATION ON THE TARGET DAY[A]

Reported Number of Days of Usual Participation	Expected Proportion of Sample Participating on Target Day	Actual Proportion of Sample Participating on Target Day
School Breakfast Program		
0	0.00	0.012
1	0.20	0.053
2	0.40	0.192
3	0.60	0.379
4	0.80	0.558
5	1.00	0.740
National School Lunch Program		
0	0.00	0.051
1	0.20	0.230
2	0.40	0.306
3	0.60	0.566
4	0.80	0.746
5	1.00	0.860

[a] Tabulations using data from the School Nutrition Dietary Assessment Study-III, school year 2004-2005.

56 percent of those who reported participating four days a week obtained an SBP breakfast on the target day, compared with 19 percent of those who reported participating two days a week. In each case, however, the rate of usual participation appears to be somewhat overstated—if the former group truly did participate on four days during the typical week, one would have expected 80 percent to have participated on the target day. This evidence suggests that the usual SBP participation measure overstates the true level of participation to some extent, but is correlated with true participation behavior. While those who reported usually participating in the SBP four days a week may have overstated the precise number of days they obtained a school breakfast, it does appear to be the case that they participated in the SBP substantially more frequently than those who reported usually participating two days a week.

A similar relationship appears between reported usual NSLP participation and rates of target day participation in the SNDA-III sample. However, the usual NSLP participation variable is more accurate than the usual SBP participation variable. While the actual proportion who obtained an NSLP lunch on the target day is somewhat lower than the proportion that would be expect for most categories of reported usual participation, these differences are small. Among sample members who reported usually participating 4 days a week, for example, 75 percent obtained an NSLP lunch on the target day (Table IV.1). For those who reported participating 2 days a week, the target day participation rate was 31 percent.

3. Econometric Model for Estimating Participation-BMI Relationship

We used the following multivariate regression model to estimate the relationship between school meal participation and students' BMI:

$$y_{ij} = X_{ij}\beta + \alpha_1 P_{ij}^B + \alpha_2 P_{ij}^L + \sum_{j=1}^{J} \gamma_j S_{ij} + u_{ij}$$

where: y_{ij} = BMI-related outcome for student *i* in school *j*

X_{ij}	=	characteristics of student *i* in school *j* potentially influencing BMI
P_{ij}^{B}	=	number of days per week student *i* usually participates in SBP
P_{ij}^{L}	=	number of days per week student *i* usually participates in NSLP
S_{ij}	=	binary variables indicating whether or not student *i* attends school *j*
u_{ij}	=	random error term
$\beta, \alpha_1, \alpha_2, \gamma_j$	=	coefficients to be estimated

In the model, the estimated values of α_1 and α_2 represent the relationships between the number of school breakfasts and school lunches a student usually eats per week and the student's BMI (or BMI z-score or whether the student is classified as overweight or obese).[14] The model controlled for student characteristics (X) and included binary variables (S) representing the school the student attended (known as school effects). A single model was estimated for children of all ages to maximize the statistical power of the model. We also estimated the model separately for elementary and secondary students, like the Chapter III models, but found that the estimated associations between SBP/NSLP participation and students' weight status were very similar for the older and younger students, and thus decided to present the results from a single aggregated model.

We estimated the model using linear regression techniques for the continuous outcome variables (BMI and the BMI z-score), and logistic regression techniques for the binary outcome variables. The Statistical Analysis Software (SAS) program, version 9.1 (2004, The SAS Institute, Inc., Cary, NC) along with SUDAAN, release 9 (2005, Research Triangle Institute,

[14] To test the sensitivity of the results to these definitions of SBP and NSLP participation, we estimated alternative specifications with binary measures of usual participation—whether or not students usually consumed a school breakfast or school lunch at least 3 days per week. The results of the analysis using these alternative measures of usual participation were qualitatively similar to the basic results presented in this chapter.

Research Triangle Park, NC) was used to estimate these models. The SUDAAN software made it possible to account for the complex sampling design used to collect the SNDA-III data, which resulted in clustering of the data within schools and districts.

We considered the alternative statistical approach of propensity score matching, but did not use it because the relatively small number of students who were not usual NSLP participants made it difficult to identify a matched comparison group of students whose characteristics were not statistically different from those of program participants. In particular, for each of several different specifications attempted, an F-test indicated significant differences between the mean values of the matching variables in the participant and matched comparison groups.[1]

One of the most important methodological challenges in the estimating the effect of school meal participation on weight-related outcomes is selection bias due to the fact that school meal participants may differ from nonparticipants in observable and unobservable ways correlated with their weight status. For instance, if heartier eaters are more likely than light eaters to participate in these programs, they might also be more likely to be overweight or obese than nonparticipants even in the absence of the school meal programs. A simple comparison of the prevalence of obesity among participants and nonparticipants might therefore incorrectly attribute the observed difference to the effects of the SBP or NSLP itself, when part or all of this difference is in fact spurious.

This model used two approaches to address the issue of selection bias. First, it included an extraordinarily rich set of control variables to account for those factors that influenced whether

[1] In the case of the SBP, we did identify a matched comparison group of usual nonparticipants with characteristics statistically equivalent to those of the comparison group. The problem in the case of the SBP, however, was that a non-trivial number of usual participants had to be dropped from the analysis because their propensity score values fell out of the common support area. Nevertheless, we estimated the effect of usual SBP participation on BMI using the propensity score approach, and the results were consistent with those of the regression analysis, though estimated with less precision.

or not a given student participated in the SBP or NSLP. Table IV.2 lists the control variables included in the analysis. This set of control variables is large because we wanted to control for as many factors potentially related to both school meal participation and BMI as possible.[2] With this many control variables, however, multicollinearity was a concern, especially correlations between school meal participation and the full set of other control variables. Examination of a correlation matrix that included all explanatory variables revealed that the maximum correlation between any two variables was 0.34 and most were less than 0.10. To determine whether there was sufficient variation remaining in the participation variables after accounting for all other control variables, each participation variable was regressed on the full set of control variables. The resulting R-squared value was 0.24 in the case of SBP participation and 0.22 in the case of NSLP participation, suggesting that at least three-fourths of the total variation in school meal participation remained even in the full model that included all control variables.

In addition to the demographic and socioeconomic variables typical to models of this type, the control variables included several different measures of students' level of physical activity, a variety of indicators of their typical dietary habits (for example, their parents' assessment of whether—in general—they were heavier or lighter eaters than other children of the same age and sex), and measures of their usual "screen time" (time they spent watching television or videos, using the computer, or playing video games) that previous studies have found to be related to children's weight (Neumark-Sztainer et al. 2002; Robinson 1999; Anderson et al. 1998).Many of

[2] We also considered including the food security status of the child's household as a control variable, but ultimately decided against it because of the concern that it may be endogenous, influenced by school meal participation status. However, the model does include several of the household characteristics typically correlated with food security.

TABLE IV.2

INDEPENDENT VARIABLES INCLUDED IN THE MODEL

Characteristic	Mean Value
Student's Usual Participation in the School Meal Programs	
Number of days per week student usually gets a school lunch	3.48
Number of days per week student usually gets a school breakfast	1.29
Demographic/Socioeconomic Characteristics	
Student's sex (proportion female)	0.50
Student's age	0.23
Less than 9	0.42
9 to 13	0.35
More than 13	
Student's sex interacted with age	---
Student's race/ethnicity	
White, non-Hispanic	0.54
Black, non-Hispanic	0.22
Hispanic	0.17
Other	0.07
Family income relative to the federal poverty level	
No more than 130%	0.28
131 to 185%	0.15
186 to 200%	0.18
201 to 300%	0.14
More than 300%	0.24
Family receives public assistance	0.27
Family structure (proportion in two-parent households)	0.70
Parents' employment status	
2 parents, both employed	0.28
2 parents, one employed	0.36
2 parents, neither employed	0.05
1 parent, employed	0.15
1 parent, not employed	0.09
Parents' highest educational level	
Less than high school degree	0.11
High school degree	0.24
Some college	0.36
College degree or higher	0.29
Whether English is the primary language spoken in the home	0.87

TABLE IV.2 *(continued)*

Characteristic	Mean Value
Measures of Student's Physical Activity Level	
Parents' assessment of student's activity level relative to that of other children	
Less active than others same age	0.12
As active as others same age	0.45
More active than others same age	0.25
Much more active than others same age	0.18
Whether student takes physical education in school	0.79
Whether student is on a school athletic team	0.24
Student-reported measure of whether he/she is physically active outside school	0.50
Student's Usual Eating Habits	
Parent-reported measure of whether student is a picky eater	
Very picky eater	0.21
Somewhat picky eater	0.45
Not a picky eater	0.34
Parent-reported measure of whether student usually eats more than or less than others of that age	
Larger amount than others same age	0.23
Same amount as others same age	0.61
Smaller amount than others same age	0.16
Whether student's family usually has skim or low-fat milk	0.48
Whether student's family usually serves fried chicken (when they have chicken)	0.44
Whether student's family regularly serves butter/margarine/sour cream when they have potatoes	0.77
Other Student Habits	
Number of hours per week student usually spends watching television	1.82
Number of hours per week student usually spends on a computer or playing video games	0.98

[a] For exact specifications of the student and household characteristics shown in this table, see Table IV.6.

these variables were also related to school meal participation; for example, participants were less likely than nonparticipants to be on a school athletic team, were less likely to be viewed by parents as much more active than their peers, and spent more time watching television than nonparticipants (Gordon et al. 2007). Together, we believe that these student-level control variables covered many of the characteristics that could have led to selection bias; that is, factors that influenced students' SBP/NSLP participation decision and were independently related to their BMI.

Second, the model included school effects to control for school-level factors that potentially influenced whether or not students become school meal participants. Because the SNDA-III sample included multiple students from individual schools, we could estimate a model that controlled for the school a student attended. Effectively, this implied that the estimated effect of school meal participation was identified by comparing participants and nonparticipants who attended the same schools.

Schools in the sample had in place a variety of policies that could have both influenced students' participation decision and had an independent influence on their BMI. Examples of these policies included the presence of vending machines with low-nutrient, energy-dense foods attractive to students, having an "open campus" policy that allowed students to leave school grounds during the school day, and the presence and strength of a nutrition education program in the school. Further, since schools typically served students from the same set of neighborhoods, the students were likely to be similar to one another in various hard-to-measure ways; for example, they probably had similar socioeconomic characteristics and access to the same set of fast food restaurants outside school. The school effects were included in the model in place of the individual school characteristics in order to control for factors such as these that were common to the set of students attending a particular school. The SNDA-III data set included a

number of school-level policies and other school characteristics that could have been entered into the model explicitly as control variables. The model relied on school effects instead because they controlled not only for these measured school characteristics, but also for unmeasured characteristics that could not be included explicitly.

Equation (1) describes the basic model, but several alternative specifications were also estimated to assess the robustness of the results. While one version of the model was estimated on the full sample of children in grades 1 through 12, we also estimated separate models for elementary school versus secondary school students, to be consistent with the separate analysis by school level presented in the previous chapter. We also used alternative specifications to investigate whether participation might have different effects on BMI for children with different initial characteristics. For example, to estimate the relationship between school meal participation and weight status for several key subgroups, the participation variables were interacted with control variables representing the subgroups—age/sex, race/ethnicity, and household income. In a separate specification we examined whether there were interactions between participation in the SBP and NSLP, but found no evidence of such an interactive effect.

4. Analysis of Potential Mediating Factors

The specification shown in equation (1) includes only control variables (in the vector X) that are exogenous. We include no variables whose values are likely to be influenced by school meal participation. For example, we did not control for whether a child was a breakfast eater, which could be related to their BMI, since we felt that breakfast consumption could be influenced by usual SBP participation. In fact, breakfast consumption (or other variables like it) could be mediating factors in the relationship between SBP participation and BMI. In other words, the effect of participation could come through these mediating factors. By not controlling for the

mediating factors, estimates of α_1 and α_2 from equation (1) represent the full relationship between school meal participation and BMI. If we had controlled for some of the mediating factors shown in the figure, we would have netted out the portion of the overall relationship arising through the effect of participation on those factors.

After estimating the overall relationship between school meal program participation and BMI, however, we can examine which of the potential mediating factors appears to be most important by adding these variables to the model and examining how the addition of the variable influences the estimated relationship between participation and BMI. Suppose, for example, that NSLP participation was estimated (via equation 1) to be associated with a decrease of 1 BMI point. Suppose further that we hypothesized that the sole reason for this was that participation led children to consume fewer sugar-sweetened beverages (SSBs), which in turn led to lower weight. If we re-estimated the model after including a variable reflecting SSB consumption, our hypothesis would suggest that the coefficient on this SSB variable would be positive (greater SSB consumption associated with greater BMI) and that the coefficient on NSLP participation would become 0. In other words, if the entire relationship between NSLP participation and BMI arose due to SSB consumption, then after controlling for SSB consumption, we would no longer expect to see any relationship between participation and BMI. Alternatively, if the addition of the SSB consumption variable led to a decrease in the estimated relationship between NSLP participation and BMI from –1 to –0.5, we would argue that half of the overall relationship between NSLP participation and BMI could be explained by its mediating effect on SSB consumption.

For any estimated coefficients of either SBP or NSLP participation in any of the BMI outcome models, we explored the potential role of mediating factors in the manner described above. We focused on the dietary patterns that were examined in the previous chapter. In

particular, we wanted to know whether any effect of participation on weight status might have come through the program's influence on dietary patterns such as meal consumption or snacking behavior, and consumption of items of little nutritional value, including SSBs and LNED foods.

One mediating factor of particular interest is breakfast consumption, both because of some evidence of a relationship between breakfast consumption and lower BMI levels (Timlin et al. 2008; Fiore et al. 2006; Wolfe et al. 1994) and because of the possible role of the SBP in promoting breakfast consumption. Several studies have found no significant relationship between the availability of the SBP in a school and the likelihood that children in the school consume breakfast (e.g., Bhattacharya et al. 2004), defining breakfast as consuming any positive calorie amount. However, it may be the case that SBP participants consume substantial breakfasts, whereas the breakfasts of nonparticipants are more likely to consist of only a beverage or single food providing little food energy. Thus, Devaney and Stuart (1998) re-examined the relationship between SBP availability and breakfast consumption under multiple definitions of breakfast consumption. They found that there is a positive relationship between SBP availability and breakfast consumption if breakfast is defined to be somewhat more substantial (such as meeting a minimum calorie amount). We also estimated models of the relationship between SBP availability and breakfast consumption using alternative definitions of what constitutes a breakfast.[3] These models take the same form as the above equation, except the dependent variable is breakfast consumption the key independent variable indicates whether the student's school offers the SBP. The remaining independent variables in the breakfast consumption model match those in the BMI model.

[3] One of these definitions matches that used in Chapter III, where students who report consuming any foods with a positive calorie amount at an eating occasion they define as breakfast are defined as consuming breakfast. The other two definitions examined put a minimum calorie requirement for the student to be defined as consuming breakfast, 100 calories and 250 calories.

B. CHILDREN'S BMI OUTCOMES AND USUAL SCHOOL MEAL PARTICIPATION

1. Rates of Overweight and Obesity

Table IV.3 shows estimated levels of overweight and obesity among children in the SNDA-III sample, weighted to be representative of all children in grades 1 through 12 in public schools that offer the NSLP. The data are disaggregated into three separate school levels so that they will be as comparable as possible with previously published measures of children's obesity rates based on NHANES data (Ogden et al. 2006, 2008).

About 40 percent of children in each of the three school types—elementary, middle, and high school—were classified as either overweight or obese. Over 20 percent of children within each school type were classified as obese. Within each school type, the prevalence of overweight and obesity was similar among boys and girls for nonHispanic whites and Hispanics. A significantly higher percentage of nonHispanic black girls in middle school and in high school were overweight or obese compared with nonHispanic black boys in the same school type. Generally, the prevalence of overweight and obesity by sex within each school level did not differ significantly by race/ethnicity. However, a significantly higher percentage of nonHispanic black girls were overweight or obese compared with the nonHispanic white and Hispanic girls in middle school. There was also a significantly higher prevalence of obesity among Hispanic boys (31 percent) than among nonHispanic white boys (16 percent) in elementary school. There were no differences in overweight or obesity by race/ethnicity at the high school level.

The percentage of children classified as either obese or overweight/obese in the SNDA-III sample, as shown in Table IV.3, was comparable to that of children of the same age in published estimates from NHANES 2003-2004, as reported in Ogden et al. (2006). The prevalence of obesity was slightly higher among all adolescents in the SNDA-III sample, a result of the higher

TABLE IV.3

PERCENTAGE OF CHILDREN CLASSIFIED AS OVERWEIGHT OR OBESE, BY SCHOOL LEVEL, SEX, AND RACE/ETHNICITY[a]

	Prevalence of Overweight or Obese by School Type% (SE)					
	Elementary school		Middle School		High school	
	Overweight or Obese	Obese	Overweight or Obese	Obese	Overweight or Obese	Obese
Both Sexes						
All	38.3 (2.2)	20.9 (1.7)	41.4 (1.9)	25.1 (2.1)	38.6 (2.1)	23.7 (1.9)
Non-Hispanic white	34.8 (2.5)	17.4 (2.0)	34.8 (2.1)	19.9 (2.1)	37.0 (3.0)	21.8 (2.5)
Non-Hispanic black	37.5 (5.8)	20.7 (4.3)	50.0 (4.3)	26.7 (5.4)	41.5 (3.7)	28.0 (4.3)
Hispanic	45.5 (4.2)	30.0 (3.7)	47.2 (4.9)	34.0 (4.9)	42.7 (4.4)	27.7 (3.8)
Other	42.2 (9.8)	†	45.1 (7.2)	28.8 (6.7)	35.4 (6.1)	19.7 (5.9)
Males						
All	41.1 (2.9)	20.6 (2.3)	40.2 (2.6)	27.2 (2.8)	35.0 (2.3)	21.9 (2.2)
Non-Hispanic white	36.6 (3.4)	16.1 (2.4)	39.3 (3.1)	20.9 (3.1)	35.7 (3.9)	21.1 (3.1)
Non-Hispanic black	44.8 (8.6)	20.8 (5.4)	31.0 (6.4)	23.5 (5.3)	31.3 (5.0)	22.0 (4.7)
Hispanic	51.2 (5.3)	31.3 (5.1)	49.0 (7.0)	41.4 (7.4)	32.9 (5.3)	24.1 (5.2)
Other	†	†	44.7 (10.4)	38.8 (9.9)	41.2 (8.5)	22.0 (7.8)c
Females						
All	35.5 (2.8)	21.2 (2.2)	42.5 (2.9)	23.1 (2.4)	42.2 (3.4)	25.4 (3.0)
Non-Hispanic white	32.6 (4.0)	18.9 (3.2)	30.5 (3.5)	18.9 (3.3)	38.2 (4.5)	22.5 (3.5)
Non-Hispanic black	29.3 (6.6)	20.6 (5.8)	65.9 (5.9)	29.3 (6.8)	51.7 (4.4)	34.0 (6.2)
Hispanic	40.3 (6.0)	28.9 (5.1)	45.5 (5.4)	27.4 (4.9)	53.0 (6.6)	31.4 (5.8)
Other	47.8 (11.1)	†	45.5 (9.5)	18.9 (7.4)[c]	†	†
Sample Size	**706**		**761**		**761**	

[a] Weighted tabulations using data from the School Nutrition Dietary Assessment Study-III, school year 2004-2005.
[b] SE=Standard error.
[c] Does not meet standard of statistical reliability and precision. Relative SE was greater than 30% and less than 40%.
† Statistic omitted due to a large coefficient of variation (relative SE greater than 40%).

prevalence of obesity among the Hispanic males and females aged 12-19 (in middle and high school) in SNDA-III compared with Mexican Americans of the same sex and age groups in NHANES. Among girls in this age group, for example, the SNDA-III results indicate that 56 percent of nonHispanic black girls and 52 percent of Hispanic girls were overweight or obese (Table IV.3) while NHANES suggests that 42 percent of nonHispanic black girls and 31 percent of Mexican American girls were overweight or obese (Ogden et al. 2006). Since differences in the prevalence of overweight or obesity between NHANES and SNDA-III occurred only among certain age and racial/ethnic groups, these differences were more likely due to differences in the samples than to measurement issues. Although results from both surveys were weighted to be nationally representative, NHANES sampled children from households, while SNDA-III sampled children attending schools that were served by public School Food Authorities participating in the NSLP (a more limited population).

2. School Meal Participation Rates

Participation in the NSLP was common among sample members. Over half of all students reported that they usually eat a school lunch every day, and 72 percent reported that they usually eat a school lunch at least three days a week (Table IV.4). Only 14 percent of students said that they never eat a school lunch during a typical week. The daily participation implied by the distribution of usual NSLP participation during this week was 70 percent. In other words, the usual participation data implied that more than two-thirds of students eat a school lunch on a typical day. This rate is slightly higher than the estimated daily rate of NSLP participation of 62 percent according to the estimated SNDA-III target day participation rate, which was based on the foods sample members consumed from the school cafeteria at lunchtime on the study's intake day (Gordon et al. 2007). As discussed previously, this suggests that in reporting their usual

TABLE IV.4

STUDENT PARTICIPATION IN THE SCHOOL BREAKFAST PROGRAM (SBP) AND NATIONAL SCHOOL LUNCH PROGRAM (NSLP)[a]

Number of Days Per Week Students Usually Eats a School Meal	Usual SBP Participation		Usual NSLP Participation	
	Frequency	Cumulative Frequency	Frequency	Cumulative Frequency
0	61.9[b]	61.9	13.5	13.5
1	6.4	68.3	3.7	20.2
2	5.6	73.9	7.8	28.0
3	8.1	82.0	10.8	38.8
4	3.0	85.0	9.5	48.3
5	15.0	100.0	51.7	100.0

[a] Weighted tabulations using data from the School Nutrition Dietary Assessment Study-III, school year 2004-2005.

[b] Students who usually eat no SBP breakfasts per week include those who attend schools that do not offer the SBP. Roughly 85% of sample members attended schools that offer the SBP.

participation, children overestimated the frequency with which they obtained school lunches, though this overreporting of usual NSLP participation appeared to be modest.

Fewer students reported usually participating in the SBP than in the NSLP. In particular, 62 percent reported that they do not obtain a school breakfast at all during a typical week (Table IV.4). This figure includes about 15 percent of all children who attended schools where SBP breakfasts were not served. Only 15 percent of children reported that they usually eat a school breakfast every day of the week. Based on the usual SBP participation data, the implied daily SBP participation rate was 26 percent, again somewhat higher than the target day participation rate of 18 percent.[4]

To provide a sense of the bivariate relationship between SBP and NSLP participation and students' weight status, rates of overweight and obesity were estimated among students who usually participated in the SBP at least three times a week versus those who usually participated less often, as well as similar figures for the NSLP. Although there appears to be some evidence of a positive bivariate relationship between school meal participation and overweight/obesity, the only significant association occurred for the NSLP, where 24 percent of usual participants were obese compared with just 18 percent of nonparticipants (Table IV.5).

However, these figures do not tell us whether or not SBP or NSLP participation affects students' chances of being overweight or obese, since key differences in the characteristics of SBP and NSLP participants were not accounted for in these bivariate relationships. To take just one example, younger children were much more likely than older children to be participants in both the SBP and the NSLP (Gordon et al. 2007). The bivariate relationships did not adjust for any differences in the prevalence of overweight or obesity among younger versus older children.

[4] If the students who attended non-SBP schools are excluded, the daily SBP participation rate implied by the distribution of reported usual SBP participation is 30 percent.

TABLE IV.5

CHILDREN'S OVERWEIGHT AND OBESITY RATES BY SCHOOL BREAKFAST PROGRAM (SBP) AND NATIONAL SCHOOL LUNCH PROGRAM (NSLP) STATUS[a]

School Meal Participation Status	Overweight or obese **Percentage of students with BMI ≥85th percentile (SE in parentheses)**	Obese **Percentage of students with BMI ≥95th percentile (SE in parentheses)**
Usually Participate In SBP Three Or More Days Per Week		
No	39.1 (1.4)	21.9 (1.4)
Yes	39.0 (2.5)	24.4 (2.3)
Usually Participate In NSLP Three or More Days Per Week		
No	35.6 (2.1)	18.0 (1.8)
Yes	40.4 (1.5)	24.3* (1.3)

[a] Weighted tabulations using data from the School Nutrition Dietary Assessment Study-III, school year 2004-2005.

SE=Standard error.

*Significantly different from those who participate in NSLP fewer than three days per week, $P<0.05$.

There were many other potential differences between the two groups—race/ethnicity, income, parents' employment, and so on—that could have been associated with their weight status. Controlling explicitly for the relevant characteristics of the two groups and the schools they attended was a critical step in more fully understanding the relationship between the school meal programs and students' weight status.

C. MULTIVARIATE MODEL OF FACTORS AFFECTING BMI

Table IV.6 presents results from the estimation of the basic BMI model, including a specification of the model that excludes school effects and a specification that includes school effects. A key difference between the two sets of results is that in the more fully specified model that includes school effects, the estimated negative association between SBP participation and BMI is larger in magnitude than in the specification without school effects, and this estimated association also achieves statistical significance. In several other specifications not shown here, more limited sets of control variables were included, so that the model's control variables more closely reflected the type of demographic and socioeconomic characteristics typically included in a model like this. In these specifications, the same pattern of results emerged, though the estimated coefficient on usual SBP participation was even smaller in magnitude (and not statistically significant).[15] In other words, the relationship between SBP participation and BMI became stronger as a larger set of control variables (and school effects) designed to account more fully for potential differences between participants and nonparticipants were added. Through the

[15] In particular, in a model with just a basic set of demographic and socioeconomic set of control variables and no school fixed effects, the estimated coefficient on SBP participation was -0.06 (and not statistically significant) whereas the estimated coefficient on NSLP participation was 0.10 (and not statistically significant. These results suggest evidence of a modest amount of positive selection into these programs, with heavier children more likely to become participants. Thus, failure to control adequately for this selection results in a modest positive bias in the estimated coefficient on both the usual SBP and usual NSLP participation variables.

TABLE IV.6

COEFFICIENT ESTIMATES FROM ORDINARY LEAST SQUARES REGRESSION OF STUDENTS' BODY MASS INDEX (BMI)[A]

	No School Fixed Effects		Controlling for School Effects	
	Coefficient	SE[b]	Coefficient	SE
Intercept	22.09**	(0.88)	18.06**	(1.04)
School Meal Participation				
Number of days per week of usual SBP participation	-0.10	(0.07)	-0.15*	(0.08)
Number of days per week of usual NSLP participation	0.07	(0.06)	0.04	(0.07)
Age/Sex (Female 9-13 excluded)				
Female <9	-4.03**	(0.57)	-3.33**	(0.63)
Male <9	-4.19**	(0.63)	-3.25**	(0.63)
Male 9-13	-0.75**	(0.28)	-0.55	(0.31)
Female >13	3.52**	(0.91)	1.56	(1.09)
Male >13	2.72**	(0.88)	0.79	(1.03)
Age (Age=6, 12, 18 excluded)				
7	0.22	(0.46)	0.29	(0.61)
8	0.69	(0.43)	1.07*	(0.53)
9	-2.04**	(0.58)	-1.10	(0.59)
10	-0.56	(0.62)	0.19	(0.60)
11	0.16	(0.54)	-0.59	(0.54)
13	1.08	(0.56)	0.49	(0.60)
14	-1.53*	(0.74)	-0.63	(0.84)
15	-1.21	(0.70)	-1.35	(0.73)
16	-0.48	(0.77)	-0.53	(0.77)
17	0.20	(0.76)	0.19	(0.80)
Race/ethnicity (White, non-Hispanic excluded)				
Black, non-Hispanic	0.57	(0.35)	0.76	(0.47)
Hispanic	1.15**	(0.32)	1.12**	(0.43)
Other race	0.02	(0.40)	0.24	(0.48)
Language				
English main family language	0.48	(0.39)	0.77	(0.48)
Family Income (no more than 130% of poverty level excluded)				
131%-185% of federal poverty level	0.06	(0.38)	0.11	(0.38)
185%-200% of federal poverty level	-0.61	(0.38)	-0.52	(0.42)
200%-300% of federal poverty level	-0.39	(0.46)	-0.47	(0.46)
>300% of federal poverty level	-0.68	(0.43)	-0.94*	(0.47)
Public Assistance				
Family receives public assistance	0.14	(0.37)	0.17	(0.38)
Family Structure/Parents' Employment (Two parents, both employed excluded)				
Two parents, one employed	-0.39	(0.27)	-0.17	(0.29)

	No School Fixed Effects		Controlling for School Effects	
	Coefficient	SE[b]	Coefficient	SE
Two parents, neither employed	0.28	(0.59)	0.27	(0.66)
Single parent, employed	-0.23	(0.33)	0.19	(0.33)
Single parent, not employed	-0.03	(0.51)	0.60	(0.54)
Parents' Highest Education (high school dropout excluded)				
High school degree	-0.16	(0.38)	-0.10	(0.40)
Some college	-0.27	(0.43)	0.07	(0.44)
College degree	-0.94	(0.45)	-0.29	(0.45)
Parents' Assessment of Child's Activity Level (As active as others same age excluded)				
Less active than others same age	2.67	(0.41)	2.76**	(0.41)
More active than others same age	-1.50	(0.19)	-1.52**	(0.21)
Much more active than others	-1.79	(0.24)	-1.71	(0.27)
Other Measures of Physical Activity				
Child takes physical education	-0.43	(0.28)	-0.14	(0.32)
Child is on school athletic team	-0.22	(0.25)	-0.32	(0.26)
Physically active outside school	0.16	(0.24)	0.30	(0.25)
Parent Assessment of Child's Eating Habits—I (Somewhat picky eater excluded)				
Very picky eater	-0.20	(0.29)	-0.28	(0.30)
Not a picky eater	0.29	(0.28)	0.43	(0.28)
Parent assessment of Child's Eating Habits—II (Usually eats same amount as others same age excluded)				
Usually eats larger amount	2.23**	(0.30)	2.25**	(0.31)
Usually eats smaller amount	-2.71**	(0.25)	-2.83**	(0.26)
Family's Usual Dining Habits				
Serves skim/lowfat milk	1.09	(0.21)	1.19**	(0.23)
Eats fried chicken	0.16	(0.23)	0.20	(0.25)
Has butter/margarine/sour cream with potatoes	-0.23	(0.25)	-0.50	(0.27)
Child's Screen Time				
No. hours/week child watches TV	-0.01	(0.09)	-0.03	(0.09)
No. hours/week child uses computer	0.09	(0.11)	0.01	(0.11)
School Fixed Effects	**Not Included**		**Included**	
Mean of Dependent Variable	**22.60**		**22.60**	
R-squared	**0.357**		**0.460**	
Number of Observations	**2,228**		**2,228**	

[a] Weighted tabulations using data from the School Nutrition Dietary Assessment Study-III, school year 2004-2005.
[b] SE=Standard error.

* Estimated coefficient significantly different from zero, $P<0.05$.
**Estimated coefficient significantly different from zero, $P<0.01$.

remainder of this chapter, we focus on the specification that includes the full set of control variables and school effects.

1. Relationships Between Control Variables and BMI

The primary purpose of including control variables in the model was to account for any pre-existing differences between the characteristics and behaviors of children who chose to usually participate in the school meal programs and those who did not. By accounting for these differences, subsequent differences in BMI between those who participated more frequently versus those who participated less frequently could be attributed to the effects of the school meal programs with more confidence.

We felt that the most important measures of children's pre-existing differences were parents' reports of their children's physical activity and usual eating habits. Although these variables are potentially endogenous[5] and it may be the case that parents are not objective observers of their children's habits, we felt that they would provide an effective way to capture some hard-to-observe aspects of students' habits and nutrition-related behaviors, though perhaps not precisely those behaviors about which the parents were asked. These variables were strongly correlated with children's BMIs. Children who were more active than others of the same age, according to their parents, had a significantly lower mean BMI than those who were as active as others of the same age, while those who were less active had a significantly higher mean BMI than the average group. None of the other variables reflecting the child's level of physical

[5] One potential concern about controlling for the parents' reports of their children's usual eating habits is that this variable will be endogenous with respect to school meal program participation—that whether the child decided to eat school meals would influence the parent's opinion about their usual eating habits. Ultimately, we decided that since parents do not typically observe their children at school meal times, they would be much more likely to base their response on this item to behaviors that had been observed over a long time period at home. Because of the concern over potential endogeneity of this variable, however, we estimated a specification in which it was excluded, and found that the key results from the model were robust to this change.

activity was statistically significant (nor was television watching or other screen time), probably because any effects of activity level on BMI were captured by this parent-reported variable. Similarly, parents' reports of whether the child usually ate larger amounts, the same amount, or smaller amounts than others of the same age was also strongly and significantly related to BMI, in the expected direction.

Demographic variables related to BMI included age, race/ethnicity, and household income. All else equal, younger children had significantly lower BMIs than older children. Compared with nonHispanic whites, Hispanic children had significantly higher BMIs. The coefficient on the binary indicator for nonHispanic black children (relative to nonHispanic white children) was also positive, but not statistically significant at the 5 percent level. There appeared to be a negative relationship between household income and BMI, with children from lower income households having higher BMIs, though this was statistically significant only at the extremes (those from households with incomes above 300 percent of poverty had significantly lower BMIs than those from households with incomes at or below 130 percent of poverty). Other household characteristics, including public assistance receipt, family structure and employment, and parents' education, were not significantly related to a child's BMI.

2. Estimated Association Between School Meal Program Participation and Students' Weight Status

Usual participation in the SBP was estimated to have a negative relationship with children's BMI. For every one breakfast per week increase in usual SBP participation, BMI declined by 0.15 points, a difference that was statistically significant at the 0.05 level. The magnitude of this relationship is relatively modest, implying that those who obtain school breakfasts every day would have a BMI 0.75 points lower than those who never participate in the SBP, all else being

equal. By contrast, the estimated association between usual NSLP participation and children's BMI was not statistically significant (and the estimated coefficient was positive).

Since many children who eat school lunches also eat school breakfasts, and nearly all SBP participants are also NSLP participants, we wondered whether the effects of the two programs might be interactive. In a model specification not shown, usual SBP and usual NSLP participation were interacted to determine whether participation in both programs had a different relationship with BMI than would be implied by their individual relationships. The estimated interaction between the two programs was small in magnitude and not statistically significant. In other words, the relationship between participation in either of the meal programs and BMI was not influenced by whether or not a child also participated in the other program.

Table IV.7 summarizes the key results from estimation of the model using the three other dependent variables—whether the child is obese, overweight or obese, and the BMI z-score. The table shows only the coefficients on the two usual participation variables. As described previously, we estimated linear regression models for the two continuous measures of weight status (BMI and BMI z-score) and logistic regression models for the two binary measures (obesity, and overweight/obesity), and each model includes school effects.

The estimated relationship between SBP participation and the BMI z-score, which standardized BMI across age and sex, was negative (-0.028) and statistically significant at the 5 percent level. In both logistic regression models of overweight and obesity, the estimated

TABLE IV.7

ESTIMATED EFFECT OF SBP AND NSLP PARTICIPATION ON STUDENTS' WEIGHT STATUS—ALTERNATIVE MEASURES OF WEIGHT STATUS

	Dependent Variable			
	BMI[a]	Overweight or Obese[b]	Obese[c]	BMI z-Score[a]
Number of days per week of usual SBP participation	-0.149 *	-0.069	-0.090	-0.028 *
	(0.076)	(0.043)	(0.049)	(0.013)
Number of days per week of usual NSLP participation	0.043	0.046	-0.003	0.013
	(0.066)	(0.040)	(0.049)	(0.013)
School fixed effects	Included	Included	Included	Included
Mean of dependent variable	22.603	0.405	0.237	0.756
R-squared	0.461	---	---	0.326
Number of observations	**2,228**	**2,228**	**2,228**	**2,228**

Source: Weighted tabulations using SNDA-III data.

Note: Coefficient estimates presented in each column derived from a linear or logistic regression model that included the full set of control variables presented in Table IV.6, with school effects.

[a] Coefficients estimates shown in this column are from a linear regression model.

[b] Students are defined as overweight or obese if their BMI reaches the 85th percentile or higher of the BMI distribution of children of their age and sex. Coefficient estimates shown in this column are from a logistic regression model.

[c] Students are defined as obese if their BMI reaches the 95th percentile or higher of the BMI distribution of children of their age and sex. Coefficient estimates shown in this column are from a logistic regression model.

* Estimated coefficient significantly different from zero, $P<0.05$.

coefficient on the usual SBP participation variable was negative but not statistically significant.[16] As for usual NSLP participation, its estimated association with each of the four dependent variables was positive, small, and not statistically significant.

Table IV.8 presents estimated relationships of SBP and NSLP participation with each of the four outcomes separately for subgroups defined by race/ethnicity and household income.[6] These estimates were based on models in which the subgroup variables were interacted with usual SBP and NSLP participation. We also examined whether these relationship varied by age/sex (results not shown), but there were no systematic differences.[7] There was also no evidence that the effects of either SBP or NSLP participation varied systematically by household income, but there were differences by race/ethnicity. The negative relationships between usual SBP participation and both BMI and the BMI z-score was statistically significant only among nonHispanic white

[16] The overweight and obesity models, in conjunction with the BMI model, provide some sense of the extent to which the relationship between SBP participation and BMI extends through the full BMI distribution. In particular, there is a negative relationship with the continuous BMI measure as well as with the binary measures of overweight and obesity (and while latter estimates are not statistically significant, they are close to reaching the threshold of statistical significance). To provide additional information about the relationship between SBP participation and the full BMI distribution, we also estimated models in which the dependent variables were defined as two additional binary outcomes—one indicating whether the student was defined as being above the threshold for underweight (less than the 5th percentile of the BMI distribution for their age/sex reference population), and the other indicating whether the student's BMI was at or above the 45th percentile of this distribution, which corresponds to the midpoint of BMI values in the normal range. The coefficient on the model that used the 45th percentile was roughly the same as the coefficients on overweight and obesity, suggesting that the SBP-BMI relationship does not vary greatly across most of the BMI distribution. However, the coefficient on the model that used the underweight threshold had the opposite sign, though was not statistically significant. In other words, while the estimated relationship between SBP participation and BMI through most of the BMI distribution was negative, this result did not extend to the bottom of the distribution, and there was no evidence that SBP participation was associated with a greater likely of students being underweight.

[6] In Table IV.8, the two models with binary outcome variables were estimated using linear, rather than logistic regression. Both in the case of the original estimates presented in Table IV.7 and these subgroup impact estimates, the results were robust to whether linear or logistic regression was used.

[7] Consistent with the analysis in the previous chapter, we also conducted entirely separate analyses by school level. The results for the elementary school and secondary school BMI models, when estimated separately, were not qualitatively different from the results from the pooled BMI model presented in this chapter. For example, the estimated relationship between usual SBP participation and BMI was –0.14 in the elementary school sample and –0.17 in the middle school sample, while the estimated relationship between usual NSLP participation and BMI was 0.06 in both samples.

TABLE IV.8

ESTIMATED EFFECT OF SBP AND NSLP PARTICIPATION ON STUDENTS' WEIGHT STATUS, BY STUDENTS' RACE/ETHNICITY AND HOUSEHOLD INCOME

	Dependent variable			
	BMI[a]	Overweight or obese[b]	Obese[c]	BMI z-score[a]
Number of days per week of usual NSLP participation				
Race/ethnicity				
White, non-Hispanic (excluded group)	0.112	0.017	0.006	0.030
Hispanic	-0.077	0.003	-0.010	0.002
Black, non-Hispanic	-0.226	-0.038 * ##	-0.018	-0.066 * ##
Other race	0.476 *	0.046	0.040 ** #	0.080
Income as % of poverty				
No more than 130% (excluded)	-0.032	-0.005	0.000	0.008
131 to 185%	-0.091	0.008	0.001	-0.019
186 to 200%	0.228	0.017	0.006	0.051
201 to 300%	0.042	0.007	-0.008	-0.006
More than 300%	0.029	0.008	0.003	0.014
Number of days per week of usual SBP participation				
Race/Ethnicity				
White, non-Hispanic (excluded group)	-0.294 *	-0.019	-0.018	-0.043 *
Hispanic	0.077 #	0.011	-0.002	0.004
Black, non-Hispanic	-0.127	-0.010	-0.009	-0.028
Other race	-0.095	-0.016	0.004	-0.019
Income as % of poverty				
No more than 130% (excluded)	-0.161	-0.008	-0.011	-0.041
131 to 185%	0.020	-0.004	-0.008	0.006
186 to 200%	-0.122	-0.014	-0.006	-0.014
201 to 300%	-0.075	-0.019	-0.005	-0.022
More than 300%	-0.382 *	-0.014	-0.024 *	-0.051

Source: Weighted tabulations using SNDA-III data.

Note: Coefficient estimates presented in each column derived from a linear regression model that included the full set of control variables presented in Table IV.6, along with school effects. In addition, each model included interaction terms of usual NSLP with the race or income subgroup variables as well as a set of usual SBP participation interaction terms. The race and income subgroup models were estimated separately.

[a] Coefficients estimates shown in this column are from a linear regression model.

[b] Students are defined as overweight or obese if their BMI reaches the 85th percentile or higher of the BMI distribution of children of their age and sex. Coefficient estimates shown in this column are from a linear regression model.

[c] Students are defined as obese if their BMI reaches the 95th percentile or higher of the BMI distribution of children of their age and sex. Coefficient estimates shown in this column are from a linear regression model.

* Estimated coefficient significantly different from zero, $P<0.05$.
**Estimated coefficient significantly different from zero, $P<0.01$.

Estimated coefficient significantly different from coefficient of excluded group, $P<0.05$ level.
Estimated coefficient significantly different from coefficient of excluded group, $P<0.01$ level.

students. The estimated coefficients of school breakfast participation among the other groups were not statistically significant, and there was a significant difference between the estimated coefficients among nonHispanic white students and Hispanic students. In the case of the NSLP, the estimated relationship between participation and BMI was most positive in the case of a small group of students in the "other race" category. The estimated relationship was most negative in the case of nonHispanic black students, and statistically significant at the 5 percent level for the BMI z-score and rate of overweight or obesity.

D. POSSIBLE MEDIATING FACTORS

Given that usual SBP participation is associated with lower BMIs among children, our search for mediating factors focused on dietary behaviors shown in the previous chapter to be related to SBP participation. In particular, we focused particularly on breakfast consumption and LNED intake, which were significantly related to usual participation. We also examined intake from sugar-sweetened beverages and consumption of low-nutrient, energy-dense foods, which have been shown in previous research to be related to BMI.[8] As described previously, we added variables representing these dietary behaviors (on the SNDA-III intake day) to the model and examined the change in the estimated effect of SBP participation.

The mediating variable with the strongest influence on the estimated coefficient associated with the usual SBP participation variable in the BMI model was breakfast consumption on the target day. In the model without the mediating variable, the estimated coefficient was –0.149 and statistically significant. In the model that included the breakfast consumption mediating variable,

[8] For evidence of a positive relationship between sugar-sweetened beverages and BMI, see American Dietetic Association (2009e), Ludwig et al. (2001), Malik et al. (2006), and Vartanian et al. (2007). For evidence of a positive relationship between low-nutrient, energy-dense foods and BMI, see Kant (2003), Traveras et al. (2005), and Boutelle et al. (2007). We also explore snacking as a potential mediating factor, though the evidence on the relationship between snacking and BMI is mixed (American Dietetic Association 2004).

the magnitude of the estimated coefficient had fallen to –0.088 and was no longer statistically significant (Table IV.9).[9] Inclusion of the percentage of calories from sugar-sweetened beverages and the percentage of calories from low-nutrient, energy-dense foods also led to a much smaller decline in the estimated coefficient on the usual SBP variable (to about –0.13), while the inclusion of the percentage of calories from snacks had very little influence on the coefficient.

The influence of the breakfast participation variable arises from two relationships. First, a higher level of SBP participation is associated with a higher likelihood of breakfast consumption. In part, this relationship arises by definition, since those who participate in the SBP must have eaten a breakfast on the target day to be defined as participants.[10] By contrast, about 15 percent of SBP nonparticipants skipped breakfast (Gordon et al. 2007). Second, eating breakfast is associated with lower levels of BMI. In particular, those who consumed a breakfast on the SNDA-III target day had a BMI –1.24 points less than those who did not consume a breakfast, all else equal (Table IV.9). The other models shown in Table IV.9 indicate that, all else equal, consuming a larger percentage of calories in the form of sugar-sweetened beverages was associated with a higher BMI. Somewhat counterintuitively, consuming a larger proportion of calories in the form of low-nutrient, energy-dense foods was associated with a lower BMI.[11]

[9] In this specification, the definition of breakfast consumption involved the consumption of at least 100 calories at the morning eating occasion the respondent identified as breakfast. We also examined a specification in which breakfast was defined as consuming any positive amount of calories at breakfast (the least stringent definition) and another in which breakfast was defined as consuming at least 250 calories at breakfast (the most stringent definition). The results of these specifications were similar to that reported in Table IV.9.

[10] In the analysis, we use a measure of usual SBP participation and a measure of breakfast consumption on the target day. Thus, it is not necessarily the case that all students who were defined as usual participants actually ate a school breakfast (or any breakfast) on the target day; it is just that they normally do so.

[11] We estimated the models presented in Table IV.9 both with and without a variable indicating the number of calories from foods consumed during the target day. The patterns of results, including both the magnitudes of the variables and their levels of statistical significance, were the same regardless of whether or not intake of calories was included as a covariate.

TABLE IV.9

ESTIMATED EFFECT OF SBP AND NSLP PARTICIPATION ON STUDENTS' BMI, WITH AND WITHOUT POTENTIAL MEDIATING VARIABLES

	Dependent variable = BMI			
	Mediating Variable			
	Ate breakfast on intake day[a]	% of calories from snacks	% of calories from sugar-sweetened beverages	% of calories from low-nutrient, energy-dense foods
Main model				
Number of days per week of usual SBP participation	-0.149 *	-0.149 *	-0.149 *	-0.149 *
Number of days per week of usual NSLP participation	0.043	0.043	0.043	0.043
Model with mediating variable				
Number of days per week of usual SBP participation	-0.088	-0.152 *	-0.130	-0.132
Number of days per week of usual NSLP participation	0.047	0.040	0.058	0.031
Mediating variable	-1.237 **	-0.012	0.045 **	-0.036 **
R-squared				
Main model	0.461	0.461	0.461	0.461
Model with mediating variable	0.466	0.461	0.464	0.466

Source: Weighted tabulations using SNDA-III data

Note: Coefficient estimates presented in each column are derived from a linear regression model that included the full set of control variables presented in Table IV.6, along with school effects.

[a] Breakfast defined as occurring if students report consuming foods for breakfast that contribute 100 or more calories.

* Estimated coefficient significantly different from zero, $P<0.05$.

** Estimated coefficient significantly different from zero, $P<0.01$.

By accounting for the relationship between SBP participation and breakfast consumed as well as between breakfast consumption and BMI, we accounted for nearly half of the overall relationship between usual SBP participation and BMI. Thus, the key aspect of school breakfast participation may simply be that it ensures that children are consuming some type of breakfast, and the fact that participants are getting a school breakfast rather than some other type of breakfast may not be all that critical. If one believes that the relationships estimated in this analysis are causal, the results suggest that promoting participation in the SBP, especially among children who might not otherwise eat any breakfast, could have beneficial effects by ensuring that these children eat breakfast, which in turn may lead to a modest decline in BMI.

We conducted one additional analysis to try to dig deeper into the relationship between the SBP and eating breakfast. Based on analysis of SNDA-I data, Devaney and Stuart (1998) found that children in schools that offered the SBP were more likely to eat breakfast on a given day than were those in schools that did not offer the SBP. However, this relationship was strong and statistically significant only when breakfast was defined as being more substantial than simply consuming any calories during the morning hours. To investigate whether this relationship still holds, we estimated the relationship between SBP availability and breakfast consumption using three different definitions of what constitutes a breakfast. The first simply required the child to indicate that he or she consumed some food or beverage with positive calories at the eating occasion self-defined as breakfast. The intermediate definition required that these foods or beverages provide at least 100 calories. And the most stringent definition of breakfast required that the foods or beverages consumed at breakfast provide at least 250 calories.

The specific model estimated to examine the SBP availability-breakfast consumption relationship was similar to the main BMI model, except that SBP availability was added to the model and the usual SBP & NSLP participation variables were dropped. In other words, we

estimated the relationship between SBP availability and breakfast consumption after controlling for the same basic set of individual and households characteristics that were controlled for in the main model.[17] The model was estimated both overall and for elementary and secondary students separately, using the three alternative definitions of breakfast consumption. Table IV.10 summarizes the results of this analysis.

We did not find evidence of a relationship between SBP availability and breakfast consumption. In each of the models estimated, the coefficient on SBP availability was not statistically significant. As with Devaney and Stuart (1998), the estimated relationship became more positive with more stringent definitions of breakfast consumption, but never reached statistical significance. In addition, the estimated relationship was more positive among elementary school students—for example, the likelihood of consuming a breakfast of at least 250 calories was 9 percentage points higher among elementary school students who attended a school that offered the SBP than among those at non-SBP schools. However, this estimate was not statistically significant, perhaps because the relatively small number of elementary schools in the sample limited the statistical power of this analysis.

The lack of a significant relationship between SBP availability and breakfast consumption, while different from the findings of Devaney and Stuart (1998), was consistent with the results of Bhattacharya et al. (2004). One reason for these divergent findings may be the growth in the prevalence of the SBP across schools nationally. In 1991-1992, the year covered by the data that Devaney and Stuart analyzed, only 53 percent of NSLP schools offered SBP breakfasts. In SNDA-III, by contrast, roughly 85 percent of NSLP schools offered SBP breakfasts. The increase in the proportion of SBP schools both reduces the statistical power of this analysis and

[17] The SBP availability model did not include school fixed effects, however, because there was no variation in the availability of the SBP among students in a given school.

TABLE IV.10

ESTIMATED MARGINAL EFFECT OF SBP AVAILABILITY ON THE LIKELIHOOD OF CONSUMING BREAKFAST ON SNDA-III TARGET DAY

	Dependent variable = Breakfast Consumption					
	Consumed Foods with at Least 1 Calorie		Consumed Foods with at Least 100 Calories		Consumed Foods with at Least 250 Calories	
	Marginal Effect	(*P*-value)	Marginal Effect	(*P*-value)	Marginal Effect	(*P*-value)
All Students	-0.027	(0.24)	-0.016	(0.54)	0.023	(0.47)
Elementary School Students	0.003	(0.94)	0.043	(0.37)	0.090	(0.11)
Secondary School Students	-0.046	(0.11)	-0.043	(0.17)	-0.013	(0.67)

Source: Weighted tabulations using SNDA-III data

Note: Coefficient estimates presented in each column derived from logistic regression model that included the full set of control variables presented in Table IV.6, except that the SBP and NSLP usual participation variables were dropped and the SBP availability variable was added. The marginal effect presented represents the difference in the predicted proportion of students who consumed breakfast between those for whom the SBP is available in their school and those for whom the program is not available, controlling for the other variables in the model.

increases the likelihood that the non-SBP schools may be unique or different from SBP schools in ways that are not related to their SBP participation.

V. CONCLUSIONS

This study of the interrelationships between school meal program participation, students' dietary patterns, and their weight status used data from the third School Nutrition Dietary Assessment (SNDA-III) study. By examining the results presented here along with the original SNDA-III study results, we can get a detailed picture of the overall diets and weight status of participants and nonparticipants in the school meal programs. While neither analysis yields causal estimates of the effect of participation on these outcomes, they do control for many of the important potential differences in the individual, household, and school characteristics of school meal program participants and nonparticipants. In this chapter, we review the results of the original SNDA-III study, summarize the results of this research study, and discuss policy implications.

A. FINDINGS FROM THE SNDA-III STUDY

Results from SNDA-III (Gordon et al. 2007) suggest the presence of a relationship between school meal program participation and students' energy intake. In most specifications and for most groups, the study authors found that the mean calorie intake of students participating in the SBP and/or NSLP exceeded that of nonparticipating students, although this relationship was statistically significant in only some cases. For the NSLP, participants' regression-adjusted mean 24-hour energy intake was significantly greater than that of nonparticipants at the middle school level, but the differences at the elementary school and high school levels were not statistically significant. In an alternative specification based on a propensity score model, however, participants' energy intake was significantly greater than that of nonparticipants overall and at the elementary school and high school levels. For the SBP, the mean regression-adjusted energy

intake of participants was significantly greater than that of nonparticipants when the data were aggregated across all students.

Gordon et al. (2007) did not find strong evidence of a systematic effect of school meal program participation on students' 24-hour intakes of dietary fat or cholesterol, though participation was associated with greater sodium intake. Participation in either or both programs was also significantly associated with increased 24-hour intakes of several different vitamins and minerals, with the effects on the intake of vitamin A (for the NSLP only), riboflavin (SBP only), calcium, phosphorus, and potassium being particularly strong. These associations may be explained by some of the significant differences in students' food intakes, as both NSLP and SBP participants reported greater consumption of milk and vegetables and lower consumption of sugar-sweetened beverages such as fruit-flavored drinks.[1] SBP participation was also associated with greater fruit consumption.

Competitive foods can be a source of foods and beverages high in energy and low in nutrients and are widely available in secondary schools (O'Toole et al. 2007; U.S. General Accounting Office 2005). Candy, cookies, and sweetened beverages were the most popular competitive food choices of both school meal participants and nonparticipants, although NSLP participants were less likely to consume competitive foods than nonparticipants (Gordon and Fox 2007).

[1] Using data from NHANES 1999-2004, Cole and Fox (2008) found that NSLP participants' lunches were more nutrient-dense than lunches brought from home or elsewhere. NSLP participants had higher intakes of milk, fruits, and vegetables and lower intakes of salty snacks and sweetened beverages at lunch.

B. RELATIONSHIP BETWEEN PARTICIPATION, DIET, AND OBESITY

These findings from SNDA-III set the context for the analyses discussed in this report. The fact that participants' energy intake was generally found to be greater than that of nonparticipants raises concerns that these programs may be contributing to the prevalence of obesity among children. On the other hand, we recognized from the outset of this study that it was important to directly examine the participation-obesity relationship, for at least three reasons. First, the participation-energy intake relationship examined in SNDA-III accounted for only observed differences in the characteristics of participants and nonparticipants, and these groups may have differed in unobserved ways as well that could be related to their weight status. Second, under-reporting of energy intake is recognized as a common problem and may be more prevalent among individuals who are overweight or obese (Bandini et al. 1990; Champagne et al. 1996; Newby 2007). Thus, these differences between participants and nonparticipants in reported energy intakes may be a misleading reflection of their differences in actual energy intakes.[2] Third, students' weight status is influenced by a number of factors other than their current energy intake, including their prior intake levels, the extent to which they are physically active, and genetic factors (IOM 2005; Newby 2007). For these reasons, we directly estimated the relationship between school meal program participation and students' body mass index (BMI) and obesity in this study, and in doing so we made special efforts to control for an extensive set of individual, household, and school characteristics that may both differ for the two groups and be related to their weight status.

[2] The dietary recall method used in SNDA-III has been shown to accurately report energy intake among normal weight adults, but not overweight or obese adults (Moshfegh et al. 2008). Underreporting of energy intake was observed among overweight adolescents using the 24-hr recalls data collected in CSFII 1994-96/1998 (Huang et al. 2004).

The other set of analyses presented in this report address the fact that while the original SNDA-III study report (Gordon et al. 2007) presented evidence on the relationship between participation and dietary intake for breakfast, lunch, and over 24-hours, it did not explore the relationship between participation and the interaction of where and when foods are consumed by students. And while SNDA-III did examine the effects of participation on the consumption of particular food groups by students, the study report did not group together foods and beverages with low nutritional value and then examine the effects of participation on the consumption of these types of foods. We summarize the results of both of these types of analysis in this report. In particular, we examine the relationship between school meal participation and students' intakes of low-nutrient, energy-dense foods, and explore how patterns of consumption of these foods vary by location consumed and over different meals and snacks consumed throughout the average school day.

The differences we observed in participants' and nonparticipants' dietary patterns were typically observed at school and for the specific meal for which participation status was measured. In other words, if we estimated a statistically significant difference between NSLP participants and nonparticipants in a particular dietary pattern over the full day, we generally found that the observed difference was driven by a similar statistically significant difference in that dietary pattern among foods consumed at lunch and at school. For example, NSLP participants had significantly lower daily intakes of SSBs than did nonparticipants. At both the elementary and secondary level, participants' SSB intakes for lunch at school was significantly lower than that of nonparticipants, but at no other meal or location was the difference between the two groups statistically significant. Conversely, if a statistically significant difference emerged at school for an important dietary pattern, it was typically not offset by behavior outside of school, so there was usually also a significant difference in that dietary pattern over the course

of the day. In other words, it does not appear that students compensated for their dietary behavior at school by behaving differently from nonparticipants once they left school.

In terms of specific dietary patterns, four clear findings emerge from our regression-adjusted comparisons of participants and nonparticipants. First, participation in the SBP is associated with a significant increase in students' calorie intake at breakfast, so that participants' energy intake appears to be spread out a bit more evenly over the course of the day than that of nonparticipants. For example, secondary school SBP participants' regression-adjusted mean energy intake at breakfast is 469 calories, or nearly 20 percent of their daily intake. Nonparticipants' mean breakfast intake, by contrast, is only 298 calories, or 14 percent of their daily intake.

Second, NSLP participation is associated with reduced intake of SSBs, for both elementary and secondary school students. At the elementary school level, for example, participants consume a regression-adjusted average of 101 calories from SSBs over the course of the day, which is over 20 percent less than the 127 calories among nonparticipants. A similar absolute difference occurs at the secondary school level (197 calories among participants versus 225 calories among nonparticipants), though the percentage difference is smaller since secondary school students consume greater quantities of SSBs than do elementary school students.

Third, at the elementary school level, NSLP participants consume a lower percentage of their calories from LNED foods and beverages than do nonparticipants (22 versus 25 percent). This differential arises from lower calorie intake of both SSBs and LNED foods by participants. At the secondary school level, the difference in LNED calorie intake between participants and nonparticipants is not statistically significant. Nor is there a significant difference between SBP participants and nonparticipants in the percentage of calories from LNED foods and beverages. In fact, SBP participants' absolute intake of LNED foods is greater than that of nonparticipants at both school levels. This finding is discussed in greater detail below.

Fourth, school meal program participants consume some subcategories of LNED foods more frequently than do nonparticipants. In the case of the SBP, participants' regression-adjusted mean intake of calories from baked goods and desserts is significantly greater than that of nonparticipants. At both the elementary and secondary school level, this translates into a significantly higher mean of overall calories from LNED foods among SBP participants as compared with nonparticipants. In the case of the NSLP, both elementary and secondary school participants' intake of calories from french fries is greater than that of nonparticipants at school, but this difference is not statistically significant across all locations. On the other hand, NSLP participation is associated with a lower mean intake of calories from chips or salty snacks at both levels, and of candy at the elementary school level.

Whether or not the differences between the diets of participants and nonparticipants revealed by this analysis and the SNDA-III study report translate into differences in students' weight status is not obvious. Participants' greater energy intake could translate into a greater likelihood of obesity. On the other hand, the fact that participants are more likely to consume substantial breakfasts and have lower SSB intakes could decrease their likelihood of obesity. In examining the relationship between school meal program participation and students' body mass index and likelihood of obesity, we controlled for the characteristics of students and their schools that could be related to their participation status and independently associated with these outcomes to the extent allowable with available data. If students who tend to be heavy eaters are more attracted to these programs than are lighter eaters, for example, we wanted to control for this tendency in estimating participant-nonparticipant differences in obesity. We did this by taking advantage of the rich set of individual and household characteristics available in SNDA-III, as well as estimating a model that included school fixed effects.

We found no evidence that NSLP participation is related to students' body mass index or risk of obesity. In all specifications, the estimated effect of NSLP participation on weight-related outcomes was small and not statistically significant. There was not strong evidence of positive or negative effects of NSLP participation on students' weight for most of the key subgroups we examined. However, there were some suggestions of a modest negative effect of participation on the likelihood of being overweight or obese among black, nonHispanic students and a positive effect on the likelihood of obesity among students in the "other race" category (that is, those not classified as Hispanic, nonHispanic white, or nonHispanic black).

The lack of a significant relationship between NSLP participation and BMI or the likelihood of obesity is consistent with the findings of two of the three recent studies that estimated this relationship. Hofferth and Curtin (2005) found that after accounting for selection bias, the relationship was not statistically significant. Millimet et al. (2008) found that NSLP participation was not significantly related to third graders' weight or weight gain between kindergarten and third grade.[18] However, our findings differ from those of Schanzenbach (2005), who found that NSLP participation had a positive effect on first graders' BMI and probability of obesity. This difference could be driven by the fact that Schanzenbach studied a very young group of students, whereas first grade students make up a relatively small proportion of the SNDA-III sample. Alternatively, the difference could be the result of data or methodological differences between the two studies.

We found that participation in the SBP was associated with significantly lower BMI. Across the full sample, the size of this effect was relatively modest, implying that students who

[18] On the other hand, Millimet et al. (2008) did find that selection into the SBP could influence the NSLP-obesity relationship. In particular, under certain assumptions about the extent to which SBP participation is correlated with unobserved factors affecting obesity, the NSLP-obesity relationship became positive and significant.

participate in the SBP every day would have a mean BMI 0.75 points lower than those who never participate in the SBP, all else being equal. This result was robust across a number of different specifications, and was driven largely by the negative effect of SBP participation on BMI among nonHispanic white students. There was no evidence of systematic differences in the effect of SBP participation across the other subgroups we examined, including age/gender and household income.

The significant negative relationship between SBP participation and BMI is consistent with findings from Millimet et al. (2008). By contrast, Hofferth and Curtin found no significant relationship between SBP participation and BMI, either before or after accounting for selection bias.

In exploring potential explanations for the negative association between SBP participation and BMI, we examined the differences in participants' and nonparticipants' dietary intakes and dietary patterns. As described above, Gordon et al. (2007) found some evidence that SBP participation was associated with higher food energy intake. Thus, one potential explanation could be dismissed—that SBP participation leads to lower BMI by causing participants to eat less and have lower energy intake overall. Nor did we find evidence that SBP participants consume fewer calories (or a lower percentage of their calories) from LNED foods and beverages than do nonparticipants, so consumption of LNEDs does not appear to be a likely explanation for the SBP-BMI result either.

The one large difference in the dietary patterns of SBP participants and nonparticipants is that participants are more likely to eat breakfast and have a greater intake of calories at breakfast than do nonparticipants. Thus, we examined the hypothesis that SBP participation leads to lower BMI by promoting the consumption of substantial breakfasts. Thus, participants' energy intake may be more evenly spread over the course of the day than that of nonparticipants. We found

some evidence in support of this hypothesis. Breakfast consumption itself was associated with significantly lower BMI, and after we accounted for this relationship, the remaining association between SBP participation and BMI was substantially diminished.

C. POLICY IMPLICATIONS

A key objective of this analysis has been to determine whether there is a relationship between school meal program participation and students' BMI and risk of being overweight or obese. One motivation for examining this issue was the concern that the SBP and/or NSLP may be contributing to the prevalence of obesity among children. Our findings here were clear. The analysis produced no evidence that participation in the SBP and/or NSLP is leading students to have greater BMI or obesity levels. In the case of the SBP, in fact, the estimated relationship was the opposite—SBP participation was associated with lower BMI levels.

Further examination of the SBP-BMI relationship suggested that breakfast consumption may play an important mediating role. In other words, the program may help encourage students to eat breakfast or eat more frequently throughout the day, which in turn may lead to lower BMI levels or smaller gains in BMI (Newby 2007; Franko et al. 2008). Policies that further promote breakfast consumption, either through the SBP or even among nonparticipants, may be promising. The evidence here is more suggestive than conclusive, but is worth further investigation in future research.

The SNDA-III findings provide support for wellness policies that aim to increase students' eating healthful breakfasts. Model local school wellness policies developed by the National Alliance for Nutrition and Activity (NANA 2005) in response to the 2004 Child Nutrition and

WIC Reauthorization Act[19] include policies to ensure that all children have breakfast, either at home or at school. Schools are expected to operate, to the extent possible, the SBP and utilize various methods of disseminating and scheduling breakfasts in school to increase participation. Nutrition education and communication to parents about the importance of children eating breakfast are additional school practices that can be implemented to improve the diets of school-age children.

Regardless of its effect on BMI and obesity, SBP and NSLP participation may positively or negatively affect students' nutrition and health status by influencing dietary intake. While the programs appear to discourage students' consumption of SSBs, their influence on consumption of LNED solid foods is mixed, suggesting some room for improvement. In particular, SBP participants' intake of baked goods/desserts was significantly higher than that of nonparticipants, so further exploration into the specific foods in this category that participants are consuming and how this might be discouraged seems warranted. In the case of the NSLP, participants consumption of fried potatoes at school is substantial (and significantly higher than that of nonparticipants), which both may increase their intake of energy, sodium, and saturated fat and also crowd out the consumption of more healthful vegetables.

The school meal programs provide an opportunity to increase consumption of fruits and non-fried vegetables. In another analysis using SNDA-III data, Briefel et al. (2009a) found that students' consumption of vegetables (excluding french fries) was significantly associated with the elementary school meal practices of offering fresh fruits and vegetables daily and not

[19] The Act requires that, by 2006-2007, local school wellness policies include goals for nutrition education, physical activity, and other school-based activities, including nutrition guidelines for all foods available on campus during the school day [Public Law 108-265, 118 Stat 729].

offering french fries, and with the middle school practice of not offering low-nutrient, energy-dense à la carte items. At the high school level, students' non-fried vegetable consumption intake was not associated with school food practices but was significantly higher among NSLP participants. However, total consumption of fruits and non-fried vegetables is very low[3] for most students at all levels and an area to target for nutrition interventions and nutrition education in schools. USDA's Fresh Fruit and Vegetable Program makes fruit and vegetable snacks available in participating elementary schools and thereby introduces children to healthier eating behaviors at an early age. There is also some evidence that restricting unhealthy snacks in elementary schools can increase consumption of fruits and vegetables[4]and decrease consumption of LNED foods (Gonzalez et al. 2009; Cullen et al. 2008).

School food practices that may improve students' fruit and vegetable consumption in secondary schools include reducing the frequency of serving fried potatoes, minimizing the availability of less healthy competitive foods, and restricting open campus policies, especially in schools with fast food restaurants nearby (Briefel et al. 2009a; Currie et al. 2008; Davis and Carpenter 2008). Strong local school wellness policies that restrict the sales of competitive foods and beverages high in fat, sugar, and/or calories and low in nutrients in schools are one way that school districts can improve the healthfulness of the school food environment (NANA 2005).

Of course, any changes to the content of school lunches or breakfasts should be made with some caution. Given the positive effects of these programs on selected aspects of children's diets, serving more nutritious meals could be counterproductive if they discourage a substantial

[3] The mean consumption of fruits and vegetables obtained and consumed at school among all middle and high school students was 0.3 cup equivalents; those who consumed any fruit or vegetable had a mean of about one-cup equivalent (Briefel et al. 2009a).

[4] Gonzales et al. (2009) found a small (three percent) increase in fruit and vegetable consumption among U.S. fifth graders when unhealthy snacks were restricted.

number of students from participating in them. However, the evidence suggests that changes are possible without discouraging participation. Between 1991-1992 and 2004-2005, meals served in these programs became lower in total fat and saturated fat as a percentage of calories, without associated declines in participation from SNDA-I to SNDA-III (Gordon et al. 2007). One example is the shift from consumption of whole milk to lower-fat milk in school that parallels changes in the general population and past nutrition education emphasis on reducing total and saturated fat in the diet by choosing reduced-fat milks (Briefel 2007).

School meals can make an important contribution to children's diet quality. School-aged children's diets fall short of recommendations for intake of fruits (especially whole fruits), vegetables, and whole grains. Previous research and this analysis of SNDA-III data show that school meals tend to be less energy-dense than alternative meals consumed from home or away from home or school such as fast food restaurants (Keystone Center 2006; O'Donnell et al. 2008). Fast food consumption has increased among children, along with increases in overweight, and the proximity of fast food restaurants to schools provides an alternative to the school lunch or an increased opportunity to consume energy-dense meals or snacks before and after school. Fast food meals are often energy-dense and include large portion sizes, thereby providing more calories and fewer nutrients compared to healthier alternatives. In fact, only three percent of fast food meals meet NSLP criteria (O'Donnell et al. 2008). Further, overweight adolescents are less likely than lean adolescents to adjust their energy intake over the remainder of the day to compensate for a fast food meal (Ebbeling et al. 2004). Recent evidence suggests that the presence of fast food restaurants in close proximity to schools is associated with an increased likelihood of obesity among children at these schools (Currie et al. 2008), which suggests that a policy of not allowing fast food restaurants to locate very close to schools might be considered.

Research suggests that changes to school meals to reduce energy-density may provide an effective approach to moderate children's energy intake. Energy density of meals can be accomplished by reducing fat and sugar content, incorporating additional fruits and vegetables as recipe ingredients, and substituting commercial products that are reduced-fat or reduced-sugar and also familiar to children in place of the higher-fat and higher-sugar alternatives. However, these changes are likely to be associated with higher costs since leaner meats, fish, fruit, and fresh vegetables generally cost more (Drewnowski and Darmon 2005). An IOM expert committee is reviewing the content of school meals in light of children's dietary needs and providing recommendations in fall 2009 (IOM 2008).

In summary, several factors have been linked to the increases in childhood obesity -- including the number of meals eaten at restaurants (fast foods, LNED items), portion sizes, snacking (LNED items), and meal-skipping. Based on the analysis of SNDA-III data in this report, school meal participation was associated with meal patterns (breakfast, lunch, and dinner/supper) and location, but less so with snacking behavior and location. There was no evidence that either the SBP or the NSLP is contributing to rates of childhood obesity. In fact, SBP participation may be a protective factor, perhaps by encouraging students to consume breakfast more regularly. School meals and school food practices can therefore influence risk of childhood obesity based on the quality and portion sizes of the school meals offered, the availability of certain types of foods and beverages in the school food environment (à la carte, meals, snack bars, vending machines, etc.), and promoting eating breakfast.

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APPENDIX A

DIETARY PATTERNS OF SCHOOL MEAL PARTICIPANTS AND NONPARTICIPANTS: SUPPLEMENTAL TABLES

Table A1: Meal and Snack Patterns of National School Lunch Program Participants (NSLP) and Nonparticipants (Proportion Consuming)

	Elementary School						Secondary School							
	NSLP Participants		NSLP Non-participants		All Students		NSLP Participants		NSLP Non-Participants		All students		All students	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
Total Daily														
Breakfast	90.1	(1.60)	91.7	(2.60)	90.5	(1.40)	77.5	(1.80)	77.0	(2.00)	77.2	(1.40)	84.0	(1.00)
Lunch	100.0*	(0.00)	95.1	(2.00)	98.6	(0.60)	100.0**	(0.00)	87.7	(1.60)	93.8	(0.80)	96.2	(0.40)
Supper/dinner	96.0	(1.0)	94.7	(2.20)	95.6	(0.80)	92.2	(1.20)	92.0	(1.20)	92.1	(0.80)	93.9	(0.60)
Snacks	95.1	(1.4)	92.7	(2.60)	94.5	(1.20)	93.5	(0.80)	93.7	(1.20)	93.6	(0.80)	94.0	(0.80)
Mean number of snacks	2.4	(0.10)	2.3	(0.11)	2.3	(0.08)	2.4	(0.07)	2.4	(0.07)	2.4	(0.06)	2.4	(0.05)
At School														
Breakfast	34.1**	(3.60)	8.3	(2.40)	27.0	(3.00)	24.1**	(2.00)	13.0	(1.60)	18.6	(1.40)	22.9	(1.80)
Lunch	100.0**	(0.00)	89.8	(2.80)	97.1	(0.80)	100.0**	(0.00)	68.3	(2.80)	84.1	(1.40)	90.7	(0.80)
Supper/dinner	3.0	(1.00)	1.9	(1.00)	2.7	(0.80)	1.3	(0.40)	1.5	(0.60)	1.4	(0.40)	2.0	(0.40)
Snacks	40.1**	(3.20)	56.4	(6.00)	44.6	(3.40)	35.5	(2.40)	36.9	(2.60)	36.2	(1.80)	40.4	(2.00)
Mean number of snacks	0.5*	(0.05)	0.7	(0.09)	0.6	(0.05)	0.5	(0.04)	0.5	(0.05)	0.5	(0.03)	0.5	(0.03)
At Home														
Breakfast	56.9**	(3.40)	83.6	(3.60)	64.2	(2.80)	54.1**	(2.60)	62.1	(2.00)	58.0	(2.00)	61.2	(2.00)
Lunch	0.7*	(0.60)	5.7	(2.00)	2.1	(0.60)	2.3**	(0.80)	9.4	(1.40)	5.8	(1.00)	3.9	(0.60)
Supper/dinner	82.4	(1.80)	83.2	(3.20)	82.6	(1.60)	78.8	(1.80)	75.2	(2.00)	77.0	(1.40)	79.8	(1.00)
Snacks	84.2	(2.00)	78.9	(3.20)	82.8	(1.80)	84.5	(1.40)	82.1	(1.40)	83.3	(1.00)	83.0	(1.00)
Mean number of snacks	1.7*	(0.08)	1.4	(0.08)	1.6	(0.06)	1.6	(0.05)	1.6	(0.06)	1.6	(0.04)	1.6	(0.04)
At Locations Away From School/Home														
Breakfast	2.0	(0.80)	1.0	(0.80)	1.7	(0.60)	1.1**	(0.40)	2.8	(0.60)	1.9	(0.40)	1.8	(0.40)
Lunch	0.1*	(0.00)	3.5	(1.40)	1.0	(0.40)	0.8**	(0.40)	10.7	(1.40)	5.7	(0.80)	3.3	(0.40)
Supper/dinner	10.6	(1.40)	11.9	(2.80)	11.0	(1.20)	12.5	(1.40)	15.9	(2.00)	14.2	(1.20)	12.6	(0.80)
Snacks	14.6	(1.80)	16.3	(3.20)	15.1	(1.40)	19.6	(2.00)	19.7	(1.80)	19.7	(1.40)	17.4	(1.00)
Mean number of snacks	0.2	(0.02)	0.2	(0.04)	0.2	(0.02)	0.2	(0.03)	0.2	(0.02)	0.2	(0.02)	0.2	(0.01)
Sample Size	**531**		**201**		**732**		**855**		**727**		**1,582**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A2: Mean Energy (kcal) by Location for National School Lunch Program Participants (NSLP) Participants and Nonparticipants

	Elementary School						Secondary School							
	NSLP Participants		NSLP Non-participants		All Students		NSLP Participants		NSLP Non-participants		All students		All students	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
Total All Day														
Total	2,048	(37.1)	2,075	(67.4)	2,055	(32.8)	2,250**	(44.0)	2,076	(43.5)	2,163	(30.4)	2,109	(24.5)
Breakfast	351	(13.5)	359	(26.2)	353	(12.4)	326	(11.0)	312	(11.8)	319	(7.9)	337	(7.5)
Lunch	567	(10.7)	592	(48.0)	574	(15.55)	656**	(17.3)	528	(17.8)	593	(12.0)	583	(9.8)
Supper/dinner	619	(20.3)	632.5	(32.8)	623	(18.4)	698	(20.7)	657	(18.4)	678	(13.7)	650	(12.5)
Snacks	511	(20.1)	492	(24.3)	506	(16.2)	569	(24.3)	578	(25.3)	573	(19.2)	539	(13.4)
At School														
Total	790	(24.2)	710	(45.5)	768	(20.3)	808**	(17.4)	533	(24.2)	672	(15.7)	720	(12.7)
Breakfast	128**	(14.4)	26	(8.8)	100	(11.9)	94**	(9.3)	51	(5.8)	72	(5.9)	86	(6.9)
Lunch	562	(10.1)	544	(49.4)	557	(15.7)	639**	(14.8)	382	(21.2)	512	(13.8)	535	(10.4)
Supper/dinner	18	(6.1)	12	(6.9)	16	(5.1)	5	(2.0)	10	(5.3)	8	(2.8)	12	(2.9)
Snacks	82*	(9.9)	128	(17.7)	95	(9.3)	70*	(6.5)	90	(8.9)	80	(6.0)	87	(5.5)
At Home														
Total	1,105	(32.0)	1,224	(52.0)	1,137	(28.8)	1,234	(35.8)	1,233	(33.8)	1,234	(24.6)	1,185	(20.2)
Breakfast	215**	(16.2)	322	(26.2)	244	(14.2)	226	(12.6)	248	(12.1)	236	(10.0)	240	(9.7)
Lunch	4	(2.6)	21	(8.5)	8	(2.8)	12**	(5.5)	54	(9.6)	33	(5.6)	21	(3.0)
Supper/dinner	510	(17.3)	556	(33.7)	523	(17.1)	580	(21.8)	525	(20.2)	553	(14.5)	538	(12.2)
Snacks	375	(18.5)	325	(28.7)	362	(16.1)	416	(19.5)	406	(19.6)	411	(14.6)	386	(10.7)
At Locations Away from School/Home														
Total	153	(17.3)	142	(26.7)	150	(15.6)	208**	(19.8)	309	(25.2)	258	(15.3)	203	(10.5)
Breakfast	8	(3.5)	11	(9.8)	9	(3.6)	7	(2.2)	14	(3.2)	11	(2.1)	10	(2.3)
Lunch	<0.5*	(0.4)	28	(12.0)	8	(3.2)	5**	(3.0)	92	(15.1)	48	(7.8)	28	(4.2)
Supper/dinner	91	(14.2)	64	(15.2)	84	(11.2)	113	(13.2)	122	(16.4)	117	(10.5)	100	(7.4)
Snacks	53	(8.3)	39	(8.3)	49	(6.0)	83	(11.3)	81	(10.6)	82	(8.0)	66	(5.1)
Sample Size	**531**		**201**		**732**		**855**		**727**		**1,582**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

* Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A3: Mean Energy Density by Location for National School Lunch Program (NSLP) Participants and Nonparticipants

	Elementary School						Secondary School						All Students	
	NSLP Participants		NSLP Non-participants		All Students		NSLP Participants		NSLP Non-Participants		All Students			
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Total Daily														
Total	1.16	0.02	1.23	0.04	1.18	0.02	1.09**	0.01	1.02	0.02	1.06	0.01	1.11	0.01
Breakfast	1.11	0.02	0.98	0.07	1.07	0.03	1.05	0.02	1.01	0.04	1.03	0.02	1.05	0.02
Lunch	1.26**	0.02	1.55	0.08	1.33	0.03	1.25	0.03	1.25	0.03	1.25	0.02	1.29	0.02
Supper/dinner	1.21	0.02	1.20	0.05	1.21	0.02	1.17	0.02	1.11	0.02	1.14	0.02	1.17	0.01
Snacks	1.05*	0.04	1.21	0.05	1.09	0.03	0.90	0.03	0.81	0.04	0.86	0.03	0.95	0.02
At School														
Total	1.24**	0.02	1.51	0.06	1.30	0.03	1.15	0.03	1.05	0.05	1.11	0.03	1.20	0.02
Breakfast	1.10	0.03	~	~	1.10	0.03	1.11	0.05	1.13	0.07	1.12	0.04	1.11	0.02
Lunch	1.26**	0.02	1.60	0.08	1.34	0.03	1.26	0.03	1.26	0.04	1.26	0.03	1.30	0.02
Supper/dinner	~	~	~	~	~	~	~	~	~	~	~	~	1.30	0.10
Snacks	1.28**	0.07	1.40	0.11	1.32	0.06	0.69	0.06	0.58	0.08	0.62	0.06	0.88	0.06
At Home														
Total	1.09	0.02	1.11	0.05	1.10	0.02	1.04	0.02	0.99	0.02	1.01	0.01	1.05	0.01
Breakfast	1.11	0.03	0.96	0.08	1.05	0.04	1.02	0.02	0.97	0.04	0.99	0.03	1.02	0.02
Lunch	~	~	~	~	~	~	~	~	1.08	0.07	1.07	0.06	1.10	0.06
Supper/dinner	1.17	0.03	1.20	0.05	1.18	0.03	1.13	0.02	1.10	0.02	1.12	0.02	1.15	0.02
Snacks	0.98	0.04	1.13	0.07	1.02	0.04	0.94	0.03	0.88	0.03	0.91	0.03	0.96	0.02
At Locations Away from School/Home														
Total	1.39	0.05	1.27	0.09	1.36	0.04	1.17	0.05	1.1	0.04	1.13	0.03	1.20	0.03
Breakfast	~	~	~	~	~	~	~	~	~	~	1.41	0.16	1.39	0.11
Lunch	~	~	~	~	~	~	~	~	1.32	0.08	1.31	0.08	1.26	0.07
Supper/dinner	~	~	~	~	~	~	1.36**	0.06	1.10	0.07	1.21	0.05	1.29	0.04
Snacks	1.32	0.10	1.47	0.26	1.35	0.09	0.98	0.07	0.9	0.09	0.94	0.06	1.06	0.05
Sample Size	**531**		**201**		**732**		**855**		**727**		**1,582**		**2,314**	

Table A.3 (*continued*)

Source: Third School Nutrition Dietary Assessment Study (SNDA-III)**,** unadjusted data, participation on target recall day.

Note: Energy density was calculated as a population ratio based on calories and grams from solid foods and beverages.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.
~ Sample sizes were too small to compute a reliable statistic.

Table A4: Consumption of Sugar-sweetened Beverages (SSBs) and Low-nutrient, Energy Dense (LNED) Foods Among National School Lunch Program (NSLP) Participants and Nonparticipants (Mean Kcal)

	Elementary school				Secondary school				All	
	NSLP Partici-pants	SE	NSLP Non-participants	SE	NSLP Partici-pants	SE	NSLP Non-participants	SE	All	SE
All Locations										
SSBs – total	107	(7.4)	118	(11.2)	196	(9.8)	224	(9.9)	159	(5.2)
-- at breakfast	5	(1.9)	12	(3.2)	12	(2.1)	12	(1.8)	10	(1.0)
-- at lunch	3**	(0.9)	39	(6.5)	28**	(2.8)	60	(4.0)	28	(1.8)
-- at dinner/supper	48	(3.4)	36	(5.6)	72	(4.9)	68	(3.9)	57	(2.7)
-- at snacks	51**	(5.3)	31	(4.8)	85	(6.5)	84	(7.4)	65	(3.2)
LNED solid foods-total	334	(18.2)	378	(27.3)	399	(17.5)	380	(16.6)	368	(10.0)
-- at breakfast	57	(9.0)	43	(9.0)	44	(5.2)	38	(5.6)	47	(3.9)
-- at lunch	69*	(8.1)	102	(13.4)	99	(7.7)	102	(6.0)	89	(4.4)
-- at dinner/supper	54	(7.5)	52	(11.4)	50	(5.6)	63	(8.5)	55	(4.1)
-- at snacks	154	(10.6)	181	(19.0)	207	(13.5)	177	(9.6)	177	(7.2)
All LNED items – total	441	(18.1)	495	(31.2)	596	(22.1)	604	(22.4)	527	(12.0)
% kcal from all LNEDs[a]	21.5	(0.71)	23.9	(1.55)	26.5*	(0.78)	29.1	(0.92)	25.0	(0.47)
At School										
SSBs – total	11**	(2.0)	40	(5.2)	45**	(4.4)	61	(4.8)	36	(2.5)
-- at breakfast	1*	(0.6)	<0.5	(0.22)	4	(1.4)	3	(0.8)	2	(0.5)
-- at lunch	3**	(0.8)	32	(4.8)	26**	(2.7)	40	(3.4)	22	(1.6)
-- at dinner/supper	1	(0.8)	1	(0.8)	<0.5	(0.2)	1	(0.6)	1	(0.35)
-- at snacks	5	(1.5)	7	(2.2)	15	(2.6)	18	(2.9)	11	(1.4)
LNED solid foods-total	121	(10.6)	166	(20.5)	157**	(8.5)	127	(8.7)	138	(6.1)
-- at breakfast	18**	(4.7)	4	(2.0)	19*	(3.9)	10	(2.3)	14	(2.2)
-- at lunch	69	(8.1)	96	(13.4)	98**	(7.8)	75	(5.3)	82	(4.3)
-- at dinner/supper	0.0	(0.00)	<0.5	(0.41)	<0.5	(0.14)	<0.5	(019)	<0.5	(0.08)
-- at snacks	34*	(4.2)	66	(14.3)	40	(5.0)	42	(5.8)	42	(3.4)
All LNED items – total	132**	(11.4)	206	(21.6)	203	(10.1)	189	(11.3)	174	(7.4)
% kcal from all LNEDs[a]	16.7**	(1.26)	29.0	(2.99)	25.1**	(1.09)	35.4	(1.70)	24.1	(0.97)
At Home										
SSBs – total	77	(7.2)	62	(7.2)	117	(6.5)	110	(6.6)	93	(3.7)
-- at breakfast	4	(1.9)	10	(2.9)	6	(1.1)	9	(1.6)	6	(0.9)
-- at lunch	<0.5	(0.1)	3	(2.0)	1*	(0.6)	6	(1.6)	2	(0.5)

Table A.4 (*continued*)

	Elementary school				Secondary school				All	
	NSLP Partici-pants	SE	NSLP Non-participants	SE	NSLP Partici-pants	SE	NSLP Non-participants	SE	All	SE
-- at dinner/supper	35	(2.8)	27	(5.3)	56	(3.9)	47	(3.7)	42	(2.3)
-- at snacks	38**	(4.9)	21	(4.3)	54	(4.3)	49	(4.7)	43	(2.3)
LNED solid foods-total	177	(12.1)	171	(16.9)	199	(13.4)	183	(12.9)	183	(7.0)
-- at breakfast	36	(6.6)	38	(9.3)	23	(3.7)	25	(4.7)	31	(3.2)
-- at lunch	0.0	(0.00)	2	(1.4)	<0.5**	(0.4)	6	(1.9)	2	(0.5)
-- at dinner/supper	34	(5.7)	36	(9.4)	35	(5.0)	36	(7.7)	36	(3.5)
-- at snacks	106	(8.9)	95	(12.4)	140	(11.3)	113	(8.5)	115	(5.4)
All LNED items – total	254	(11.9)	232	(19.8)	315	(15.9)	293	(16.6)	276	(7.5)
% kcal from all LNEDs[a]	23.0*	(0.89)	19.0	(1.35)	25.5	(1.12)	23.8	(1.14)	23.3	(0.53)
At Locations Away From School/Home										
SSBs – total	20	(2.9)	17	(4.2)	34*	(3.7)	52	(6.3)	31	(2.1)
-- at breakfast	<0.5	(0.14)	2	(1.2)	2	(0.7)	1	(0.6)	1	(0.39)
-- at lunch	0.0	(0.00)	4	(2.3)	<0.5**	(0.15)	15	(2.9)	4	(0.8)
-- at dinner/supper	128	(1.9)	8	(2.9)	16	(2.1)	19	(3.2)	14	(1.2)
-- at snacks	8*	(2.0)	2	(0.9)	17	(3.0)	17	(3.4)	12	(1.4)
LNED solid foods-total	36	(6.8)	40	(8.8)	44*	(6.4)	70	(8.1)	47	(3.6)
-- at breakfast	3	(1.4)	0.7	(0.7)	1	(1.0)	3	(1.2)	2	(0.6)
-- at lunch	0.0	(0.0)	5	(3.3)	<0.5**	(0.09)	22	(4.7)	6	(1.3)
-- at dinner/supper	20	(6.1)	15	(5.8)	15	(3.2)	24	(4.9)	19	(2.9)
-- at snacks	13	(2.6)	20	(5.9)	27	(5.0)	22	(3.5)	20	(2.0)
All LNED items – total	56	(9.2)	57	(11.2)	78*	(9.0)	122	(13.3)	78	(5.1)
% kcal from all LNEDs[a]	36.5	(3.26)	40.1	(3.49)	37.5	(2.37)	39.5	(2.43)	38.2	(1.34)
Sample size	**531**		**201**		**855**		**727**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III)**,** unadjusted data, participation on target recall day.

[a] Calculated as a population ratio.

Table A5: Consumption of Low-nutrient, Energy-dense (LNED) Foods Among National School Lunch Program (NSLP) Participants and Nonparticipants (mean kcal)

	Elementary school				Secondary school				All	
	NSLP participants	SE	NSLP Non-participants	SE	NSLP participants	SE	NSLP Non-participants	SE	All	SE
All Locations										
Baked goods/desserts	149	(13.9)	154	(17.7)	157	(10.8)	137	(9.5)	149	(6.7)
Dairy-based desserts	46	(7.0)	49	(11.7)	39	(4.1)	31	(4.1)	41	(3.6)
Candy	33*	(4.7)	65	(14.0)	65	(7.9)	68	(7.1)	54	(4.5)
French fries	50	(7.0)	37	(7.6)	70	(6.6)	69	(7.5)	58	(3.7)
Chips/salty snacks	55	(5.3)	72	(9.8)	66	(4.7)	74	(5.3)	65	(3.2)
At School										
Baked goods/desserts	57	(8.5)	54	(10.7)	53*	(5.1)	38	(5.1)	51	(3.8)
Dairy-based desserts	12	(3.1)	20	(9.4)	7*	(1.9)	3	(0.7)	10	(2.0)
Candy	9**	(2.1)	33	(8.6)	27	(5.5)	32	(5.4)	23	(2.9)
French fries	22**	(4.4)	8	(2.9)	45**	(6.1)	14	(3.4)	24	(2.6)
Chips/salty snacks	20**	(3.1)	51	(7.8)	25**	(2.8)	40	(3.5)	30	(2.1)
At Home										
Baked goods/desserts	85	(8.7)	84	(14.2)	96	(9.6)	83	(8.1)	88	(5.2)
Dairy-based desserts	31	(5.9)	20	(9.4)	30	(4.1)	23	(4.3)	28	(3.2)
Candy	17	(3.1)	26	(7.7)	28	(4.1)	30	(5.3)	24	(2.3)
French fries	13	(2.9)	15	(4.7)	10	(1.6)	18	(4.0)	14	(1.7)
Chips/salty snacks	31*	(4.2)	19	(4.2)	34	(3.8)	25	(3.1)	29	(2.0)
At Locations Away from School/Home										
Baked goods/desserts	8	(2.3)	17	(7.3)	9	(2.5)	13	(3.3)	10	(1.7)
Dairy-based desserts	3	(0.9)	1	(0.7)	2	(0.7)	5	(1.3)	3	(0.5)
Candy	6	(2.5)	6	(2.5)	9	(2.5)	7	(1.8)	7	(1.2)
French fries	15	(4.1)	14	(5.3)	15**	(3.6)	37	(6.1)	20	(2.2)
Chips/salty snacks	4	(2.2)	3	(1.3)	7	(1.6)	9	(2.5)	6	(1.0)
Sample size	**531**		**201**		**855**		**727**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A6: Meal and Snack Patterns of School Breakfast Program Participants (SBP) and Nonparticipants (Proportion Consuming)

	Elementary School						Secondary School							
	SBP Participants		SBP Non-participants		All Students		SBP Participants		SBP Non-participants		All Students		All Students	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
Total Daily														
Breakfast	100**	(0.0)	87.7	(1.8)	90.5	(1.4)	100**	(0.0)	74.3	(1.6)	77.2	(1.4)	84.0	(1.0)
Lunch	100*	(0.0)	98.2	(0.8)	98.6	(0.6)	93.4	(2.2)	93.9	(0.8)	93.8	(0.8)	96.2	(0.4)
Supper/dinner	94	(2.6)	96.1	(0.8)	95.6	(0.8)	94.2	(1.8)	91.8	(1.0)	92.1	(0.8)	93.9	(0.6)
Snacks	96.7	(1.6)	93.8	(1.4)	94.5	(1.2)	90.5	(2.8)	94.1	(0.8)	93.6	(0.8)	94.0	(0.8)
Mean number of snacks	2.3	(0.14)	2.3	(0.08)	2.3	(0.08)	2.3	(0.13)	2.4	(0.06)	2.4	(0.06)	2.4	(0.05)
At School														
Breakfast	100**	(0.0)	5.9	(1.4)	27.0	(3.0)	100**	(0.0)	8.2	(0.8)	18.6	(1.4)	22.9	(1.8)
Lunch	100**	(0.0)	96.3	(1.0)	97.1	(0.8)	90.0	(2.4)	83.3	(1.6)	84.1	(1.4)	90.7	(0.8)
Supper/dinner	5.1	(2.0)	2	(0.6)	2.7	(0.8)	1.8	(1.2)	1.3	(0.4)	1.4	(0.4)	2.0	(0.4)
Snacks	40.2	(5.4)	45.9	(3.8)	44.6	(3.4)	34.0	(4.0)	36.5	(2.0)	36.2	(1.8)	40.4	(2.0)
Mean number of snacks	0.5	(0.08)	0.6	(0.05)	0.6	(0.05)	0.5	(0.06)	0.5	(0.04)	0.5	(0.03)	0.5	(0.03)
At Home														
Breakfast	11.0**	(3.4)	80.2	(2.2)	64.2	(2.8)	11.6**	(2.4)	64.5	(1.8)	58.0	(2.0)	61.2	(2.0)
Lunch	0.4**	(0.4)	2.6	(0.8)	2.1	(0.6)	3**	(1.2)	6.2	(1.0)	5.8	(1.0)	3.9	(0.6)
Supper/dinner	82.1	(4.0)	82.8	(1.6)	82.6	(1.6)	83.5*	(3.0)	76.1	(1.4)	77.0	(1.4)	79.8	(1.0)
Snacks	83.4	(3.6)	82.6	(1.8)	82.8	(1.8)	81.7	(3.6)	83.6	(1.0)	83.3	(1.0)	83.0	(1.0)
Mean number of snacks	1.6	(0.14)	1.6	(0.07)	1.6	(0.06)	1.6	(0.10)	1.6	(0.04)	1.6	(0.04)	1.6	(0.04)
At Locations Away From School/Home														
Breakfast	0.8	(0.8)	2	(0.6)	1.7	(0.6)	0**	(0)	2.2	(0.4)	1.9	(0.4)	1.8	(0.4)
Lunch	0*	(0)	1.3	(0.6)	1.0	(0.4)	0.7**	(0.6)	6.3	(0.8)	5.7	(0.8)	3.3	(0.4)
Supper/dinner	6.8*	(2.2)	12.2	(1.6)	11.0	(1.2)	9.7*	(2.0)	14.8	(1.2)	14.2	(1.2)	12.6	(0.8)
Snacks	15.5	(3.0)	14.9	(1.6)	15.1	(1.4)	16.7	(3.2)	20.1	(1.6)	19.7	(1.4)	17.4	(1.0)
Mean number of snacks	0.2	(0.04)	0.2	(0.02)	0.2	(0.02)	0.2	(0.04)	0.2	(0.02)	0.2	(0.02)	0.2	(0.01)
Sample Size	**160**		**572**		**732**		**221**		**1,361**		**1,582**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A7: Mean Energy (kcal) by Location for School Breakfast Program (SBP) Participants and Nonparticipants

	Elementary School						Secondary School							
	SBP Participants		SBP Non-participants		All Students		SBP Participants		SBP non-participants		All Students		All Students	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
Total All Day														
Total	2,156	(54.7)	2,025	(39.7)	2,056	(32.7)	2,374*	(102.9)	2,134	(32.5)	2,163	(30.4)	2,109	(24.5)
Breakfast	414**	(16.0)	335	(15.0)	353	(12.4)	415**	(20.8)	306	(9.2)	319	(7.9)	336	(7.5)
Lunch	579	(17.8)	572	(20.3)	574	(15.6)	616	(30.0)	589	(12.3)	593	(12.0)	583	(9.8)
Supper/dinner	618	(33.5)	624	(21.0)	623	(18.4)	721	(49.9)	672	(13.7)	678	(13.7)	650	(12.5)
Snacks	545	(37.8)	494	(18.2)	506	(16.2)	621	(51.6)	567	(20.7)	573	(19.2)	539	(13.4)
At School														
Total	1,062**	(34.2)	680	(18.2)	768	(20.3)	1,053**	(44.4)	619	(16.9)	672	(15.7)	720	(12.7)
Breakfast	371**	(15.0)	18	(4.3)	100	(11.9)	376**	(18.3)	30	(3.9)	72	(5.9)	86	(6.9)
Lunch	577	(17.7)	551	(20.5)	557	(15.7)	583*	(31.0)	502	(14.7)	512	(13.8)	535	(10.4)
Supper/dinner	35	(15.1)	11	(3.7)	16	(5.1)	9	(6.6)	8	(3.1)	8	(2.8)	12	(2.9)
Snacks	78	(17.9)	100	(10.3)	95	(9.3)	86	(17.4)	79	(6.8)	80	(6.0)	87	(5.5)
At Home														
Total	968**	(50.5)	1,188	(31.9)	1,137	(28.8)	1,129	(58.9)	1,248	(25.9)	1,234	(24.6)	1,185	(20.2)
Breakfast	42**	(14.2)	305	(15.7)	244	(14.2)	39**	(7.9)	264	(9.6)	236	(10.0)	240	(9.7)
Lunch	1**	(1.2)	11	(3.6)	8	(2.8)	26	(13.7)	34	(5.5)	33	(5.6)	21	(3.0)
Supper/dinner	526	(34.5)	522	(19.4)	523	(17.1)	623	(44.2)	543	(14.5)	553	(14.5)	538	(12.2)
Snacks	400	(35.2)	350	(20.5)	362	(16.1)	441	(36.6)	407	(15.8)	411	(14.6)	386	(10.7)
At Locations Away from School/Home														
Total	126	(26.7)	157	(19.0)	150	(15.6)	191	(43.9)	267	(16.7)	258	(15.3)	203	(10.5)
Breakfast	1*	(1.0)	11	(4.6)	9	(3.6)	<0.05**	(0.1)	12	(2.5)	11	(2.1)	10	(2.3)
Lunch	0*	(0.0)	10	(4.1)	8	(3.2)	7**	(6.3)	54	(8.9)	48	(7.8)	28	(4.2)
Supper/dinner	57	(18.4)	91	(13.2)	94	(11.2)	89	(30.3)	121	(11.4)	117	(10.5)	100	(7.4)
Snacks	67	(18.7)	44	(5.9)	49	(6.0)	94	(22.6)	80	(8.7)	82	(8.0)	66	(5.1)
Sample Size	**160**		**572**		**732**		**221**		**1,361**		**1,582**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

* Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A8: Mean Energy Density (ED) by Location for School Breakfast Program (SBP) Participants and Nonparticipants

	Elementary School						Secondary School							
	SBP Participants		SBP non-participants		All Students		SBP Participants		SBP Non-participants		All Students		All Students	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
All Day														
Total	1.15	0.03	1.19	0.02	1.18	0.02	1.15**	0.03	1.04	0.01	1.06	0.01	1.11	0.01
Breakfast	1.09	0.03	1.06	0.04	1.07	0.03	1.14**	0.04	1.01	0.02	1.03	0.02	1.05	0.02
Lunch	1.27	0.03	1.35	0.04	1.33	0.03	1.29	0.05	1.24	0.02	1.25	0.02	1.29	0.02
Supper/dinner	1.21	0.04	1.21	0.03	1.21	0.02	1.16	0.04	1.13	0.02	1.14	0.02	1.17	0.01
Snacks	1.03	0.08	1.11	0.03	1.09	0.03	1.01*	0.07	0.84	0.03	0.86	0.03	0.95	0.02
At School														
Total	1.20**	0.02	1.35	0.03	1.30	0.03	1.21**	0.03	1.09	0.03	1.11	0.03	1.20	0.02
Breakfast	1.09	0.03	1.17	0.09	1.10	0.03	1.14	0.04	1.08	0.08	1.12	0.04	1.11	0.02
Lunch	1.27	0.03	1.36	0.04	1.34	0.03	1.29	0.05	1.25	0.03	1.26	0.03	1.30	0.02
Supper/dinner	~	~	~	~	1.30	0.11	2.88	1.54	1.2	0.22	1.3	0.23	1.30	0.10
Snacks	1.14	0.1	1.38	0.07	1.32	0.06	1.00*	0.15	0.59	0.06	0.62	0.06	0.88	0.06
At Home														
Total	1.08	0.05	1.10	0.02	1.10	0.02	1.08	0.04	1.01	0.01	1.01	0.01	1.05	0.01
Breakfast	1.15	0.13	1.05	0.04	1.05	0.04	1.16	0.10	0.99	0.03	0.99	0.03	1.02	0.02
Lunch	~	~	~	~	1.22	0.2	1.54*	0.25	1.03	0.06	1.07	0.06	1.10	0.06
Supper/dinner	1.18	0.04	1.18	0.03	1.18	0.03	1.12	0.04	1.12	0.02	1.12	0.02	1.15	0.02
Snacks	0.96	0.09	1.04	0.03	1.02	0.04	1.00	0.08	0.9	0.03	0.91	0.03	0.96	0.02
At Locations Away from School/Home														
Total	1.37	0.08	1.36	0.05	1.36	0.04	1.25	0.13	1.12	0.03	1.13	0.03	1.20	0.03
Breakfast	~	~	~	~	~	~	~	~	~	~	1.41	0.16	1.39	0.11
Lunch	~	~	~	~	~	~	1.21	0.05	1.31	0.08	1.31	0.08	1.26	0.07
Supper/dinner	1.31	0.14	1.42	0.07	1.40	0.07	1.45	0.18	1.19	0.05	1.21	0.05	1.29	0.04
Snacks	1.49	0.20	1.30	0.10	1.35	0.09	1.10	0.18	0.92	0.06	0.94	0.06	1.06	0.05
Sample Size	**160**		**572**		**732**		**221**		**1,361**		**1,582**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

Table A.8 (*continued*)

Note: Energy density was calculated as a population ratio based on calories and grams from solids foods and beverages.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.
~ Sample sizes were too small to compute a reliable statistic.

Table A9: Consumption of Sugar-sweetened Beverages (SSBs) and Low-nutrient, Energy dense (LNED) Foods among School Breakfast Program (SBP) Participants and Nonparticipants (mean kcal)

	Elementary school				Secondary school				All	
	SBP participants	SE	SBP Non-participants	SE	SBP Participants	SE	SBP Non-participants	SE	All	SE
All Locations										
SSBs – total	105	(9.1)	112	(7.5)	200	(19.0)	211	(7.7)	159	(5.2)
-- at breakfast	2*	(1.2)	9	(2.1)	7	(2.8)	13	(1.5)	10	(1.0)
-- at lunch	4**	(1.8)	15	(2.6)	32*	(5.3)	45	(3.2)	28	(1.8)
-- at dinner/supper	52	(6.8)	42	(3.6)	77	(13.2)	69	(3.5)	57	(2.7)
-- at snacks	47	(5.7)	45	(5.2)	84	(11.9)	84	(5.5)	65	(3.2)
LNED solid foods-total	349	(25.1)	345	(15.4)	485**	(34.8)	377	(11.7)	368	(10.0)
-- at breakfast	60	(16.4)	51	(6.8)	73*	(13.7)	36	(3.7)	47	(3.9)
-- at lunch	84	(13.8)	76	(6.6)	110	(15.8)	99	(4.9)	89	(4.4)
-- at dinner/supper	37	(8.8)	58	(8.0)	69	(17.2)	55	(4.5)	55	(4.1)
-- at snacks	167	(17.7)	159	(11.6)	234*	(19.8)	186	(9.6)	177	(7.2)
All LNED items - total	454	(27.9)	456	(16.7)	685*	(43.1)	588	(15.9)	527	(12.0)
% kcal from all LNEDs[a]	21.1	(1.10)	22.5	(0.76)	28.9	(1.21)	27.6	(0.63)	25.0	(0.47)
At School										
SSBs – total	13	(4.0)	20	(2.6)	44	(6.9)	55	(4.1)	36	(2.5)
-- at breakfast	2	(1.0)	1	(0.5)	6	(2.3)	3	(0.9)	2	(0.5)
-- at lunch	4**	(1.8)	13	(2.1)	28	(5.5)	34	(2.7)	22	(1.6)
-- at dinner/supper	3	(1.9)	1	(0.5)	<0.5	(0.3)	1	(0.34)	1	(0.34)
-- at snacks	4	(2.0)	6	(1.5)	10	(3.2)	17	(2.3)	11	(1.4)
LNED solid foods-total	173	(15.8)	121	(10.1)	216**	(17.1)	132	(7.6)	138	(6.1)
-- at breakfast	49**	(13.0)	4	(1.4)	68**	(13.4)	7	(1.5)	14	(2.2)
-- at lunch	84	(13.8)	74	(6.6)	101	(15.7)	85	(4.7)	81	(4.3)
-- at dinner/supper	0	(0)	<0.5	(0.15)	0	(0)	<0.5	(0.13)	<0.5	(0.08)
-- at snacks	40	(8.1)	44	(6.6)	48	(8.5)	40	(4.9)	42	(3.4)
All LNED items – total	186*	(16.6)	142	(11.1)	260**	(20.0)	187	(9.5)	174	(7.4)
% kcal from all LNEDs[a]	17.5	(1.50)	20.8	(1.53)	24.7**	(1.49)	30.2	(1.28)	24.1	(0.97)
At Home										
SSBs – total	78	(8.4)	71	(6.4)	129	(13.7)	111	(5.4)	93	(3.7)
-- at breakfast	1**	(0.8)	7	(2.0)	1**	(1.0)	8	(1.1)	6	(0.9)
-- at lunch	0	(0)	1	(0.7)	2	(1.6)	4	(0.8)	2	(0.5)

Table A.9 (*continued*)

	Elementary school				Secondary school				All	
	SBP participants	SE	SBP Non-participants	SE	SBP Participants	SE	SBP Non-participants	SE	All	SE
-- at dinner/supper	41	(5.0)	30	(3.1)	66	(10.7)	49	(2.9)	42	(2.3)
-- at snacks	36	(5.5)	33	(4.6)	59	(10.6)	50	(3.5)	42	(2.3)
LNED solid foods-total	152	(18.6)	182	(11.3)	237	(25.1)	184	(10.1)	183	(7.0)
-- at breakfast	11**	(7.1)	45	(6.9)	5**	(2.3)	27	(3.2)	31	(3.2)
-- at lunch	0	(0)	1	(0.5)	5	(3.4)	3	(1.0)	2	(0.5)
-- at dinner/supper	30	(8.8)	36	(5.8)	58	(16.9)	34	(4.0)	36	(3.5)
-- at snacks	111	(15.0)	101	(8.7)	169**	(15.9)	121	(7.7)	115	(5.4)
All LNED items – total	230	(20.7)	253	(11.6)	366*	(27.8)	295	(12.7)	276	(7.5)
% kcal from all LNEDs[a]	23.7	(2.00)	21.3	(0.77)	32.4**	(1.86)	23.7	(0.89)	23.3	(0.53)
At Locations Away from School/Home										
SSBs – total	14	(3.8)	20	(3.1)	28	(7.6)	45	(3.9)	31	(2.1)
-- at breakfast	0	(0)	1	(0.35)	0*	(0)	2	(0.6)	1	(0.39)
-- at lunch	0	(0)	2	(0.8)	1**	(1.4)	8	(1.7)	4	(0.8)
-- at dinner/supper	8	(3.0)	12	(1.9)	11	(4.7)	18	(2.3)	14	(1.2)
-- at snacks	7	(2.6)	6	(1.7)	15	(4.7)	17	(2.3)	12	(1.4)
LNED solid foods-total	24	(5.5)	41	(6.7)	31**	(8.8)	60	(5.4)	47	(3.5)
-- at breakfast	0*	(0)	3	(1.3)	0*	(0)	2	(1.0)	2	(0.6)
-- at lunch	0	(0)	2	(1.2)	3*	(2.9)	12	(2.7)	6	(1.3)
-- at dinner/supper	7	(2.5)	22	(6.0)	11*	(5.2)	21	(2.9)	19	(2.9)
-- at snacks	17	(5.3)	15	(2.6)	17	(6.8)	25	(3.3)	20	(2.0)
All LNED items - total	38	(8.0)	61	(9.1)	59**	(14.9)	106	(8.3)	78	(5.1)
% kcal from all LNEDs[a]	30.6	(4.41)	39.1	(2.54)	30.8	(4.55)	39.5	(1.55)	38.2	(1.34)
Sample size	**160**		**572**		**221**		**1,361**		**2,314**	

Note: School Nutrition Dietary Assessment Study-III, 24-hour Dietary Recall Interview, school year 2004-2005. Tabulations are weighted to be nationally representative of children in public National School Lunch Program schools. Sample sizes are unweighted.

[a] Calculated as a population ratio.

*Significantly different from nonparticipants at $P<0.05$ level.

**Significantly different from nonparticipants at $P<0.01$ level.

Table A10: Consumption of Low-nutrient, Energy-dense (LNED) Foods among School Breakfast Program Participants and Nonparticipants (mean kcal)

	Elementary school				Secondary school				All	
	SBP Partici-pants	SE	SBP Non-participants	SE	SBP Partici-pants	SE	SBP Non-participants	SE	All	SE
All Locations										
Baked goods/desserts	176	(21.4)	143	(11.3)	193	(20.3)	141*	(8.2)	149	(6.7)
Dairy-based desserts	31	(7.7)	51*	(7.6)	39	(9.1)	34	(3.3)	41	(3.6)
Candy	33	(7.4)	44	(6.6)	88	(15.5)	63	(6.7)	54	(4.5)
French fries	45	(8.7)	47	(5.9)	85	(15.5)	68	(4.9)	58	(3.7)
Chips/salty snacks	63	(8.9)	59	(5.1)	79	(11.7)	68	(3.7)	65	(3.2)
At School										
Baked goods/desserts	103	(16.3)	42**	(5.8)	100	(13.8)	38**	(4.1)	51	(3.8)
Dairy-based desserts	8	(3.2)	16	(4.5)	7	(3.7)	4	(1.1)	10	(2.0)
Candy	15	(5.7)	16	(3.5)	33	(8.6)	29	(5.5)	23	(2.9)
French fries	25	(6.4)	16	(3.2)	46	(10.4)	28	(3.7)	24	(2.6)
Chips/salty snacks	20	(4.5)	31*	(3.5)	31	(5.7)	32	(2.6)	30	(2.1)
At Home										
Baked goods/desserts	70	(12.7)	89	(9.5)	92	(13.8)	91	(7.4)	88	(5.2)
Dairy-based desserts	19	(6.9)	33	(6.5)	32	(8.4)	26	(3.4)	28	(3.2)
Candy	13	(4.8)	22	(3.8)	47	(10.5)	26	(3.3)	24	(2.3)
French fries	10	(3.5)	15	(3.0)	22	(8.3)	13	(1.8)	14	(1.7)
Chips/salty snacks	40	(7.7)	24*	(3.1)	44	(9.8)	28	(2.2)	29	(2.0)
At Locations Away from School/Home										
Baked goods/desserts	3	(1.7)	12**	(3.2)	1	(0.6)	12**	(2.4)	10	(1.7)
Dairy-based desserts	4	(1.6)	2	(0.7)	0.24	(0.2)	2**	(0.9)	3	(0.5)
Candy	5	(2.5)	6	(2.3)	8	(3.9)	8	(1.7)	7	(1.2)
French fries	9	(3.5)	17	(4.2)	18	(6.4)	27	(3.6)	20	(2.2)
Chips/salty snacks	3	(1.5)	4	(2.1)	5	(2.3)	8	(1.6)	6	(1.0)
Sample size	**160**		**572**		**221**		**1,361**		**2,314**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A11: Meal and Snack Patterns of National School Lunch Program (NSLP) and School Breakfast Program (SBP) Participants and Nonparticipants (Proportion Consuming)

	Elementary School						Secondary School					
	NSLP/SBP participants		NSLP/SBP non-participants		All students		NSLP/SBP participants		NSLP/SBP non-participants		All students	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
Total Daily												
Breakfast	100.0**	(0.0)	91.4	(2.6)	90.5	(1.4)	100.0**	(0.0)	75.7	(2.0)	77.0	(1.4)
Lunch	100.0*	(0.0)	94.9	(2.0)	98.6	(0.6)	100.0**	(0.0)	88.6	(1.4)	94.0	(0.8)
Supper/dinner	94.1	(2.4)	94.8	(2.2)	95.6	(0.8)	93.2	(2.4)	91.7	(1.2)	92.0	(0.8)
Snacks	96.5	(1.6)	92.5	(2.6)	94.5	(1.2)	91.8	(2.2)	94.2	(1.2)	94.0	(0.8)
Mean number of snacks	2.4	(0.15)	2.3	(0.12)	2.3	(0.08)	2.3	(0.13)	2.4	(0.08)	2.4	(0.06)
At School												
Breakfast	100.0**	(0.0)	5.1	(2.0)	27.0	(3.0)	100.0**	(0.0)	8.5	(1.2)	19.0	(1.4)
Lunch	100.0**	(0.0)	89.4	(2.8)	97.1	(0.8)	100.0**	(0.0)	68.9	(2.8)	84.0	(1.4)
Supper/dinner	5.3	(2.0)	2.0	(1.0)	2.7	(0.8)	2.3	(1.6)	1.5	(0.6)	1.4	(0.4)
Snacks	39.8	(5.8)	6.2	(6.2)	44.6	(3.4)	33.8	(4.6)	37.0	(2.8)	36.0	(1.8)
Mean number of snacks	0.5	(0.09)	0.7	(0.10)	0.6	(0.05)	0.4	(0.07)	0.5	(0.05)	0.5	(0.03)
At Home												
Breakfast	9.8**	(3.4)	85.5	(3.4)	64.2	(2.8)	10.1**	(2.2)	64.8	(2.0)	58.0	(2.0)
Lunch	0.4*	(0.4)	6.0	(2.0)	2.1	(0.6)	0.9**	(0.8)	9.3	(1.4)	5.8	(1.0)
Supper/dinner	91.8	(4.0)	83.0	(3.2)	82.6	(1.6)	83.0*	(3.4)	74.6	(2.2)	77.0	(1.4)
Snacks	83.1	(3.8)	78.4	(3.4)	82.8	(1.8)	82.8	(3.2)	82.4	(1.4)	83.0	(1.0)
Mean number of snacks	1.6	(0.14)	1.4	(0.08)	1.6	(0.06)	1.6	(0.1)	1.6	(0.06)	1.6	(0.04)
At Locations Away From School/Home												
Breakfast	0.8	(0.8)	1.0	(0.8)	1.7	(0.6)	0**	(0)	3.0	(0.6)	1.9	(0.4)
Lunch	0*	(0)	3.6	(1.6)	1.0	(0.4)	0**	(0)	11.1	(1.4)	5.7	(0.8)
Supper/dinner	7.0	(2.2)	12.2	(2.8)	11.0	(1.2)	8.9*	(2.2)	16.1	(2.0)	14.0	(1.2)
Snacks	15.8	(3.2)	16.6	(3.2)	15.1	(1.4)	16.8	(3.6)	19.9	(1.8)	20.0	(1.4)
Mean number of snacks	0.2	(0.04)	0.2	(0.04)	0.2	(0.02)	0.2	(0.05)	0.2	(0.02)	0.2	(0.02)
Sample Size	**150**		**191**		**341**		**173**		**679**		**852**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A12: Mean Energy (kcal) by Location for National School Lunch Program Participants (NSLP) and School Breakfast Program (SBP) Participants and Nonparticipants

	Elementary School						Secondary School					
	NSLP/SBP Participants		NSLP/SBP Non-participants		All students		NSLP/SBP Participants		NSLP/SBP Non-participants		All Students	
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)
All Day												
Total	2,152	(54.8)	2,069	(70.0)	2,107	(44.2)	2,434**	(108.8)	2,070	(46.2)	2,131	(43.8)
Breakfast	408	(15.2)	352	(26.7)	377	(16.3)	420**	(25.6)	307	(12.7)	326	(10.4)
Lunch	584	(19.1)	597	(49.7)	5941	(27.1)	661**	(27.6)	532	(17.3)	553	(15.0)
Supper/dinner	616	(34.9)	631	(34.0)	624	(25.2)	752	(56.9)	660	(18.7)	675	(18.6)
Snacks	543	(39.5)	489	(25.5)	514	(22.7)	601	(56.3)	571	(27.0)	576	(25.0)
At School												
Total	1,074**	(38.3)	706	(47.3)	874	(36.2)	1,110**	(37.6)	513	(25.9)	613	(23.0)
Breakfast	376**	(15.8)	16	(7.0)	181	(20.5)	382**	(22.0)	32	(4.8)	91	(9.6)
Lunch	583	(18.9)	547	(51.2)	563	(28.0)	657**	(26.7)	384	(21.6)	430	(18.2)
Supper/dinner	37	(15.7)	13	(7.2)	24	(8.7)	11	(8.5)	11	(5.6)	11	(4.8)
Snacks	78	(19.3)	131	(18.2)	107	(13.6)	60	(11.6)	85	(9.0)	81	(7.7)
At Home												
Total	949**	(53.3)	1,218	(54.5)	1,095	(40.2)	1,123	(69.6)	1,239	(35.9)	1,219	(32.9)
Breakfast	31**	(12.3)	324	(26.8)	190	(19.3)	38**	(8.5)	260	(12.1)	223	(12.9)
Lunch	1*	(1.3)	21	(8.9)	12	(4.9)	4**	(4.2)	51	(8.8)	44	(7.5)
Supper/dinner	521	(36.3)	554	(34.9)	539	(25.6)	648*	(47.6)	524	(20.0)	545	(19.1)
Snacks	395	(37.9)	318	(29.8)	353	(21.4)	433	(40.7)	403	(21.5)	408	(19.5)
At Locations Away from School/Home												
Total	129	(28.6)	145	(27.6)	138	(20.3)	201	(52.5)	319	(26.6)	299	(23.3)
Breakfast	1	(1.0)	11	(10.2)	7	(5.6)	0**	(0)	15	(3.4)	12	(2.8)
Lunch	0*	(0)	29	(12.5)	16	(6.8)	0**	(0)	96	(16.1)	80	(13.5)
Supper/dinner	58	(19.2)	65	(15.7)	62	(13.1)	93	(37.5)	124	(17.3)	119	(15.4)
Snacks	70	(20.1)	40	(8.4)	53	(10.0)	108	(28.7)	83	(11.1)	87	(10.6)
Sample Size	**150**		**191**		**341**		**173**		**679**		**852**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III)**,** unadjusted data, participation on target recall day.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A13: Mean Energy Density by Location for National School Lunch Program (NSLP) and School Breakfast Program (SBP) Participants and Nonparticipants

	Elementary School						Secondary School					
	NSLP/SBP Participants		NSLP/SBP Non-participants		All Students		NSLP/SBP Participants		NSLP/SBP Non-Participants		All Students	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
All Day												
Total	1.15	0.03	1.24	0.04	1.18	0.02	1.15**	0.03	1.01	0.02	1.06	0.01
Breakfast	1.09	0.03	0.97	0.08	1.07	0.03	1.13*	0.04	0.99	0.04	1.03	0.02
Lunch	1.26**	0.03	1.55	0.08	1.33	0.03	1.29	0.06	1.25	0.03	1.25	0.02
Supper/dinner	1.21	0.04	1.20	0.05	1.21	0.02	1.22*	0.04	1.12	0.03	1.14	0.02
Snacks	1.02	0.08	1.21	0.05	1.09	0.03	0.99*	0.08	0.8	0.04	0.86	0.03
At School												
Total	1.20**	0.03	1.53	0.07	1.30	0.03	1.20**	0.03	1.03	0.06	1.11	0.03
Breakfast	1.09	0.03	1.14	0.07	1.10	0.03	1.14	0.04	1.11	0.1	1.12	0.04
Lunch	1.26**	0.03	1.60	0.08	1.34	0.03	1.30	0.06	1.27	0.04	1.26	0.03
Supper/dinner	~	~	~	~	~	~	~	~	~	~	~	~
Snacks	1.14	0.10	1.41	0.12	1.32	0.06	0.74	0.14	0.54	0.08	0.62	0.06
At Home												
Total	1.07	0.05	1.11	0.05	1.10	0.02	1.09*	0.04	0.99	0.02	1.01	0.01
Breakfast	1.08	0.15	0.95	0.08	1.05	0.04	~	~	0.96	0.04	0.99	0.03
Lunch	~	~	~	~	~	~	~	~	1.04	0.06	1.07	0.06
Supper/dinner	1.18	0.04	1.21	0.06	1.18	0.03	1.17	0.04	1.12	0.03	1.12	0.02
Snacks	0.95	0.09	1.12	0.07	1.02	0.04	0.99	0.09	0.87	0.04	0.91	0.03
At Locations Away from School/Home												
Total	1.38	0.08	1.27	0.09	1.36	0.04	1.31	0.15	1.11	0.04	1.13	0.03
Breakfast	~	~	~	~	~	~	~	~	~	~	1.41	0.16
Lunch	~	~	~	~	~	~	~	~	1.32	0.08	1.31	0.08
Supper/dinner	~	~	~	~	1.40	0.07	~	~	1.09	0.06	1.21	0.05
Snacks	~	~	1.49	0.27	1.35	0.09	1.18	0.18	0.91	0.09	0.94	0.06
Sample Size	**150**		**191**		**341**		**173**		**679**		**852**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

Table A.13 (*continued*)

Note: Energy density was calculated as a population ratio based on calories and grams from solid foods and beverages.

* Significantly different from nonparticipants at $P<0.05$ level.
** Significantly different from nonparticipants at $P<0.01$ level.
~ Sample sizes were too small to compute a reliable statistic.

Table A14: Consumption of Sugar-Sweetened Beverages (SSBs) and Low-Nutrient Energy Dense (LNED) Foods Among National School Lunch Program (NSLP) and School Breakfast Program (SBP) Participants and Nonparticipants (Mean Kcal)

	Elementary school				Secondary school			
	NSLP/SBP participants	SE	NSLP/SBP Non-participants	SE	NSLP/SBP Participants	SE	NSLP/SBP Non-participants	SE
All Locations								
SSBs – total	103	(9.2)	117	(11.5)	183	(21.0)	222	(10.6)
-- at breakfast	2**	(1.0)	12	(3.2)	9	(3.4)	13	(1.9)
-- at lunch	5**	(1.9)	40	(6.7)	24**	(5.0)	60	(4.2)
-- at dinner/supper	49	(6.9)	34	(5.4)	73	(12.7)	66	(3.8)
-- at snacks	48	(5.7)	31	(4.9)	78	(9.6)	83	(7.7)
LNED solid foods-total	342	(24.2)	373	(27.5)	461*	(39.3)	369	(16.5)
-- at breakfast	56	(16.9)	39	(8.8)	74*	(16.7)	36	(5.9)
-- at lunch	83	(14.1)	102	(14.0)	96	(16.5)	99	(5.9)
-- at dinner/supper	38	(9.2)	52	(11.8)	57	(19.0)	60	(7.6)
-- at snacks	165	(18.6)	180	(20.2)	233*	(22.1)	174	(10.2)
All LNED items - total	445	(26.7)	489	(31.4)	684	(52.0)	590	(23.1)
% kcal from all LNEDs[a]	20.7	(1.09)	23.7	(1.59)	26.5	(1.48)	28.5	(0.93)
At School								
SSBs – total	14**	(4.1)	41	(5.4)	39*	(7.6)	62	(4.8)
-- at breakfast	2	(1.0)	<0.5	(0.23)	7	(2.8)	2	(0.9)
-- at lunch	5**	(1.9)	33	(4.9)	22**	(5.0)	39	(3.4)
-- at dinner/supper	3	(2.0)	1	(0.9)	1	(0.5)	1	(0.6)
-- at snacks	4	(2.1)	7	(2.2)	10	(3.8)	18	(3.1)
LNED solid foods-total	171	(16.1)	165	(21.3)	203**	(16.8)	119	(9.2)
-- at breakfast	48**	(13.2)	2	(1.0)	69**	(16.3)	7	(2.2)
-- at lunch	83	(14.1)	95	(13.9)	96	(16.6)	72	(5.0)
-- at dinner/supper	0	(0)	<0.5	(0.43)	0	(0)	<0.5	(0.2)
-- at snacks	40	(8.8)	67	(15.0)	38	(8.4)	40	(6.0)
All LNED items - total	185	(17.1)	206	(22.3)	242**	(20.2)	181	(11.7)
% kcal from all LNEDs[a]	17.2**	1.54)	29.1	(3.09)	21.8**	(1.61)	35.2	(1.88)
At Home								
SSBs – total	76	(8.4)	59	(7.3)	112	(12.1)	106	(6.9)
-- at breakfast	0**	(0)	10	(3.0)	2**	(1.2)	9	(1.7)

Table A.14 (*continued*)

	Elementary school				Secondary school			
	NSLP/SBP participants	SE	NSLP/SBP Non-participants	SE	NSLP/SBP Participants	SE	NSLP/SBP Non-participants	SE
-- at lunch	0	(0)	3	(2.1)	1*	(1.3)	5	(1.6)
-- at dinner/supper	38	(4.9)	24	(5.0)	58	(8.3)	44	(3.3)
-- at snacks	37*	(5.6)	22	(4.4)	51	(6.4)	47	(4.5)
LNED solid foods-total	146	(17.9)	167	(16.7)	226	(30.5)	177	(12.8)
-- at breakfast	8*	(6.5)	36	(9.0)	5**	(2.6)	26	(4.9)
-- at lunch	0	(0)	2	(1.4)	0*	(0)	5	(1.8)
-- at dinner/supper	31	(9.1)	37	(9.7)	48	(18.9)	35	(6.7)
-- at snacks	108	(15.8)	92	(12.8)	173**	(19.3)	111	(8.8)
All LNED items – total	222	(19.2)	226	(19.3)	338	(34.4)	283	(17.0)
% kcal from all LNEDs[a]	23.4*	(1.96)	18.5	(1.35)	30.1**	(2.17)	22.8	(1.13)
At Locations Away from School/Home								
SSBs – total	14	(4.0)	17	(4.4)	32	(9.1)	54	(6.7)
-- at breakfast	0	(0)	2	(1.3)	0	(0)	1	(0.6)
-- at lunch	0	(0)	4	(2.4)	0**	(0)	15	(3.1)
-- at dinner/supper	7	(3.1)	8	(3.0)	14	(6.0)	21	(3.5)
-- at snacks	6	(2.7)	2	(1.0)	18	(5.8)	17	(3.5)
LNED solid foods-total	25	(5.8)	41	(9.1)	32**	(9.8)	73	(8.3)
-- at breakfast	0	(0)	1	(0.8)	0*	(0)	3	(1.3)
-- at lunch	0	(0)	5	(3.4)	0**	(0)	33	(5.0)
-- at dinner/supper	7	(2.6)	15	(6.0)	10*	(5.3)	25	(4.7)
-- at snacks	18	(5.6)	21	(6.0)	22	(8.6)	23	(3.6)
All LNED items - total	39	(8.5)	58	(11.6)	64**	(16.8)	127	(13.8)
% kcal from all LNEDs[a]	30.1	(4.43)	39.8	(3.55)	31.8	(4.99)	37.9	(2.30)
Sample size	**150**		**191**		**173**		**679**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III)**,** unadjusted data, participation on target recall day.

[a]Calculated as a population ratio.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

Table A15: Consumption of Types of Low-Nutrient, Energy-Dense (LNED) Foods Among National School Lunch Program (NSLP) and School Breakfast Program (SBP) Participants and Nonparticipants (Mean Kcal)

	Elementary school				Secondary school			
	NSLP/SBP Participants	SE	NSLP/SBP Nonparticipants	SE	NSLP/SBP Participants[a]	SE	NSLP/SBP Nonparticipants	SE
All Locations								
Baked goods/desserts	175	(22.0)	153	(18.5)	197*	(26.5)	134	(10.0)
Dairy-based desserts	29	(7.9)	48	(12.1)	41	(10.2)	31	(4.3)
Candy	32*	(6.7)	65	(14.4)	80	(15.0)	65	(6.9)
French fries	45	(9.1)	37	(7.8)	75	(14.9)	66	(7.3)
Chips/salty snacks	59	(9.1)	70	(9.7)	67	(13.0)	71	(5.5)
At School								
Baked goods/desserts	102*	(16.5)	51	(11.3)	99**	(16.3)	34	(5.6)
Dairy-based desserts	8	(3.3)	21	(9.6)	9	(4.7)	3	(0.8)
Candy	15	(6.1)	34	(8.9)	23	(6.3)	30	(5.5)
French fries	26*	(6.7)	8	(3.0)	50**	(12.0)	13	(3.1)
Chips/salty snacks	18**	(4.7)	51	(7.9)	22**	(5.4)	38	(3.4)
At Home								
Baked goods/desserts	70	(13.0)	85	(14.5)	97	(17.9)	86	(8.7)
Dairy-based desserts	17	(7.0)	26	(9.1)	32	(9.3)	23	(4.4)
Candy	11	(3.4)	25	(7.8)	50	(13.3)	29	(5.2)
French fries	10	(3.6)	15	(4.9)	7	(3.6)	15	(3.0)
Chips/salty snacks	38*	(8.0)	16	(4.1)	39	(9.2)	23	(2.9)
At Locations Away from School/Home								
Baked goods/desserts	3	(1.8)	17	(7.6)	1**	(0.7)	14	(3.5)
Dairy-based desserts	4	(1.7)	1	(0.7)	<0.5**	(0.3)	5	(1.4)
Candy	6	(2.6)	6	(2.6)	7	(4.3)	7	(1.8)
French fries	9	(3.7)	14	(5.4)	17*	(7.4)	38	(6.5)
Chips/salty snacks	3	(1.5)	3	(1.4)	6	(3.0)	9	(2.6)
Sample size	**150**		**191**		**173**		**679**	

Source: Third School Nutrition Dietary Assessment Study (SNDA-III), unadjusted data, participation on target recall day.

*Significantly different from nonparticipants at $P<0.05$ level.
**Significantly different from nonparticipants at $P<0.01$ level.

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