Chapter 5

National School Lunch Program

The National School Lunch Program (NSLP) is the oldest and second-largest food and nutrition assistance program (FANP) in the U.S. Department of Agriculture (USDA) nutrition safety net. Targeted specifically to school-age children, the NSLP is the cornerstone of the largely school-based child nutrition programs, which also include the School Breakfast Program (SBP), the Child and Adult Care Food Program (CACFP), the Summer Food Service Program (SFSP), and the Special Milk Program (SMP).

Schools that participate in the NSLP receive Federal reimbursement for each program meal served to students. USDA does not reimburse schools for adult meals, second meals, and a la carte items (including extra servings of components of program meals). Since 1998, the program has also covered snacks served to children in after-school programs. Any child in a participating school is eligible to receive NSLP meals; in FY 2002, more than 28 million children participated on an average school day. The program served more than 4.7 billion lunches and 123 million after-school snacks, at a cost of $6.9 billion (USDA, Food and Nutrition Service (FNS), 2003a).

Program Overview

The NSLP was established in 1946 to "safeguard the health and well-being of the Nation's children and to encourage the domestic consumption of nutritious agricultural commodities and other foods...."[77] A major impetus for the program was the prevalence of nutrition-related health problems identified during the screening of young men for military service in World War II.

Today, almost 99 percent of public schools and 83 percent of all public and private schools combined participate in the NSLP. Nationally, the program is available to about 92 percent of all students (Burghardt et al., 1993; Burghardt and Devaney, 1995). On an average school day, about 60 percent of children in schools that offer the NSLP participate in the program (Fox et al., 2001). Participation varies with household income, age, and gender. For example, studies have shown that students certified to receive free or reduced-price lunches are more likely to participate than students who are not certified for meal benefits, elementary school students are more likely to participate than secondary school students, and males are more likely to participate than females (Fox et al., 2001; Gleason, 1996; Maurer, 1984; Akin, 1983a).

[77]National School Lunch Act of 1946, Public Law 79-396.

Since 1998, when the NSLP was expanded to include after-school snacks, this component of the program has been growing steadily. Between FY 2000 and FY 2002, the number of after-school snacks provided through the NSLP increased from 70 million to 123 million (USDA/FNS, 2003a).[78]

The NSLP is administered by the Food and Nutrition Service (FNS) and its regional offices. At the State level, the program is administered by State agencies, most often departments of education. State agencies oversee Federal reimbursements, provide technical assistance, and monitor program performance. At the local level, the program is operated by school food authorities (SFAs). Most SFAs are individual school districts; however, regional school unions and residential childcare institutions also serve as SFAs.

Federal Subsidies

Participating SFAs receive two types of Federal assistance: cash reimbursements and commodities. Cash reimbursements are based on the number of lunches and after-school snacks served, established reimbursement rates, and the poverty level of participating students. A cash subsidy is provided for every program lunch and snack served. Additional cash subsidies are provided for meals and snacks served to children who qualify for free or reduced-price meal benefits. Currently, students eligible for free lunches and snacks are those from families with incomes at or below 130 percent of the Federal poverty level. Students from families with incomes between 130 and 185 percent of poverty are eligible to receive reduced-price lunches and snacks.[79]

[78]To be eligible to receive reimbursement for after-school snacks, school districts must participate in the NSLP and must sponsor or operate an after-school program that provides children with regularly scheduled educational or enrichment activities in a supervised environment (USDA/FNS, 2003b).

[79]Federal regulations allow schools that operate in high-poverty areas (areas where 50 percent or more of school-age children are eligible for free or reduced-price meals) to receive the "free" reimbursement rate for all after-school snacks, regardless of the students' family incomes.

Basic cash reimbursement rates for the 2002-03 school year were $2.14 for free lunches, $1.74 for reduced-price lunches, and $0.20 for lunches served to children who purchased meals at the full price (referred to as “paid meals”).[80] Snacks were reimbursed at rates of $0.58, $0.29, and $0.05, respectively.

Children eligible for reduced-price lunches cannot be charged more than $0.40 per lunch. SFAs set their own prices for full-price/paid lunches, but must operate their school meal service program on a non-profit basis (USDA/FNS, 2003c). Of the 4.7 billion lunches served in FY 2002, 48 percent were served to children eligible for free meals and 9 percent to children eligible for reduced-price meals (USDA/FNS, 2003a).[81]

Schools receive agricultural commodities on an entitlement basis and may also receive bonus commodities. Entitlement commodity assistance is based on the number of reimbursable lunches served the previous school year. For the 2002-03 school year, the cash value of entitlement commodities was $0.1525 per meal (USDA/FNS, 2003c). Schools may elect to receive cash in lieu of commodity foods. In addition to entitlement commodities, schools may request bonus commodities—commodities that become available through agricultural surplus—in amounts that can be used without waste. The types and amounts of bonus commodities available vary from year to year depending on purchasing decisions made by USDA.

Nutrition Standards

To be eligible for Federal subsidies, NSLP meals must meet defined nutrition standards. Program regulations have long stipulated that lunches should provide one-third of the children’s Recommended Dietary Allowances (RDAs). To ensure that these standards are met, program regulations have historically included food-based menu planning guidelines. These guidelines, originally known as the “Type A meal pattern,” define specific types of food to be offered as well as minimum acceptable portion sizes.

[80]Reimbursement rates for both lunches and snacks are higher in Hawaii and Alaska. In addition, lunch reimbursement rates are higher for schools that operate in high-poverty areas (60 percent or more of students eligible for free or reduced-price meals).

[81]Information on the percentage of after-school snacks served to children eligible for free or reduced-price meal benefits is not available in publicly available summaries of administrative data.

The components of the traditional NSLP meal pattern are:

- Meat or meat alternate: 1 serving per meal
- Vegetables, fruits, and/or full-strength juices: 2 or more servings per meal
- Grains/breads: 1 or more servings per meal/8 servings per week
- Milk: 1 serving per meal.

Over the years, research has shown that, with few exceptions, the meals offered in the NSLP provide students the opportunity to satisfy one-third of their daily needs for food energy and an array of essential vitamins and minerals (Burghardt et al., 1993; Wellisch et al., 1983).

In the early 1990s, however, USDA’s first School Nutrition Dietary Assessment Study (SNDA-I) examined the nutrient content of school lunches in comparison with recommendations included in the *Dietary Guidelines for Americans* (USDA and U.S. Department of Health and Human Services, 1990) and the National Research Council’s *Diet and Health* report (National Research Council, 1989). SNDA-I found that, in comparison with these guidelines, NSLP meals were high in fat, saturated fat, and sodium, and low in carbohydrates (Burghardt et al., 1993). At the time the SNDA-I data were collected (the 1991-92 school year), schools were not required to offer meals that were consistent with these guidelines.

The School Meals Initiative for Healthy Children

In response to the SNDA-I findings, USDA made a commitment to implement the *Dietary Guidelines* in the NSLP. The embodiment of this commitment is the School Meals Initiative for Healthy Children (SMI). The SMI, launched in 1995, is designed to improve the nutritional quality of school meals by providing schools with educational and technical resources that can be used to (1) assist foodservice personnel in preparing nutritious and appealing meals and (2) encourage children to eat more healthful meals. Key components of the SMI include revised nutrition standards for school meals, a major restructuring of menu planning requirements, and a broad-based nutrition education program.

The nutrition standards established under the SMI maintain the longstanding goal of providing one-third of students’ daily needs for food energy and nutrients. In addition, the standards include goals for fat and saturated fat content that are consistent with the *Dietary Guidelines* recommendations.[82] The Healthy Meals for Healthy Americans Act (P.L. 103-448) formally required that school meals be consistent with the *Dietary Guidelines* and that schools begin complying with SMI nutrition standards in the 1996-97 school year unless a waiver was granted by the relevant State agency. The regulatory requirement that school meals be consistent with the *Dietary Guidelines* has been incorporated into the FNS strategic plan. The current goal is for all schools to satisfy these standards by 2005 (USDA/FNS, 2000a).

Under SMI and the Healthy Meals for Healthy Americans Act, menu planning requirements were restructured to offer schools several alternatives to the traditional food-based NSLP meal pattern. These include a computer-based menu planning approach known as Nutrient Standard Menu Planning (NSMP). NSMP focuses on the nutrient content of meals rather than the specific types of food offered. School districts may implement NSMP on their own or may contract with an outside agency. An enhanced food-based meal pattern was also developed. This is similar to the traditional pattern but requires more servings of breads and grain products over the course of a week and larger servings of fruits and vegetables. School districts may also use any other reasonable approach to menu planning, subject to State agency guidelines. Implementation of new menu planning systems has proved to be a lengthy process. In the 1999-2000 school year, only 63 percent of all SFAs reported that they had "fully implemented" the menu planning system of their choice (Abraham et al., 2002). Eighty-five percent indicated that their plans were at least three-quarters implemented.

The nutrition education component of the SMI is the Team Nutrition Initiative (TN) (see chapter 16). TN provides technical assistance, educational resources, and training to school foodservice personnel, children, parents, teachers, and school administrators. TN uses behavior-oriented strategies to (1) assist school foodservice personnel in preparing and serving meals that meet the SMI nutrition standards without sacrificing taste or attractiveness, (2) promote healthful eating habits and regular physical activity among both children and parents, and (3) build a support base among school administrators and other school and community partners for healthy patterns of eating and physical activity (USDA/FNS, 2002).

[82]Goals for sodium and cholesterol content are not included in SMI nutrition standards. However, schools are encouraged to monitor levels of these dietary components.

Related Program Changes

The SMI has been supported by several parallel initiatives. For example, considerable effort has been devoted to improving the nutrient profile of the commodity foods provided to NSLP schools (Buzby and Guthrie, 2002). In addition, under the Nutrition Title of the 2002 Farm Act, USDA received $6 million for a pilot program to provide fresh and dried fruits and fresh vegetables to children in elementary and secondary schools. The pilot program, which was implemented in the 2002-03 school year, was very well received (Buzby et al., 2003) and was expanded under the Child Nutrition and WIC Reauthorization Act of 2004 (P.L. 108-265).

Most recently, policymakers have begun to focus on the "school nutrition environment" (Ralston et al., 2003; American School Food Service Association (ASFSA), 2003; USDA/FNS, 2000b). A school's nutrition environment includes the nutritional quality of reimbursable school meals, the availability and nutritional quality of competitive (non-NSLP) foods, meal scheduling, physical characteristics of the cafeteria, nutrition education and marketing activities, and the school's commitment to nutrition and physical activity.

Major attention has been focused on the issue of "competitive foods" in school meal programs—foods other than those included in NSLP and SBP meals (USDA/FNCS, 2001). In 1998-99, USDA's *second* School Nutrition Dietary Assessment Study (SNDA-II) found that more than half of all elementary schools had a la carte programs that offered items other than milk, juice, and desserts (Fox et al., 2001). The same was true of roughly 90 percent of middle schools and high schools. Many schools had a la carte programs that made it possible for students to purchase complete meals on an a la carte basis. SNDA-II also demonstrated that revenue from a la carte sales was inversely related to rates of student participation in the NSLP.

The CDC-sponsored School Health Policies and Programs Study (SHPPS) found that more than a quarter of elementary schools, 62 percent of middle/junior high schools, and 95 percent of senior high schools had vending machines (Wechsler et al., 2001). A substantial number of schools also had school stores, canteens, or snack bars available to students during meal time. Some school districts have entered into potentially lucrative "pouring rights" contracts that may lead to increased availability and marketing of soft drinks (Lin and Ralston, 2003; Nestle, 2000).

Although not part of the reimbursable NSLP meal, competitive foods contribute to students' in-school dietary intake. Currently, there are no Federal nutrition-related standards governing competitive foods, and research has shown that foods offered through these alternative sources tend to be high in fat, sodium, and/or sugar (French et al., 2003; Kubik et al., 2003; Zive et al., 2002; USDA/FNCS, 2001; Wechsler et al., 2001; Glengdahl and Seaborn, 1999). Concerns about the negative impact of competitive foods has prompted calls for action at local, State, and Federal levels to limit their availability and/or to establish nutrition standards for them.

Implications for Interpreting Available Research

The vast majority of the research reviewed in this chapter is based on data that were collected *before* the SMI was launched or in the very early stages of its implementation. This includes all of the studies that were national in scope, those with the strongest designs and analysis methods, and all of the studies that looked at impacts on students' dietary intakes over 24 hours.

Given the nature and extent of the changes associated with the SMI—changes that specifically targeted the nutrient content of school lunches and students' consumption of healthful lunches—it is important that results of the available research be interpreted in the proper context. Existing research provides a comprehensive picture of past and potential impacts of the NSLP; however, because of the major changes that have been implemented under SMI and related ongoing changes, it cannot be assumed that these findings apply to today's NSLP.

Indeed, there is evidence that the nutrient content of meals offered in the NSLP has changed since the implementation of the SMI. The SNDA-II study found that, relative to lunches offered in 1991-92 (as reported in SNDA-I), lunches offered in 1998-99 were significantly lower in total fat, saturated fat, and sodium (although, on average, lunches continued to exceed *Dietary Guidelines* and NRC recommendations for those nutrients). Moreover, SNDA-II demonstrated that reductions in fat and saturated fat content could be achieved without sacrificing overall nutrient content. That is, although lower in fat, NSLP lunches continued to meet the goal of providing one-third of the RDAs for key nutrients.

The SNDA-II data were collected relatively early in the implementation of the SMI and, since that time, efforts to implement the SMI nutrition standards have continued at the Federal, State, and local levels. Consequently, even these relatively recent data may not provide an accurate picture of the nutrient content of meals currently offered in the NSLP.

It is important to keep the changing nature of the NSLP in mind when reviewing the summary of NSLP research that follows. The existing research provides information on previous and potential impacts of the NSLP; however, new research is essential to understanding the impact of the NSLP as it operates today (Guthrie, 2003).

Research Overview

The literature search identified a total of 26 studies that examined the impact of the NSLP on nutrition- and health-related outcomes of participating children. Among these are two USDA-sponsored national evaluations that included student-level outcomes: the National Evaluation of School Nutrition Programs (NESNP) conducted in 1980-81 and the SNDA-I study, conducted in 1991-92. A third USDA-sponsored national evaluation, the SNDA-II study, conducted in the 1998-99 school year, is not included in this summary because it did not collect student-level data.

Most studies examined impacts on dietary intake at lunch and/or over 24 hours. A smaller number considered impacts of NSLP participation on other measures of nutrition and health status or on household food expenditures. One study also looked at impacts on school attendance and cognitive performance.

The majority of the available research is quite dated. Fifteen of the 26 studies used data that were collected during or prior to the early 1980s. And, as noted, almost all studies used data that were collected prior to implementation of the SMI.

Measures of Participation

Measures of program participation varied across studies (and sometimes within studies, depending on the outcome being evaluated). Most studies equated the purchase or consumption of a school lunch on the day(s) of dietary assessment with program participation. This entails some risk that children who usually eat a school lunch did not do so on the day of the survey, or that some who ate the school lunch on that day usually do not participate. However, NESNP researchers evaluated the extent of this problem and concluded that defining participation on the basis of one day's behavior gave an accurate picture of participation, at least with the large sample available in that study and with data collected on all 5 weekdays (Wellisch et al., 1983).

Several studies defined program participation on the basis of usual NSLP participation practices, such as whether a student usually ate a school lunch a minimum number of times per week or the proportion of potential lunches eaten during the study period. In evaluating the impact of the NSLP on students' linear growth, the NESNP used historical information on students' participation from grade 1 through the current grade, and computed an average weekly NSLP participation rate for each student (Wellisch et al., 1983).

Definition of nonparticipant comparison groups also differed across studies. Most researchers used nonparticipants in the same schools as NSLP participants. Hoagland (1980) distinguished between students who did and did not have the NSLP available to them. The NESNP oversampled schools that did not offer the NSLP. However, investigators ultimately concluded that schools not offering the NSLP did not constitute an appropriate comparison group, so they used nonparticipants in NSLP schools instead.

The following two sections summarize major findings from existing research on the impact of the NSLP on nutrition- and health-related outcomes. The first section summarizes studies that assessed impacts on students' dietary intake. The second section discusses studies that examined impacts on other nutrition and health outcomes, including weight and height, nutritional biochemistries, household food expenditures, and school performance.

Impacts on Dietary Intake

Estimates of NSLP impacts on dietary intake are subject to the limitations discussed in chapter 2. Most studies used data for a single day or meal, and therefore provide weak estimates of individuals' usual intake. Some studies used multiple days of data or other means (such as a food frequency checklist) to better capture usual intake. However, none of the available studies used the approach to estimating usual intake that was recently recommended by the Institute of Medicine (IOM, 2001).[83]

Similarly, in assessing intakes of food energy, vitamins, and minerals, researchers generally compared mean intakes of participants and nonparticipants or compared the proportion of individuals in each group with intakes below a defined cutoff. Again, none used the approach recommended by the IOM, which calls for use of data on usual intake in conjunction with defined Estimated Average Requirements (EARs) (IOM, 2001).

Consequently, the available research presents an imperfect picture of the substantive significance of differences observed in the dietary intakes of NSLP participants and nonparticipants. It provides information on whether NSLP participants consumed more or less energy and nutrients than nonparticipants. However, this information cannot be used to draw conclusions about whether NSLP participants were more or less likely than nonparticipants to have adequate intakes.

In addition, research has shown that assessing the dietary intakes of children presents unique challenges (Medlin and Skinner, 1988; Baranowski and Simons-Morton, 1991) and that recall-based data collection methodologies do not necessarily work well with young children (Baxter, 2000 and 2003). As a result, recall-based measures of the dietary intakes of NSLP participants and nonparticipants are subject to increased measurement error.

Research Overview

The literature search identified 19 studies that examined the impact of NSLP participation on students' dietary intakes. Characteristics of these studies are summarized in table 26. Most studies examined impacts on intake of food energy and nutrients. However, three studies (Devaney et al., 1993; Gleason and Suitor, 2001; Rainville, 2001) looked at impacts on food consumption as well as energy and nutrient intake, and four studies (Cullen et al., 2000; Melnick et al.,1998; Wolfe and Campbell, 1993; Yperman and Vermeersh, 1979) looked only at impacts on food consumption. Five studies focused exclusively on impacts on dietary intake at lunch, seven studies looked at both lunch and 24-hour intakes, and seven studies focused exclusively on 24-hour intake.

The available research can be divided into three groups. Group I includes the two national evaluations that examined student-level outcomes: SNDA-I (1991-92 school year) and NESNP (1980-81 school year). Group II includes five studies that are based on secondary analysis of data from national cross-sectional surveys. Two of these studies (Gleason and Suitor, 2001 and 2003) used data collected between 1994 and 1996. The other three studies in this group are based on data from the late 1970s or early 1990s. Group III consists of 11

[83] Gleason and Suitor (2001) used these methods to describe dietary intakes of U.S. children. However, in assessing differences in intakes of NSLP participants and nonparticipants, they used regression-adjusted mean intakes that were based on 1 or 2 days of data.

Table 26—Studies that examined the impact of the National School Lunch Program on students' dietary intakes

Study	Outcome(s)	Data source[1]	Data collection method	Population (sample size)	Design	Measure of participation	Analysis method
Group I: National evaluations							
Devaney et al. (1993) (SNDA-I)	Nutrient intake at lunch and over 24 hours Food intake at lunch	Nationally representative sample of students from 329 public and private schools (1991-92)	Single 24-hour recall	Children and adolescents in grades 1-12 (n~3,350)	Participant vs. nonparticipant	Ate NSLP lunch on recall day	Multivariate regression with selection-bias-adjustment (nutrients) Bivariate t-tests (foods)
Wellisch et al. (1983) (NESNP)	Nutrient intake at lunch and over 24 hours	Nationally representative sample of students from 276 public schools (1980-81)	Single 24-hour recall	Children and adolescents in grades 1-12 (n=6,556)	Participant vs. nonparticipant	Ate NSLP lunch on recall day	Multivariate regression
Group II: Secondary analysis of national surveys							
Gleason and Suitor (2003)	Nutrient intake at lunch and over 24 hours	1994-96 CSFII	2 nonconsecutive 24-hour recalls	Children and adolescents ages 6-18 with 2 days of intake data (n=1,614)	Participant vs. nonparticipant	Ate NSLP lunch on recall day	Multivariate regression with fixed-effects model to control for selection bias
Gleason and Suitor (2001)	Nutrient intake at lunch and over 24 hours Food intake at lunch and over 24 hours	1994-96 CSFII	2 nonconsecutive 24-hour recalls	Children and adolescents ages 6-18 with 1 or 2 school days of intake data (n=1,866)	Participant vs. nonparticipant	Ate NSLP lunch on recall day	Comparison of regression-adjusted means
Fraker (1987)	Nutrient intake at lunch and over 24 hours	1980-81 NESNP	Single 24-hour recall	Children and adolescents in grades 1-12 (n=6,556)	Participant vs. nonparticipant	Ate NSLP lunch on recall day	Bivariate t-tests for full sample and low-income sample

See notes at end of table.

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Table 26—Studies that examined the impact of the National School Lunch Program on students' dietary intakes—Continued

Study	Outcome(s)	Data source[1]	Data collection method	Population (sample size)	Design	Measure of participation	Analysis method
Akin et al. (1983a)	Nutrient intake over 24 hours	1977-78 NFCS	24-hour recall plus 2-day food record	Children and adolescents ages 6-18 (n=1,554)	Participant vs. nonparticipant[2,3]	Ratio of number of days ate school lunch to number of days of dietary data	Multivariate regression
Akin et al. (1983b)	Nutrient intake over 24 hours	1977-78 NFCS	24-hour recall plus 2-day food record	Children and adolescents ages 6-18 (n=1,554)	Participant vs. nonparticipant[4]	Ratio of number of days ate school lunch to number of days ate any lunch	Switching regression; Chow tests
Hoagland (1980)	Nutrient intake over 24 hours	1971-74 NHANES-I	Single 24-hour recall	Children and adolescents ages 6-21 (n=3,155)	Participant vs. nonparticipant[2]	Ate school lunch on recall day	Analysis of variance
Group IIIA: State and local studies with large samples							
Rainville (2001)	Nutrient intake at lunch Food intake at lunch	Students in 10 schools in southeastern Michigan (1998)	Visual observation of food selection and waste	Children in grades 2-4 (n=570)	Participant vs. nonparticipant	Ate school lunch on observation day (vs. sack lunch)	Analysis of variance
Melnick et al. (1998)	Food intake over 24 hours	All students in randomly selected classrooms in 25 sampled public and private schools in New York City (1989-90)	Single 24-hour recall (nonquantitative)	Children in grades 2 and 5 (n=1,397)	Participant vs. nonparticipant[2]	Ate school lunch on recall day	Gender-adjusted anlaysis of covariance
Wolfe and Campbell (1993)	Food intake at lunch	Students in 51 schools in New York State, excluding New York City (1987-88)	Single 24-hour recall (nonquantitative)	Children in grades 2 and 5 (n=1,797)	Participant vs. nonparticipant	Ate school lunch on recall day	Bivariate t-tests and chi-square tests

See notes at end of table.

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Table 26—Studies that examined the impact of the National School Lunch Program on students' dietary intakes—Continued

Study	Outcome(s)	Data source[1]	Data collection method	Population (sample size)	Design	Measure of participation	Analysis method
Price et al. (1978)	Nutrient intake over 24 hours	Students in schools/districts in 8 regions in Washington State, Blacks and Mexican-Americans were oversampled (1971-73)	3 nonconsecutive 24-hour recalls, including 1 weekend day	Children ages 8-12 (n=728)	Participant vs. nonparticipant	Participation dummies based on usual frequency: 0-1 time per week, 2-3 times per week, 4-5 times per week	Multivariate regression
Emmons et al. (1972)	Nutrient intake at lunch and over 24 hours	All students in selected grades in 1 district in rural New York State (1970-71)[5]	Single 24-hour recall	Children in grades 1-4 (n=512)	Participants, before vs. after[6]	Took 70% or more of school meals offered during study period	Comparison of means (type of statistical test not reported)
U.S. Department of Health, Education, and Welfare (HEW) (10-State Nutrition Survey)	Nutrient intake over 24 hours	Sample of children from 10 States, plus volunteers (1972)	Single 24-hour recall	Children and adolescents ages 10-16 (n=8,495)	Participant vs. nonparticipant[2]	Usually ate school lunch at least 3 times/week	Comparison of means (no statistical tests reported)
Group IIIB: State and local studies with small samples							
Cullen et al. (2000)	Food intake at lunch	Students in 1 middle school in Texas (dates not reported)	5 consecutive daily food records	Children in grade 5 (n=282)	Participant vs. nonparticipant	Ate NSLP lunch (vs. home lunch or snack bar lunch) on food record days	Analysis of variance
Ho et al. (1991)	Nutrient intake at lunch	Students in 1 middle school in Salt Lake City (1989)	Visual observation of food selection and waste	Children and adolescents in grades 7 and 8 (n=254)	Participant vs. nonparticipant	Ate NSLP lunch (vs. sack lunch or vending machine lunch) on observation day	Analysis of variance and Student-Newman-Keuls range test
Perry et al. (1984)	Nutrient intake at lunch	All students in selected classrooms in 3 schools in 1 district in Alabama	3-day food record	Children in grades 5 and 6 (n=233)	Participant vs. nonparticipant[7]	Ate NSLP lunch (vs. brown bag lunch) on food record days	Unmatched t-test

See notes at end of table. Continued—

Table 26—Studies that examined the impact of the National School Lunch Program on students' dietary intakes—Continued

Study	Outcome(s)	Data source[1]	Data collection method	Population (sample size)	Design	Measure of participation	Analysis method
Howe and Vaden (1980)	Nutrient intake at lunch and over 24 hours	Randomly selected students in 1 urban public high school in Kansas	Single 24-hour recall	Adolescents in grades 10 and 11 (n=104)	Participant vs. nonparticipant	Ate NSLP lunch on recall day	2-way analysis of variance
Yperman and Vermeersch (1979)	Food intake over 24 hours	All students in 2 classrooms per grade in 2 schools in California	Food frequency checklist	Children in grades 1-3 (n=307)	Participant vs. nonparticipant	Number of days ate school lunch on 5 days prior to data collection	Multivariate regression

[1] Data sources:
CSFII = Continuing Survey of Food Intakes by Individuals.
NHANES-I = First National Health and Nutrition Examination Survey.
NFCS = Nationwide Food Consumption Survey.
[2] Did not differentiate NLSP and other lunch programs.
[3] Included lunch skippers with nonparticipants.
[4] Accounted for lunch skippers.
[5] Study included a second district where both free lunch and free breakfast were offered. The two districts were considered separately in the analysis, but the analysis of the second district did not separate contributions of breakfast and lunch meals.
[6] Study compared intakes before and after introduction of a free lunch program. Results were reported for four different subgroups based on baseline characteristics: nutritionally adequate, nutritionally needy, low-income (eligible for free lunch), and not low-income.
[7] Unit of analysis was lunches rather than students; 60 percent of students ate NSLP daily.

State and local studies. Six of these studies (Group III-A) included relatively large numbers of children (more than 500) from multiple sites—schools, SFAs, or States. The remaining five studies (Group III-B) had substantially smaller samples and generally weaker designs. With the exception of studies by Rainville (2001) and Cullen et al. (2000), all of the Group III studies are based on data collected before the implementation of the SMI. Six are based on data from the mid-1980s or earlier.

The strongest evidence about the impact of the NSLP on the dietary intake of participating students comes from the SNDA-I study (Devaney et al., 1993) and an analysis by Gleason and Suitor (2003) that used data from the 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII). SNDA-I is the most recent, comprehensive, and state-of-the-art study designed specifically to study the NSLP. It included nationally representative samples of public and private schools and of students attending those schools. Information, including a single 24-hour recall, was collected for 3,350 school-age children in 329 schools.

SNDA-I used a participant vs. nonparticipant design. However, Devaney and her colleagues used an instrumental variables approach to control for selection bias. The authors confirmed the robustness of their results using a variety of specifications. The model used to estimate impacts on dietary intake at lunch controlled for the price charged for a full-price lunch; student status with regard to free and reduced-price meal benefits; interaction terms for the price of a full-price lunch and benefit eligibility categories; availability of offer-vs.-serve;[84] ability to leave school for lunch; availability of low-, moderate-, and high-fat lunches;, and serving capacity of the lunch room. In estimating impacts on 24-hour nutrient intake, researchers adjusted for self-selection into the NSLP but not into the SBP because they concluded, based on exploratory analyses, that there was no selection bias in breakfast intakes.

Selection-bias adjustments are not without problems and frequently produce implausible results (see discussion in chapter 4). SNDA-I analysts, however, had access to many relevant variables and their findings, including differences between selection-adjusted and unadjusted results, make intuitive sense. Others reviewing the same literature (see, for example, Rossi, 1998 and Devaney et al., 1997) have reached the same conclusion.

A more recent study by Gleason and Suitor (2003) used data from the 1994-96 wave of the CSFII. This study improved upon the SNDA-I analysis by using a fixed-effects model to control for selection bias. The analysis included 1,614 children who (1) attended schools where the NSLP was offered and (2) had 2 days of intake data, at least one of which was a school day. The fixed-effects model was estimated in a paired-differences form, where differences between the 2 days of intake data were regressed on corresponding differences in student characteristics, including NSLP participation status. Thus, the estimation of NSLP impacts was based on variation in NSLP participation status of specific individual students rather than on variation in participation status of different groups of students. This ensured that the estimate was not influenced by unmeasured differences that may have existed between different groups of students.

The analysis included both students who reported intake for 2 school days and those who reported intake for 1 school day and 1 non-school day. To control for the possibility that students' intakes varied on school and non-school days for reasons other than the NSLP, the model included a dummy variable that indicated whether the intake day was a school day. The model also attempted to control for potential unobserved differences that may have had varying influences on children's consumption behaviors on the 2 days. For example, it included the day of the week, the number of hours of television watched on the intake day, two variables that indicated frequency of exercise, and variables that indicated whether reported intakes were heavier or lighter than usual.

An earlier study by Gleason and Suitor (2001) also used the 1994-96 CSFII. However, that study did not attempt to control for selection bias. The authors raised appropriate concerns about likely selection bias and cautioned that estimates of differences between NSLP participants and nonparticipants observed in that analysis should not be interpreted as valid estimates of NSLP impacts.

Although SNDA-I (Devaney et al., 1993) and the most recent study by Gleason and Suitor (2003) provide the strongest available data on NSLP impacts, both studies

[84]Offer vs. serve (OVS) is a NSLP policy that allows students to refuse some of the foods offered to them in reimbursable school lunches. At the time the SNDA-I data were collected, OVS was mandatory for secondary schools and was optional, at the discretion of local authorities, for elementary schools. Under OVS, students could refuse two of the three meal components in the traditional food-based meal pattern that was in effect at the time.

are based on data collected prior to the SMI. The literature search identified only two studies that compared dietary intakes of NSLP participants and nonparticipants using data collected sometime after the SMI was implemented (Rainville, 2001; Cullen et al., 2000).[85] Rainville looked at both food and nutrient consumption at lunch, comparing intakes of students who ate NSLP lunches and students who ate lunches from home. The study by Cullen et al. looked only at consumption of fruits and vegetables at lunch, comparing contributions of NSLP lunches and snack-bar lunches. Both of these studies were local in scope and both have substantial methodological limitations relative to SNDA-I and Gleason and Suitor (2003), particularly with regard to generalizability and selection bias. However, when viewed in concert with findings from SNDA-II, these more recent studies provide suggestive evidence of post-SMI impacts of the NSLP.

Impacts on Intake of Food Energy and Nutrients at Lunch

Nine studies examined the impact of NSLP participation on students' intake of food energy and nutrients at lunch. Results of these studies are summarized in table 27. The table is divided into four sections: food energy and macronutrients, vitamins, minerals, and other dietary components. The text follows this general organization, but combines findings for vitamins and minerals in one section.

In the interest of providing a comprehensive picture of the body of research, both significant and nonsignificant results are reported in table 27 and in all other "findings" tables. As noted in chapter 1, a consistent pattern of nonsignificant findings may indicate a true underlying effect, even though no single study's results would be interpreted in that way. Readers are cautioned, however, to avoid the practice of "vote counting," or adding up all the studies with particular results. Because of differences in research design and other considerations, findings from some studies merit more consideration than others. The text discusses methodological limitations and emphasizes findings from the strongest studies. In this case, emphasis is given to findings from SNDA-I (Devaney et al., 1993) and from the most recent Gleason and Suitor (2003) study, for the reasons discussed previously. All findings reported for SDNA-I are based on selection-bias-adjusted models, and all findings reported for Gleason and Suitor (2003) are based on fixed-effects models. For the most part, findings from the two studies are consistent. Where findings diverge, Gleason and Suitor's results are considered stronger because of the improved methods used to control for selection bias.

SNDA-I researchers stressed the importance of looking separately at NSLP effects by both age and gender. They pointed out, for example, that lunch options are usually more varied for older students and that these students typically make their own decisions about what to eat for lunch. Younger students, on the other hand, generally have fewer options and decisions about their lunches are often made by parents. Moreover, research has shown that adolescent females are more likely than males or younger children to consume diets low in nutrients relative to the RDAs.

In SNDA-I, selection-bias adjustments made little difference in conclusions about NSLP effects on younger children, but substantially affected the conclusions about older students, particularly females. SNDA-I conducted subgroup analysis by age and gender (6- to 10-year-olds, 11- to 18-year-old males, 11- to 18-year-old females) and by income (low-income and non-low-income (income greater than 185 percent of poverty)). In table 27, results of SNDA-I subgroup analyses are reported when estimates for one or more subgroups differed from results of the overall analysis *and* when the result of one of the analyses—the overall analysis or the subgroup analysis—revealed a statistically significant difference.

Food Energy and Macronutrients

Findings from SNDA-I (Devaney et al., 1993) and Gleason and Suitor (2003) suggest that, prior to the implementation of the SMI, NSLP participants and nonparticipants consumed roughly equivalent amounts of food energy at lunch. (Note that results are reported in table 27 using only the senior author's name and that SNDA-I results are reported as Devaney (1993).) Neither study found a significant difference in the energy intakes of NSLP participants and nonparticipants at lunch. Interestingly, however, both sets of researchers found that impact estimates that were *not adjusted for selection bias* showed that NSLP participants consumed significantly more food energy than nonparticipants (data not shown). Devaney and her colleagues attributed the difference between the two results to differences in unobserved characteristics that may affect participation, such as differences in appetite, food preferences, and food energy needs. These factors are controlled for in the selection-bias-adjusted

[85] Studies that examined the nutrient content of NSLP and non-NSLP meals as offered or served, but did not assess food and/or nutrient intakes of NSLP participants and nonparticipants, were not included in this review.

Table 27—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes at lunch

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Food energy and macronutrients				
Food energy	Gleason (2001) [national] Ho (1991) [1 school] Wellisch (1983) [national] Fraker (1987) [national] {females, 11-14}	Gleason (2003) [national] Howe (1980) [1 site] Fraker (1987) [national] {except subgroups noted}	Rainville (2001) [10 schools] Devaney (1993) [national] Fraker (1987) [national] {females, 5-10} Perry (1984) [3 schools]	Fraker (1987) [national] {males, 5-10}
Protein	Gleason (2003) [national] Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] {6-10; low-income} Ho (1991) [1 school] Fraker (1987) [national] {except subgroup noted} Wellisch (1983) [national] Howe (1980) [1 school]	Perry (1984) [1 site] Devaney (1993) [national] {except subgroups noted} Fraker (1987) [national] {females, 15-21}		
Carbohydrates		Ho (1991) [1 school][1]	Rainville (2001) [10 schools] Devaney (1993) [national] {11-18; females} Fraker (1987) [national] {males, 15-21}	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] {except subgroups noted} Fraker (1987) [national] {except subgroup noted}
Fat	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] {except subgroups noted} Ho (1991) [1 school]	Devaney (1993) [national] {11-18; low-income} Fraker (1987) [national] {except subgroup noted}	Rainville (2001) [10 schools] Fraker (1987) [national] {males, 15-21}	
Saturated fat	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] Ho (1991) [1 school][2]	Rainville (2001) [10 schools]		

See notes at end of table.

Continued—

Table 27—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes at lunch—Continued

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Vitamins				
Vitamin A	Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] {except subgroup noted} Wellisch (1983) [national] Perry (1984) [3 schools] Howe (1980) [1 school]	Gleason (2003) [national] Devaney (1993) [national] {non-low-income} Ho (1991) [1 school][1]		
Vitamin B_6	Gleason (2001) [national] Rainville (2001) [10 schools] Wellisch (1983) [national]	Gleason (2003) [national] Devaney (1993) [national] {except subgroup noted}	Devaney (1993) [national] {non-low-income}	
Vitamin B_{12}	Gleason (2003) [national] Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] {except subgroups noted}	Devaney (1993) [national] {females, 11-18; non-low-income}		
Vitamin C	Howe (1980) [1 school]	Perry (1984) [3 schools]	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] {11-18}	Rainville (2001) [10 schools] Devaney (1993) [national] {except subgroup noted} Ho (1991) [1 school][2] Wellisch (1983) [national]
Vitamin D	Rainville (2001) [10 schools]			
Vitamin E		Gleason (2001) [national]	Gleason (2003) [national]	
Folate	Gleason (2001) [national] Rainville (2001) [10 schools]		Gleason (2003) [national] Devaney (1993) [national]	
Niacin	Rainville (2001) [10 schools] Wellisch (1983) [national]	Gleason (2001) [national] Howe (1980) [1 school]	Gleason (2003) [national] Devaney (1993) [national]	
Riboflavin	Gleason (2003) [national] Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] {except subgroups noted} Wellisch (1983) [national] Perry (1984) [3 schools] Howe (1980) [1 school]	Devaney (1993) [national] {females, 11-18; non-low-income}		

See notes at end of table.

Continued—

Table 27—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes at lunch—Continued

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Thiamin	Gleason (2001) [national] Rainville (2001) [10 schools] Wellisch (1983) [national] Howe (1980) [1 school]	Gleason (2003) [national] Perry (1984) [3 schools]	Devaney (1993) [national]	
Minerals				
Calcium	Gleason (2003) [national] Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] {except subgroup noted} Wellisch (1983) [national] Perry (1984) [3 schools] Howe (1980) [1 school]	Devaney (1993) [national] {females, 11-18}		
Iron	Gleason (2001) [national] Rainville (2001) [10 schools] Howe (1980) [1 school] Wellisch (1983) [national] {younger}	Gleason (2003) [national] Devaney (1993) [national] {except subgroup noted} Ho (1991) [1 school][1]	Devaney (1993) [national] {females, 11-18; non-low-income}	Wellisch (1983) [national] {older}
Magnesium	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] {except subgroups noted}[3] Wellisch (1983) [national]	Devaney (1993) [national] {6-10; 11-18; non-low-income}[3]		
Phosphorus	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] {except subgroups noted} Wellisch (1983) [national] Perry (1984) [3 schools]	Devaney (1993) [national] {11-18; non-low -income}		
Zinc	Gleason (2003) [national] Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] {except subgroups noted}	Devaney (1993) [national] {11-18; non-low -income}		

See notes at end of table.

Continued—

Table 27—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes at lunch—Continued

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Other dietary components				
Added sugars				Gleason (2003) [national] Gleason (2001) [national] Rainville (2001) [10 schools]
Cholesterol	Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] {6-10; low -income} Ho (1991) [1 school]	Gleason (2003) [national] Devaney (1993) [national] {except subgroups noted}	Devaney (1993) [national] {females, 11-18}	
Fiber	Gleason (2003) [national] Gleason (2001) [national] Rainville (2001) [10 schools]	Ho (1991) [1 school][1]		
Sodium	Gleason (2001) [national] Rainville (2001) [10 schools] Ho (1991) [1 school][2]	Gleason (2003) [national] Devaney (1993) [national] Fraker (1987) [national] {females, 15-21}	Fraker (1987) [national] {except subgroups noted}	Fraker (1987) [national] {females, 5-10}

Notes: Cell entries show the senior author's name, the publication date, and the scope of the study (for example, national vs. 3 schools). Where findings pertain only to a specific subgroup rather than the entire study population, the cell entry also identifies the subgroup {in brackets}.

Nonsignificant results are reported in the interest of providing a comprehensive picture of the body of research. As noted in chapter 1, a consistent pattern of nonsignificant findings may indicate a true underlying effect, even though no single study's results would be interpreted in that way. Readers are cautioned to avoid the practice of "vote counting," or adding up all the studies with particular results. Because of differences in research design and other considerations, findings from some studies merit more consideration than others. The text discusses methodological limitations and emphasizes findings from the strongest studies.

To maintain readability, results of SNDA-I (Devaney et al., 1993) subgroup analyses are presented only when results differed from results for overall sample *and* at least one of the analyses reported a statistically significant effect. All findings are from selection-bias-adjusted models.

[1] Results for NSLP vs. sack lunch. Difference between NSLP and vended lunch was in same direction and was statistically significant.

[2] Results for NSLP vs. sack lunch. Difference between NSLP and vended lunch was in same direction but was not statistically significant.

[3] In main analysis for overall sample, selection-bias-adjusted difference between participants and nonparticipants indicated that NSLP participants consumed significantly more magnesium than nonparticipants. This pattern was observed in all subgroup analyses; however, the differences were significant only among low-income students.

results. This may explain the significant differences in energy intake reported by other researchers whose analyses did not account for selection bias.

The available studies are largely consistent in finding that NSLP participants consumed significantly more protein at lunch than nonparticipants. SNDA-I did not find this effect in the overall analysis. However, subgroup analyses revealed a significant NSLP impact among 6- to 10-year-olds and among low-income children.

SNDA-I and Gleason and Suitor (2003) both found that lunches consumed by NSLP participants prior to the SMI were significantly lower in carbohydrates, as a percentage of total food energy, than lunches consumed by nonparticipants. SNDA-I subgroup analyses revealed that this pattern did not hold for females ages 11-18. Gleason and Suitor (2003) found that the difference in carbohydrate consumption was due to decreased consumption of added sugars among NSLP participants. Consumption of other forms of carbohydrates was essentially equivalent for the two groups.

Findings from SNDA-I and Gleason and Suitor (2003) are also consistent with regard to intakes of total fat and saturated fat. The data indicate that, prior to implementation of the SMI, lunches consumed by NSLP participants provided significantly more fat and saturated fat, as a percentage of total energy intake, than lunches consumed by nonparticipants. SNDA-I subgroup analyses revealed that the difference in intake of total fat was concentrated among 6- to 10-year-old and non-low-income students.

Findings from Rainville (2001), the only study in this group based on data collected after implementation of the SMI, paint a notably different picture. Rainville found no significant differences in the mean carbohydrates, fat, and saturated fat content of NSLP lunches and sack lunches consumed by elementary school students. These results suggest that the carbohydrate content of NSLP lunches has increased since the implementation of the SMI, while the fat and saturated fat content has decreased. This is consistent with the trend observed in SNDA-II (Fox et al., 2001).

However, Rainville's analysis did not adjust for selection bias, and factors other than selection bias may have contributed to their more positive findings. For example, Rainville included only 2nd, 3rd, and 4th graders, while both SNDA-I and Gleason and Suitor (2003) included students in grades 1 through 12. SNDA-II found that lunches offered in elementary schools were lower in fat and saturated fat, on average, than lunches offered in secondary schools (the statistical significance of these differences was not tested). In addition, the schools included in Rainville's study, and the lunches they offered, may not be representative of lunches offered nationwide. The two volunteer school districts that participated in Rainville's study were relatively affluent—with 18 percent and 25 percent of students approved for free and reduced-price meals, respectively—and the reimbursable lunches offered in these districts provided even less fat (29.4 percent of total food energy) than required under the SMI (no more than 30 percent). By comparison, SNDA-II found that lunches offered in elementary schools provided an average of 33.5 percent of total food energy from fat.

Vitamins and Minerals

Data from SNDA-I (Devaney et al., 1993) and Gleason and Suitor (2003) suggest that prior to implementation of the SMI, NSLP participants had significantly greater lunch intakes of vitamin B_{12}, riboflavin, calcium, magnesium, phosphorus, and zinc than nonparticipants. Subgroup analyses conducted by Devaney and her colleagues revealed substantial variation in these results across subgroups. Most often, significant differences were concentrated among 6- to 10-year-olds and low-income students.

Findings from SNDA-I and Gleason and Suitor differ for vitamins A and C. SNDA-I found that NSLP participants consumed significantly more vitamin A and significantly less vitamin C at lunch than nonparticipants.[86] Gleason and Suitor observed comparable trends in intake, but found that differences between NSLP participants and nonparticipants were not statistically significant. As noted above, results from Gleason and Suitor are considered stronger because of the improved approach to selection-bias adjustment in their analysis.

For all other vitamins and minerals, neither SNDA-I nor Gleason and Suitor (2003) found significant differences between lunch intakes of NSLP participants and nonparticipants. It is likely that the significant effects reported in other studies are at least partially attributable to selection bias. Both SNDA-I researchers and Gleason and Suitor (2003) found significant effects for thiamin, vitamin B_6, folate, and iron in regression models that did not adjust for selection bias (data not

[86]Although participants consumed significantly less vitamin C at lunch than nonparticipants, intakes of both groups far exceeded the one-third RDA standard defined for NSLP meals.

shown); however, these effects disappeared in models that controlled for selection bias.

Every study that examined intakes of riboflavin, calcium, and phosphorus found that NSLP participants consumed significantly larger amounts of these nutrients at lunch than nonparticipants (although SNDA-I found that results varied for some subgroups of children). It is generally accepted that this pattern is due to increased consumption of milk, a concentrated source of all these nutrients, by NSLP students (Lin and Ralston; 2003, Devaney et al., 1993; Radzikowski and Gale, 1984). (Impacts on food consumption patterns are discussed in more detail in a subsequent section.)

Moreover, analyses completed by both SNDA-I and NESNP (Wellisch et al., 1983) researchers suggested that differences in the vitamin and mineral intakes of NSLP participants and nonparticipants at lunch are due to the *types* of food consumed, rather than the *quantities*. Both SNDA-I and NESNP examined the nutrient density of lunches and found it to be higher in lunches eaten by NSLP participants than those eaten by nonparticipants.[87] Although only the NESNP results were tested for statistical significance, both groups of investigators concluded that the NSLP increased intakes of selected nutrients by providing lunches that were more dense in those nutrients, rather than by providing more food.

Results of the SNDA-II study, which found that reductions in the fat and saturated fat content of NSLP meals were achieved without reducing vitamin and mineral content, suggest that impacts on intake of key vitamins and minerals are likely to persist in post-SMI meals. In fact, SNDA-II found that the average vitamin and mineral content of the lower fat lunches offered in the 1998-99 school year was significantly greater than the vitamin and mineral content of higher fat lunches offered in 1992-93 (SNDA-I) (Fox et al., 2001).[88]

Other Dietary Components

Both SNDA-I (Devaney et al., 1993) and Gleason and Suitor (2003) found that pre-SMI lunches consumed by NSLP participants and nonparticipants provided comparable amounts of cholesterol and sodium. However, the SNDA-I subgroup analysis revealed that among 6- to10-year-olds and low-income students, NSLP participants consumed significantly more cholesterol than nonparticipants.[89]

Gleason and Suitor (2003) also studied fiber intake. They found that lunches consumed by NSLP participants contributed significantly more fiber than those consumed by nonparticipants.

Impacts on Total Daily Intake of Food Energy and Nutrients

To have a meaningful influence on students' nutrition or health status, NSLP impacts on dietary intake must be sustained over the course of the day. It is possible for effects on lunch intakes to be offset by other meals and snacks consumed throughout the day. Therefore, for a more complete appreciation of how the NSLP affects students' dietary intake, it is important to examine the program's effect on the total diet. In the available literature, this was generally assessed as impacts on 24-hour intake.

Fourteen studies examined the impact of NSLP participation on 24-hour intake of food energy and nutrients. (Seven of these studies also assessed lunch intake and were included in the preceding section.) Findings are summarized in table 28 and discussed below. All the studies that assessed impacts on 24-hour intake were completed before implementation of the SMI. In addition, SNDA-I did not include subgroup analyses for the 24-hour intake data. Consequently, little is known about differential impacts on 24-hour intake for various subgroups of students. A few of the early NSLP studies did look at impacts among selected subgroups (Akin, 1983a and b; Hoagland, 1980; U.S. Department of Health Education and Welfare, 1972; Emmons et al., 1972). However, findings from these studies are quite dated, most of the studies used simple bivariate comparisons, and none attempted to control for selection bias.

Food Energy and Macronutrients

With emphasis given to findings from SNDA-I (Devaney et al., 1993) and Gleason and Suitor (2003), the available data indicate that before implementation of the SMI, NSLP participants and nonparticipants consumed similar amounts of food energy and protein over 24 hours.

SNDA-I and Gleason and Suitor (2003) both found that, in comparison with nonparticipants, 24-hour

[87]Nutrient density measures nutrient intake relative to energy intake: % RDA for nutrient 'X' % RDA for energy.

[88]SNDA-II looked only at vitamin A, vitamin C, calcium, and iron—the nutrients that are specifically addressed in SMI standards.

[89]Overall mean cholesterol intakes at lunch were less than one-third of the recommended daily maximum of 300 milligrams (NRC, 1989b).

Table 28—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes over 24 hours

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Food energy and macronutrients				
Food energy	Gleason (2001) [national] Wellisch (1983) [national] Akin (1983a, b) [national] Emmons (1972) [1 district] {except subgroup noted} HEW (1972) [10 States]	Gleason (2003) [national] Fraker (1987) [national] {except subgroup noted} Emmons (1972) [1 district] {nutritionally adequate}	Devaney (1993) [national] Hoagland (1980) [national] Howe (1980) [1 school] Price (1978) [1 State] {2-3 times per week}	Fraker (1987) [national] {females, 5-10}
Protein	Gleason (2003) [national] Gleason (2001) [national] Wellisch (1983) [national] Fraker (1987) [national] {except subgroups noted} Akin (1983a) [national] Price (1978) [1 State] Emmons (1972) [1 district] {except subgroup noted} HEW (1972) [10 States]	Devaney (1993) [national] Fraker (1987) [national] {females, 15-21} Hoagland (1980) [national] Howe (1980) [1 school] Emmons (1972) [1 district] {nutritionally adequate}	Fraker (1987) [national] {males, 15-21}	
Carbohydrate		Fraker (1987) [national] {males, 15-21}	Fraker (1987) [national] {females, 5-10, 15-21} Hoagland (1980) [national] [1]	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] Fraker (1987) [national] {except subgroups noted}
Fat	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national] Fraker (1987) [national] {females, 11-14}	Hoagland (1980) [national] [1] Fraker (1987) [national] {males, 5-14}	Fraker (1987) [national] {except subgroups noted}	
Saturated fat	Gleason (2003) [national] Gleason (2001) [national] Devaney (1993) [national]			

See notes at end of table.

Continued—

Table 28—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes over 24 hours—Continued

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Vitamins				
Vitamin A	Devaney (1993) [national] Wellisch (1983) [national] Akin (1983a) [national] Akin (1983b) [national] {except subgroups noted} Price (1978) [1 State] HEW (1972) [10 States]	Gleason (2003) [national] Akin (1983b) [national] {6-11years; low income} Hoagland (1980) [national]	Gleason (2001) [national] Howe (1980) [1 school] Emmons (1972) [1 district] {except subgroup noted}	Emmons (1972) [1 district] {nutritionally adequate}
Vitamin B_6	Gleason (2001) [national] Wellisch (1983) [national] Akin (1983a, b) [national]	Gleason (2003) [national]	Devaney (1993) [national]	
Vitamin B_{12}	Gleason (2003) [national] Gleason (2001) [national] Akin (1983a) [national]	Devaney (1993) [national]		
Vitamin C	Akin (1983a) [national] {6-11 years} Akin (1983b) [national] {6-11 years; non-low income} Hoagland (1980) [national] [1] Emmons (1972) [1 district] {nutritionally needy; not low-income} HEW (1972) [10 States]	Gleason (2003) [national] Akin (1983a) [national] {12-18 years} Akin (1983b) [national] {except subgroup noted} Emmons (1972) [1 district] {nutritionally adequate; low-income}	Gleason (2001) [national] Wellisch (1983) [national] Howe (1980) [1 school]	Devaney (1993) [national]
Vitamin E		Gleason (2003) [national] Gleason (2001) [national]		
Folate		Gleason (2003) [national] Gleason (2001) [national]	Devaney (1993) [national]	
Niacin	Wellisch (1983) [national] Akin (1983a) [national] {6-11 years} Emmons (1972) [1 district] {nutritionally needy} HEW (1972) [10 States]	Gleason (2003) [national] Gleason (2001) [national] Akin (1983a) [national] {12-18 years} Emmons (1972) [1 district] {except subgroups noted}	Devaney (1993) [national] Hoagland (1980) [national] Howe (1980) [1 school] Emmons (1972) [1 district] {nutritionally adequate}	

See notes at end of table.

Continued—

Table 28—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes over 24 hours—Continued

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Riboflavin	Gleason (2003) [national] Gleason (2001) [national] Wellisch (1983) [national] Price (1978) [1 State] Emmons (1972) [1 district] {nutritionally needy} HEW (1972) [10 States]	Devaney (1993) [national] Hoagland (1980) [national] Howe (1980) [1 school] Emmons (1972) [1 district] {except subgroups noted}	Emmons (1972) [1 district] {nutritionally adequate}	
Thiamin	Gleason (2001) [national] Akin (1983a) [national] {6-11 years} Emmons (1972) [1 district] {except subgroup noted} HEW (1972) [10 States]	Gleason (2003) [national] Wellisch (1983) [national] Akin (1983a) [national] {12-18 years} Howe (1980) [1 school] Emmons (1972) [1 district] {nutritionally adequate}	Devaney (1993) [national] Hoagland (1980) [national]	Price (1978) [1 State] {2-3 times per week}
Minerals				
Calcium	Gleason (2003) [national] Gleason (2001) [national] Wellisch (1983) [national] Akin (1983a) [national] Howe (1980) [1 school] Price (1978) [1 State] Emmons (1972) [1 district] {nutritionally needy} HEW (1972) [10 States]	Devaney (1993) [national] Hoagland (1980) [national] Emmons (1972) [1 district] {except subgroups noted}	Emmons (1972) [1 district] {nutritionally adequate}	
Iron	Akin (1983a, b) [national] Price (1978) [1 State] {0-1 time per week} Emmons (1972) [1 district] {nutritionally needy; not low-income} HEW (1972) [10 States]	Gleason (2003) [national] Gleason (2001) [national] Wellisch (1983) [national] Howe (1980) [1 school] Emmons (1972) [1 district] {low-income}	Devaney (1993) [national] Hoagland (1980) [national] Emmons (1972) [1 district] {nutritionally adequate}	
Magnesium	Gleason (2003) [national] Gleason (2001) [national] Wellisch (1983) [national] Akin (1983a) [national]	Devaney (1993) [national]		

See notes at end of table.

Continued—

Table 28—Findings from studies that examined the impact of the National School Lunch Program on students' dietary intakes over 24 hours—Continued

	Significant impact	No significant impact		Significant impact
Outcome	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Phosphorus	Gleason (2003) [national] Gleason (2001) [national] Wellisch (1983) [national] Akin (1983a) [national] Price (1978) [1 State]	Devaney (1993) [national] Hoagland (1980) [national]		
Zinc	Gleason (2003) [national] Gleason (2001) [national]	Devaney (1993) [national]		
Other dietary components				
Added sugars				Gleason (2003) [national] Gleason (2001) [national]
Cholesterol	Gleason (2001) [national]	Gleason (2003) [national] Devaney (1993) [national]		
Fiber	Gleason (2003) [national]	Gleason (2001) [national]		
Sodium	Gleason (2001) [national	Gleason (2003) [national] Devaney (1993) [national] Fraker (1987) [national] {males, 5-10; females, 15-21} Hoagland (1980) [national][1]	Fraker (1987) [national] {except subgroups noted}	

Notes: Cell entries show the senior author's name, the publication date, and the scope of the study (for example, national vs. 3 schools). Where findings pertain only to a specific subgroup rather than the entire study population, the cell entry also identifies the subgroup {in brackets}.

Nonsignificant results are reported in the interest of providing a comprehensive picture of the body of research. As noted in Chapter 1, a consistent pattern of nonsignificant findings may indicate a true underlying effect, even though no single study's results would be interpreted in that way. Readers are cautioned to avoid the practice of "vote counting," or adding up all the studies with particular results. Because of differences in research design and other considerations, findings from some studies merit more consideration than others. The text discusses methodological limitations and emphasizes findings from the strongest studies.

Findings for SNDA-I (Devaney et al., 1993) are based on selection-bias-adjusted model.

Findings for Akin et al. (1983b) were reported as significant at $p \leq 0.10$.

Unless otherwise noted, results for Price et al. (1978) are for children who usually participated in NSLP 4-5 times per week.

Findings for Emmons et al. (1972) are based on comparison of intakes before and after introduction of free lunch program. Authors looked at differences in at-home intakes and 24-hour intakes. Differences reported as significant are those where 24-hour intakes were different but at-home intakes were either not different or smaller than 24-hour differences. Study assessed impacts in four subgroups (see table 26).

[1] Significance of differences not tested/not reported.

intakes of NSLP participants were lower in carbohydrates and higher in total fat and saturated fat as a percentage of total energy intake. Gleason and Suitor (2003) also found that 24-hour intakes of NSLP participants were significantly lower in added sugars than the intakes of nonparticipants. All these findings are consistent with findings from the analysis of lunch intakes, indicating that pre-SMI impacts on intakes of carbohydrate, fat, and saturated fat persisted over the course of the day.

Vitamins and Minerals

Findings from SNDA-I (Devaney et al., 1993) and Gleason and Suitor (2003) are divergent for 24-hour intakes of most vitamins and minerals. SNDA-I found that most of the increases in vitamin and mineral intakes observed at lunch diminished over the course of the day. In SNDA-I, the only significant NSLP impacts that persisted over 24 hours were an increase in vitamin A intake and a decrease in vitamin C intake. (Overall mean vitamin C intakes of both groups were more than 250 percent of the RDA.) NSLP participants' 24-hour intakes of vitamin B_{12}, calcium, phosphorus, magnesium, and zinc continued to be greater than those of nonparticipants, but the differences were not statistically significant.

In contrast, Gleason and Suitor (2003) found that all of the impacts on vitamin and mineral intakes observed at lunch persisted over 24 hours. Specifically, they found that, relative to nonparticipants, NSLP participants had significantly greater 24-hour intakes of vitamin B_{12}, riboflavin, calcium, magnesium, phosphorus, and zinc. In keeping with findings from their analysis of lunch intakes, Gleason and Suitor (2003) found no significant impact on 24-hour intakes of vitamins A or C.

As noted, findings from Gleason and Suitor (2003) are considered stronger than findings from SNDA-I. Indeed, Devaney and colleagues cautioned that SNDA-I's estimates of NSLP impacts over 24 hours were less precise than their estimates of NSLP impacts at lunch. This is true because estimates of 24-hour impacts are influenced by differences in unmeasured characteristics and measurement error associated with other eating occasions, in addition to differences in unmeasured characteristics and measurement error associated with lunch. The same is true of Gleason and Suitor's (2003) estimates of NSLP impacts over 24 hours, of course; however, the fixed-effects model estimated by Gleason and Suitor (2003) did a better job than the SNDA-I model of controlling for unmeasured characteristics that may have affected consumption at eating occasions other than lunch. Gleason and Suitor's model was based on differences within individual students rather than between groups of students, and the model included covariates that controlled for several potentially relevant variables, including Body Mass Index (BMI),[90] frequency of exercise, hours of television watched, and whether reported intakes were heavier or lighter than usual.

Other Dietary Components

Both SNDA-I (Devaney et al., 1993) and Gleason and Suitor (2003) found that NSLP participation did not affect students' 24-hour intakes of cholesterol or sodium. This is consistent with findings from their respective analyses of lunch intakes (using results for the overall SNDA-I sample).

In addition, Gleason and Suitor (2003) found that NSLP participants consumed significantly more fiber over 24 hours than nonparticipants. This is consistent with the finding from the analysis of lunch intakes and suggests that the NSLP's impact on fiber intake persists over the course of the day.

Impacts on Food Consumption Patterns

Examining the food consumption patterns of NSLP participants and nonparticipants can prove helpful in understanding the effects the NSLP has on students' nutrient intake. Several researchers looked at food consumption patterns, using a number of approaches. SNDA-I researchers examined the percentage of students consuming specific foods and food groups at lunch (Devaney et al., 1993). Simple weighted tabulations were reported, without adjustment for observed differences in characteristics of the two groups or for selection bias. In their first analysis of the CSFII data, Gleason and Suitor (2001) computed the number of Food Guide Pyramid servings consumed by each child and compared regression-adjusted means. Their analysis looked at both lunch and 24-hour consumption.

Cullen et al. (2000) also looked at Food Guide Pyramid servings, but their analysis was limited to lunch and to fruits and vegetables. Rainville (2001) and Wolfe and Campbell (1993) compared cumulative counts of food items within Food Guide Pyramid groups (expressed as categorical variables). Finally, Melnick et al. (1998) and Yperman and Vermeersh (1979) used index scores to reflect 24-hour food consumption. Melnick and his colleagues computed a Food Guide Pyramid score and

[90]BMI is the accepted standard for defining overweight and obesity. BMI is equal to [weight in kilograms] ÷ [height in meters]^2.

a 5-A-Day score for each student and also tabulated the number of servings of fats, oils, and sweets consumed. Yperman and Vermeersch constructed a measure similar to the Food Guide Pyramid score, using data from a food frequency checklist.

Because none of the studies that examined impacts on food consumption controlled for selection bias, conclusions about impacts on these outcomes are more tentative than those about impacts on intake of energy and nutrients. Results of the available studies, summarized in table 29, are largely consistent. Only the studies by Rainville and Cullen are based on data that were collected sometime after the implementation of the SMI.

Food Consumption at Lunch

The available data suggest that NSLP participants consumed *more* milk and vegetables at lunch and *fewer* sweets and snack foods than nonparticipants. Findings for other food groups are equivocal. SNDA-I found that a significantly greater proportion of NSLP participants than nonparticipants consumed grain products at lunch. In contrast, Gleason and Suitor (2001) found that, on average, NSLP participants consumed significantly *fewer servings* of grains at lunch than nonparticipants. In both cases, between-group differences were relatively small.

The Gleason and Suitor (2001) finding deserves more weight than the SNDA-I finding because the former analysis looked at the actual number of servings consumed (rather than the percentage of children eating at least one item within the food group) and adjusted for differences in observed characteristics of students. Rainville (2001) reported results similar to Gleason and Suitor and found that the increase in the number of grain items consumed by nonparticipants was attributable to a high prevalence of sandwiches in lunches from home.

Gleason and Suitor (2001) found no difference between NSLP participants and nonparticipants in consumption of fruits and juices at lunch. However, most of the other studies reported that NSLP participants consumed more fruit and juices than nonparticipants.

Food Consumption Over 24 Hours

Data on food consumption patterns of NSLP participants and nonparticipants over 24 hours are more limited. (SNDA-I (Devaney et al., 1993), Rainville (2001), and Cullen (2000) did not evaluate 24-hour consumption.) The available data suggest that some NSLP impacts on food consumption at lunch maintained over 24 hours, while others faded.

Gleason and Suitor (2001) reported that NSLP impacts on consumption of milk, vegetables, and meat were maintained over 24 hours. However, the decreased consumption of grain products at lunch noted among NSLP participants did not persist over 24 hours, nor did the decreased consumption of sweetened beverages.

Melnick et al. (1998) found that NSLP participants consumed fewer servings of fats, sweets, and oils over 24 hours than nonparticipants. These researchers also found that NSLP participants scored higher than nonparticipants on a composite measure that evaluated servings from the Food Guide Pyramid (5th graders), as well as on a 5-A-Day score that looked specifically at fruit and vegetable consumption.

The study by Yperman and Vermeersch (1979), which found that the NSLP had a significant negative impact on students' "dietary complexity," stands in stark contrast to the positive or neutral findings of other studies. This result can be heavily discounted, however, because the study is dated and methods used to collect and analyze food group data do not meet current standards.

Impacts on Other Nutrition- and Health-Related Outcomes

The literature search identified 10 studies that looked at impacts of the NSLP beyond food and nutrient intake. Table 30 describes these studies, three of which are also included in the preceding section on dietary intake (Wellisch et al., 1983; Hoagland et al., 1980; and Emmons et al., 1972). Six studies looked at children's weight and/or height. Four studies looked at biochemical measures, specifically iron status or serum cholesterol levels, and three looked at impacts on household food expenditures. Findings from these studies are summarized in table 31. One study (Gretzen and Vermeersch, 1980) also looked at school attendance and cognitive performance. That study, which is dated and has serious limitations as a test of the NSLP, found no effects of participation in a free school lunch program on any of these measures.[91]

Weight and Height

Few studies have looked at the relationship between NSLP participation and children's weight status or linear growth, and none of them offers definitive evidence. The NESNP (Wellisch et al., 1983) measured students' height, weight, and triceps skinfold (a measure of body

[91] The study analyzed 8 years of school records in an attempt to determine the impact of free school lunch, alone and in combination with Head Start.

Table 29—Findings from studies that examined the impact of the National School Lunch Program on students' food consumption patterns

	Significant impact	No significant impact		Significant impact
Measure	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Lunch consumption				
Fruits and fruit juices	Rainville (2001) [10 schools] Devaney (1993) [national][1] Wolfe (1993) [51 schools]	Gleason (2001) [national] Cullen (2000) [5 schools]		
Grain products	Devaney (1993) [national]			Gleason (2001) [national] Rainville (2001) [10 schools]
Meat, poultry, fish, and meat substitutes	Gleason (2001) [national] Devaney (1993) [national]			Rainville (2001) [10 schools] Wolfe (1993) [51 schools]
Milk and milk products	Gleason (2001) [national] Rainville (2001) [10 schools] Devaney (1993) [national] Wolfe (1993) [51 schools]			
Vegetables	Gleason (2001) [national] Rainville (2001) [10 schools] Cullen (2000) [5 schools] Devaney (1993) [national][1] Wolfe (1993) [51 schools]			
Fats, oils, and salad dressings			Devaney (1993) [national]	
Snack foods				Rainville (2001) [10 schools] Wolfe (1993) [51 schools]
Sugar, sweets, and sweetened beverages[2]				Gleason (2001) [national] Devaney (1993) [national]

See notes at end of table.

Continued—

Table 29—Findings from studies that examined the impact of the National School Lunch Program on students' food consumption patterns—Continued

	Significant impact	No significant impact		Significant impact
Measure	Participants consumed more	Participants consumed more/same	Participants consumed less	Participants consumed less
Food diversity/ total number of food items	Rainville (2001) [10 schools] Wolfe (1993) [51 schools]			
24 hours				
Fruit and fruit juices	Wolfe (1993) [51 schools]		Gleason (2001) [national]	
Grain products		Gleason (2001) [national]		
Meat, poultry, fish, and meat substitutes	Gleason (2001) [national]			
Milk and milk products	Gleason (2001) [national] Wolfe (1993) [51 schools]			
Vegetables	Gleason (2001) [national] Wolfe (1993) [51 schools]			
Fats, sweets, and oils				Melnick (1998) [25 schools]
Snack foods				Wolfe (1993) [51 schools]
Sweetened beverages			Gleason (2001) [national]	

See notes at end of table.

Continued—

Table 29—Findings from studies that examined the impact of the National School Lunch Program on students' food consumption patterns—Continued

	Significant impact	No significant impact		Significant impact
Measure	Participants scored higher	Participants scored higher/same	Participants scored lower	Participants scored lower
Summary measures				
5-A-Day Index Score	Melnick (1998) [25 schools]			
Food Guide Pyramid Index Score	Melnick (1998) [25 schools] {5th grade}	Melnick (1998) [25 schools] {2nd grade}		
Dietary Complexity Score				Yperman (1979) [2 schools]

Notes: Cell entries show the senior author's name, the publication date, and the scope of the study (for example, national vs. 3 schools). Where findings pertain only to a specific subgroup rather than the entire study population, the cell entry also identifies the subgroup {in brackets}.

Nonsignificant results are reported in the interest of providing a comprehensive picture of the body of research. As noted in chapter 1, a consistent pattern of nonsignificant findings may indicate a true underlying effect, even though no single study's results would be interpreted in that way. Readers are cautioned to avoid the practice of "vote counting," or adding up all the studies with particular results. Because of differences in research design and other considerations, findings from some studies merit more consideration than others. The text discusses methodological limitations and emphasizes findings from the strongest studies.

Food group results for Gleason et al. (2001) and for Cullen (2000) are based on mean number of servings consumed. Results for Devaney et al. (1993) are based on the percentage of children consuming food group. Results for Rainville (2001) are based on cumulative counts of lunch items in each group, and results for Wolfe and Campbell (1993) are based on categorical scores based on number of items reported.

Findings for SNDA-I (Devaney et al., 1993) are not adjusted for selection bias.

Wolfe and Campbell (1993) did not present data for 24-hour consumption but reported that, with the exception of differences in meat consumption and food diversity, all differences observed in lunch consumption persisted over 24 hours.

[1] Study looked at fruits and vegetables as one group (recorded here under "fruits") and vegetables other than potatoes or tomato sauce as another group (recorded here under vegetables).

[2] Devaney et al. (1993) looked at sugar, sweets, and sweetened beverages as a group. Gleason et al. looked only at sweetened beverages and included separate measures for soda and fruit drinks/flavored drinks.

Table 30—Studies that examined the impact of the National School Lunch Program on other nutrition and health outcomes

Study	Data source[1]	Population (sample size)	Design	Measure of participation	Analysis method
Weight and/or height					
Jones et al. (2003)	1997 PSID, Child Development Supplement	Children ages 5-12 with household incomes ≤185% of poverty (n=772)	Participant vs. nonparticipant	Parent report that child "participates"	Multivariate regression
Wolfe et al. (1994)	Students in 51 schools in New York State, excluding New York City (1987-88)	Children in grades 2 and 5 (n=1,797)	Participant vs. nonparticipant	Parent report that "child eats school lunch"	Multivariate regression
Wellisch et al. (1983) (NESNP)	Nationally representative sample of students from 276 public schools (1980-81)	Children and adolescents in grades 1-12 (n=6,556)	Participant vs. nonparticipant	Average long-term weekly participation	Multivariate regression
Gretzen and Vermeersch (1980)[2]	All students in 2 intervention programs and 2 comparison programs in 1 SFA in California	Children and adolescents in grades 1-8 (n=332)	Participant vs. nonparticipant	Began receiving free school lunch in grade 1 and regularly through grade 8	Analysis of variance; bivariate t-tests
Emmons et al. (1972)	All students in selected grades in 1 district in rural New York State (1970-71)[3]	Children in grades 1-4 (n=844)	Participants, before vs. after[4]	Took 70% or more of school meals offered during study period	Comparison of means (type of statistical test not reported)
Paige (1972)	Students in 4 schools in Baltimore, MD	Children in grades 1, 2, and 6 (n=742)	Participant vs. nonparticipant, before and after	Not reported	Comparison of means (type of statistical test not reported)
Nutritional biochemistries					
Kandiah and Peterson (2001)	Students in 1 school in Indiana	Children/adolescents ages 11-15 (n=3,155)	Participants, before vs. after (cholesterol)	Ate school lunch at least 3 times per week	Multivariate regression
Hoagland (1980)	1971-74 NHANES-I	Children and adolescents ages 6-21 (n=3,155)	Participant vs. nonparticipant[5] (iron, cholesterol, protein)	Ate school lunch on recall day	Linear regression

See notes at end of table.

Continued—

Table 30—Studies that examined the impact of the National School Lunch Program on other nutrition and health outcomes—Continued

Study	Data source[1]	Population (sample size)	Design	Measure of participation	Analysis method
Emmons et al. (1972)	All students in 2 selected grades in 1 district in rural New York State (1970-71)[3]	Children in grades 1-4 (n=844)	Participants, before vs. after (iron)	Took 70% or more school meals offered during study period[4]	Comparison of means (type of statistical test not reported)
Paige (1972)	Students in 4 schools in Baltimore, MD	Children in grades 1, 2, and 6 (n=742)	Participants vs. nonparticipants, before and after (iron)	Not reported	Comparison of means (type of statistical test not reported)
Household food expenditures					
Long (1991)	1980-81 NESNP	Children and adolescents in grades 1-12 (n=5,778)	Participant vs. nonparticipant	Any household member participates in NSLP at least once during a typical week	Multivariate regression with selection-bias adjustment[6]
Wellisch et al. (1983) (NESNP)	Nationally representative sample of students in 276 public schools (1980-81)	Children and adolescents in grades 1-12 (n=6,556)	Participant vs. nonparticipant	Current weekly NSLP participation	Multivariate regression
West and Price (1976)	Students in schools/ districts in 8 regions in Washington State; Blacks and Mexican-Americans were oversampled (1972-73)	Children ages 8-12 (n=992)	Participant vs. nonparticipant	Value of free school lunches (dollars per month)	Multivariate regression. Separate models for Blacks, Whites, Mexican-Americans.

[1]Data sources:
NESNP = National Evaluation of School Nutrition Programs.
NHANES-I = First National Health and Nutrition Examination Survey.
PSID = Panel Study of Income Dynamics, Child Development Supplement.
[2]Study also examined physical fitness, school attendance, and academic performance.
[3]Study included a second district where both free lunch and free breakfast were offered. The two districts were considered separately in the analysis, but the analysis of the second district did not separate contributions of breakfast and lunch meals.
[4]Study compared intakes before and after introduction of a free lunch program. Results reported for four different subgroups based on baseline characteristics: nutritionally adequate, nutritionally needy, low-income (eligible for free lunch), and not low-income.
[5]Did not differentiate NLSP and other lunch programs.
[6]Participation measure not same week as expenditure measure; included NSLP and SBP in expenditures.

Table 31—Findings from studies that examined the impact of the National School Lunch Program on other nutrition and health outcomes

	Significant impact	No significant impact		Significant impact
Outcome	Participants higher	Participants higher/same	Participants lower	Participants lower
Weight and height				
Height		Wellisch (1983) [national] Emmons (1972) [1 district] Paige (1972) [4 schools] {grade 1} Gretzen (1980) [4 schools] {females}	Paige (1972) [4 schools] {grade 2, grade 6} Gretzen (1980) [4 schools] {males}	
Probability of underweight				Wellisch (1983) [national][1,2] Wolfe (1994) [1 State][3]
Weight	Wellisch (1983) [national] {older}	Gretzen (1980) [4 schools] Emmons (1972) [2 districts] {nutritionally needy; low income} Paige (1972) [4 schools] {grade 2}	Paige (1972) [4 schools] {grade 1, grade 6}	
Weight for height		Wellisch (1983) [national][1] Gretzen (1980) [4 schools]		Paige (1972) [4 schools] {grade 1}
Body Mass Index	Wolfe (1994) [1 State]			
Percent body fat[4]	Wellisch (1983) [national] {older} Wolfe (1994) [1 State]			
Probability of overweight/ overfatness	Wellisch (1983) [national] {older}[5]	Jones (2003) [national] {food-secure males}[6] Wolfe (1994) [1 State][7]	Jones (2003) [national] {food-insecure males and food-secure females}[6]	Jones (2003) [national] {food-insecure females}[6]

See notes at end of table.

Continued—

Table 31—Findings from studies that examined the impact of the National School Lunch Program on other nutrition and health outcomes—Continued

	Significant impact	No significant impact		Significant impact
Outcome	Participants higher	Participants higher/same	Participants lower	Participants lower
Nutritional biochemistries				
Hemoglobin		Emmons (1972) [2 districts][8]	Hoagland (1980) [national]	
Hematocrit		Emmons (1972) [2 districts][8] Paige (1972) [4 schools]	Hoagland (1980) [national]	
Composite growth and iron status variable			Paige (1972) [4 schools]	
Serum cholesterol		Hoagland (1980) [national]		Kandiah (2001)
LDL cholesterol				Kandiah (2001)

Notes: Cell entries show the senior author's name, the publication date, and the scope of the study (for example, national vs. 6 schools). Where findings pertain only to a specific subgroup rather than the entire study population, the cell entry also identifies the subgroup {in brackets}.

Nonsignificant results are reported in the interest of providing a comprehensive picture of the body of research. As noted in chapter 1, a consistent pattern of nonsignificant findings may indicate a true underlying effect, even though no single study's results would be interpreted in that way. Readers are cautioned to avoid the practice of "vote counting," or adding up all the studies with particular results. Because of differences in research design and other considerations, findings from some studies merit more consideration than others. The text discusses methodological limitations and emphasizes findings from the strongest studies.

Gretzen and Vermeersch (1980) also examined physical fitness, school attendance, and academic performance. No significant differences were found.

[1] Included only males age 11 and younger and females age 10 and younger.
[2] Based on weight for height <25th NCHS percentile.
[3] Based on arm fat area <10th percentile; results not significant using BMI.
[4] Based on measurements of triceps skinfold (Wellisch et al., 1983) or arm fat area (Wolfe et al., 1994).
[5] Based on weight for age and triceps fatfold > 75th NCHS percentile.
[6] Based on BMI >=85th percentile on CDC growth charts. CDS's definition for "at risk of overweight."
[7] Assessed using two measures: BMI >90th percentile and arm fat area > 90th percentile in NHANES I and II.
[8] Significance of differences not tested/not reported (samples too small).

fat). Participation was defined on the basis of children's average weekly participation from first grade through the current school year. The analysis, which did not control for selection bias, found that older participants weighed more and had greater mean triceps skinfold measurements than comparably aged nonparticipants. These findings are difficult to interpret, however, because the authors did not provide information on whether program participants were closer to age-standardized norms than nonparticipants (Rush, 1984). Thus, it is not clear whether the findings suggest a health benefit or risk. If, for example, children tended to be underweight for their age or stature, greater weight and fatness among participants could be considered a benefit. On the other hand, if children tended to be overweight for age or stature, these findings would not be considered beneficial.

A more recent study by Wolfe et al. (1994) obtained similar results and reported them in a more easily interpreted manner. The authors assessed the prevalence of overweight in elementary school children in New York State, using BMI and measures of triceps skinfold and arm fat area. Data were compared with national reference data for 1974 and 1980. NSLP participants were defined on the basis of a parent report that the child "eats school lunch." The authors concluded that overweight was a problem among elementary school students in New York State, and that students who ate the school lunch tended to be fatter than those who did not.

Wolfe and her colleagues made no attempt to assess or control for selection bias, a critical consideration in estimating the impact of a feeding program on weight status. Thus, these results indicate that NSLP participants in New York State were more overweight than nonparticipants. They do not, however, indicate that these differences are the result of NSLP participation. It is possible, for example, that overweight children chose to participate in the NSLP more often than nonoverweight children.

A recent study by Jones et al. (2003) looked at the relationship between food security, participation in FANPs, including the NSLP, and the risk of overweight. The authors used data from the 1997 Panel Study of Income Dynamics (PSID) Child Development Supplement to examine the risk of overweight among children ages 5-12 in low-income households (income $\leq$185 percent of poverty). Risk of overweight was defined as BMI at or above the 85th percentile. This cutoff is routinely used to identify children who are considered to be "at risk" of becoming overweight (CDC, 2003). As used by Jones et al. (2003), it also includes children who are considered to be overweight (BMI at or above the 95th percentile) (CDC, 2003). Weights were reported by primary caregivers and heights were measured by field interviewers. The authors indicate that approximately 86 percent of the children had been weighed within the preceding month and that 16 percent of caregivers had to estimate weight because they had no recent reference point.

The analysis assessed the likelihood of being at risk of becoming overweight among children living in food-secure and food-insecure households, while controlling for participation in a number of FANPs and other relevant characteristics. Results showed that NSLP participation did not affect the likelihood that males would be at risk of becoming overweight, regardless of whether they lived in food-secure or food-insecure households. The likelihood of being at risk of becoming overweight was also unaffected by NSLP participation status among females in food-secure households. Among females in food-insecure households, however, those who participated in the NSLP had 71-percent reduced odds of being at risk of becoming overweight, compared with those who did not participate. The authors offer no explanation for the apparent protective effect of NSLP participation among food-insecure females and suggest that more research is needed to understand the relationship between income, food security, FANP participation, and weight status.

It is doubtful that cross-sectional studies can adequately address questions about program impacts on children's weight and height. Indeed, researchers who attempted to assess the impact of the WIC program on these outcomes concluded that a longitudinal study with serial measurements was essential (Puma et al., 1991).

Nutritional Biochemistries

Four of the studies identified in the literature search examined impacts of the NSLP on nutritional biochemistries. Researchers examined measures of iron status (hemoglobin and/or hematocrit) and/or cholesterol levels. Only Hoagland (1980) used a national dataset in assessing these outcomes. The three smaller, local studies used the "participants, before vs. after" design (essentially a longitudinal design with a single followup measurement), which is preferable to the "participant vs. nonparticipant" design for assessing impacts on biological variables. With the exception of the recent study by Kandiah and Peterson (2001), studies are based on data from the 1970s. None of the studies reported a significant NSLP effect.

Iron

Analyzing children's hemoglobin and hematocrit values from NHANES-I, Hoagland (1980) found no significant differences between NSLP participants and nonparticipants. Working with a sample of children from four schools in Baltimore, Paige (1972) found no effects on hematocrit levels or on a composite variable that reflected both growth status and iron status. Emmons and colleagues (1972) found so few students with low iron status that they did not test the significance of differences between groups.

Cholesterol

Hoagland (1980) also used NHANES-I data to assess children's cholesterol levels. He found no significant difference between NSLP participants and nonparticipants. In the same analysis, Hoagland attempted to look for differences in biochemical indicators of protein-calorie malnutrition. Finding no abnormal levels of serum albumin in the sample, however, he concluded that these measures were not useful for assessing NSLP health impacts.

Kandiah and Peterson (2001) examined total cholesterol and LDL cholesterol levels in a group of 30 children and adolescents ages 11-15. The sample was limited to students who ate NSLP meals at least three times per week. Baseline levels were compared with followup levels measured 4 months later. Results showed that both total cholesterol and LDL cholesterol levels decreased significantly over the 4-month period. This was true for students who ate NSLP lunches as well as those who ate both breakfast and lunch. Rather than attribute these changes to a positive impact of the NSLP, the authors concluded that changes in cholesterol levels over time were due to hormonal fluctuations associated with puberty. No information was provided on the protocol used in collecting students' blood samples (for example, whether students were fasting when bloods were drawn and for what period of time) or on the reliability of the measures obtained.

Household Food Expenditures

Assessment of household food expenditures can provide information on the extent to which receipt of NSLP meal benefits increases the value of food available to families.[92] Potentially, the NSLP meal benefit will be an addition to total household food expenditures. However, its value may be partly offset if the household reduces some food expenditures because of the availability of the subsidized lunch—if, for example, money that would have been spent to purchase lunch for the student is applied to nonfood uses.

Two of the three studies that examined impacts on household food expenditures were based on data collected for the NESNP. Wellisch and her colleagues (1983) reported a dollar-for-dollar increase in the value of food available to participating households as a result of participation in the NSLP. Long (1991) reanalyzed the NESNP data, using only the sample of students who attended schools that offered the NSLP and adjusting for selection bias, and obtained somewhat different results. She found that the overall impact of NSLP participation was to increase household food expenditures, but she estimated that each additional NSLP benefit dollar reduced other food expenditures by about $0.61, for a net addition of $0.39 to the value of food expenditures on behalf of the household. Long's results were comparable to those of West and Price (1976), who evaluated the impact of free school lunches on household food expenditures for a sample of children ages 8-12 in Washington State.

West and Price (1976) and Wellisch et al. (1983) both found somewhat larger supplementation effects for Black than White households. Supplementation was also somewhat greater for Hispanic households, but the effect was not statistically significant. Long's reanalysis of the NESNP data did not include subgroup analyses.

Summary

The body of research reviewed in this chapter indicates that, prior to implementation of the SMI, the NSLP had a significant impact on the dietary intake of school-age children and adolescents. There is strong evidence that the program increased children's intakes of selected vitamins and minerals at lunch (vitamin B_{12}, riboflavin, calcium, phosphorus, magnesium, and zinc), and the strongest available evidence suggests that these effects persisted over 24 hours. Because of limitations in the dietary assessment methodologies used, it is not possible to determine whether NSLP participants were more likely than nonparticipants to have adequate intakes of these vitamins and minerals.

There is also convincing evidence that, prior to the SMI, NSLP participants consumed less carbohydrate and more fat and saturated fat (as a percentage of total

[92] Food expenditure data have also been used to evaluate the success of the NSLP in meeting its second objective: encouraging the consumption of domestic agricultural products. The program is considered efficient in meeting its agricultural support goals if most of the NSLP subsidy is spent on food and little is diverted to nonfood expenditures (Radzikowski and Gale, 1984).

food energy) than nonparticipants, both at lunch and over 24 hours. The strongest available evidence suggests that the difference in carbohydrate intake was due to decreased consumption of added sugars among NSLP participants.

Finally, the available evidence indicates that, prior to the SMI, NSLP participation had no significant effect on intake of sodium or cholesterol. NSLP participation was associated, however, with a significantly greater intake of dietary fiber, both at lunch and over 24 hours.

Evidence from the SNDA-II study demonstrates that, even in the early stages of the SMI, schools had made significant progress in decreasing the fat and saturated fat content of school lunches and in increasing the carbohydrate content. Since SNDA-II data were collected (the 1998-99 school year), efforts have continued at the Federal, State, and local levels to make school lunches consistent with SMI standards for these nutrients. In addition, there has been increased emphasis on nutrition education for school-age children to promote acceptance and consumption of healthier school meals.

Consequently, the current impact of the NSLP on students' intakes of total fat, saturated fat, and carbohydrates is unknown and can only be answered with new research. The same can be said of the program's impacts on vitamin and mineral intakes. However, evidence from SNDA-II suggests that changes in the macronutrient profile of school lunches has been achieved without compromising overall vitamin and mineral content. In fact, lunches offered in 1998-99 provided significantly greater amounts of vitamin A, vitamin C, calcium, and iron than lunches offered in 1991-92.

With the exception of impacts on household food expenditures, the existing evidence is too limited to support conclusions about whether NSLP participation affects other nutrition- and health-related outcomes. There is limited, but reasonably strong, evidence that NSLP participation increases total household food expenditures. However, the available data are quite dated (the most recent were collected in the early 1980s).

Clearly, there is a critical need for an updated study of the NSLP and its impacts on children. To provide a comprehensive picture of how the NSLP influences children's food and nutrient intakes, future studies will need to differentiate between the multiple sources of foods and beverages available at school (reimbursable meals, a la carte purchases, vending machines, snack bars, etc.).

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