

Plate Waste in School Nutrition Programs

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Abstract

This report fulfills a request by the House of Representatives Committee on Appropriations (H.R. 106-619). USDA's Economic Research Service (ERS) reviewed the literature on plate waste in school nutrition programs, particularly the National School Lunch Program (NSLP), to determine the level of plate waste in these programs, factors that contribute to plate waste, and strategies that may reduce waste. The best national estimate available indicates that about 12 percent of calories from food served to students under the NSLP go uneaten. The estimate is derived from a large, nationally representative study conducted in 1991-92 and, therefore, may not reflect current conditions in schools. Some plate waste is inevitable. Nevertheless, reducing plate waste could make program operations more efficient and lower costs. Possible causes of plate waste include wide variation in student appetites and energy needs, differences between meals served and student preferences, scheduling constraints that interfere with meal consumption or result in meals being served when children are less hungry, and availability of substitute foods from competing sources. The review identified possible strategies for reducing plate waste, such as using the offer versus serve provision for meal service, rescheduling lunch hours, improving the quality and condition of food, tailoring serving sizes to student appetites via self-service, and providing nutrition education.

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Summary

The U.S. Department of Agriculture's (USDA) school nutrition programs include the National School Lunch Program (NSLP) and the School Breakfast Program (SBP). Average participation on a typical school day is 27 million children in the NSLP, at an annual cost to USDA of \$6.2 billion, and 7.6 million children in the SBP, at a cost of about \$1.4 billion (FY 2000). Because of the importance of the programs to school children's diets and because of the programs' magnitude, interest continues in how well the programs operate. Plate waste is a direct measure of efficiency of program operations that has been used in a number of studies. Plate waste is generally defined as the quantity of edible portions of food served that is uneaten and is a common reason for food loss at the consumer and foodservice levels. While some plate waste is unavoidable, excessive waste may be a sign of inefficient operations and an unresponsive delivery system.

This report fulfills a request by the House of Representatives Committee on Appropriations (H. R. 106-619). USDA's Economic Research Service (ERS) reviewed the literature on plate waste in school nutrition programs to determine the level of plate waste in these programs, factors that contribute to plate waste, and strategies that may reduce waste. This review concentrates on studies of the NSLP because it is the largest, most widely available school nutrition program and has been more extensively and rigorously studied than other school nutrition programs.

Based on this review, the best national estimate available indicates that approximately 12 percent of calories from food served to students in the NSLP goes uneaten. The estimate is derived from a large, nationally representative study conducted in 1991-92 and thus this estimate may not reflect current conditions in schools. In addition, plate waste in any particular school or district may differ substantially from the national average due to local circumstances and operating conditions. Although there is no agreed-upon standard by which to judge an acceptable level of plate waste, estimates of typical levels of food waste at the consumer level suggest that the 12-percent estimate of plate waste in the NSLP is not excessive. Still, efforts to reduce waste would yield benefits in terms of operational efficiency. Decreasing excessive waste, particu-

larly of foods such as fruits and vegetables, which are underconsumed by American children in comparison to Federal dietary recommendations, would also contribute to effective delivery of program benefits. Nutritious, balanced meals during childhood may (1) provide immediate benefits in terms of children's health, well-being, and academic achievement, (2) better fulfill children's nutrition needs during critical periods of growth and maturation, and (3) reduce risk factors for chronic disease in later life. Also, good eating habits learned early in life may carry over into adulthood.

Possible causes of plate waste may include wide variation in student appetites and energy needs, differences between meals served and student preferences, scheduling constraints that interfere with meal consumption or result in meals being served when children are less hungry, and availability of substitute foods from competing sources.

As requested, ERS examined the evidence that several strategies may reduce plate waste, including the offer vs. serve provision, rescheduling of lunch hours, and improving the quality of the food. The offer vs. serve provision, in which students have some choice of lunch foods, can decrease plate waste while maintaining nutritional benefits. This provision is now mandatory in high schools; it has also become the most common style of meal service in middle and elementary schools. Scheduling recess before lunch in elementary schools also decreases plate waste, but national data from the U.S. Centers for Disease Control and Prevention (CDC) indicate that elementary schools are most likely to schedule lunch before recess. Improving the quality, appearance, and/or acceptability of foods may also be useful, but the effects on plate waste are not well documented in the literature. Other strategies, such as tailoring serving sizes to student appetites via self-service, and nutrition education tailored to cafeteria offerings, may also be useful in reducing plate waste, and there is some evidence of their success.

Most plate waste studies predate major changes in the school foodservice environment between 1996 and the present. Among the most important are the implementation of USDA's School Meal Initiative, the increase in sale of foods and beverages not part of the school nutrition programs, and the trend toward greater use of pre-prepared foods. However, we have no information on the effects of these changes.

Plate Waste in School Nutrition Programs

Report to Congress

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Introduction

This report fulfills a request to the U.S. Department of Agriculture (USDA) from the House of Representatives Appropriations Committee Report of the 106th Congress (H.R. 106-619). The request included the following statement:

The Committee directs the Department to conduct a study of plate waste in the school nutrition programs and the factors associated with it, including “offer vs. serve” in both elementary and secondary schools, scheduling of lunch hours (are they too short, are there competing activities that interfere with lunch time e.g. recreation time after a meal versus before a meal), quality and condition of food.

Time constraints precluded the collection of new data for this study. Therefore, we reviewed the existing literature on the subject, much of which predates recent changes in the programs.

Definition of Plate Waste

In this study, plate waste is defined as the quantity of edible portions of food served through USDA school nutrition programs, such as the National School Lunch Program (NSLP), that students discard each year. As detailed in Appendix A, plate waste has been assessed by a variety of methodologies and expressed in varying terms—as the proportion of food served that is uneaten, amount of calories uneaten, or amount of nutrients uneaten.

Plate waste is a common reason for food loss at the consumer and foodservice level (Kantor et al., 1997). Given both individual and day-to-day variations in appetite and energy needs and in tastes and preferences, it is unreasonable to expect that plate waste could be completely eliminated in any foodservice

setting. School meal programs may face special challenges to minimizing waste, such as school scheduling constraints that interfere with meal consumption or result in serving meals when children are less hungry, the difficulty in adapting meals to widely varying student energy needs and preferences, and availability of substitute foods from competing sources. However, lowering plate waste promotes efficient program management; excessive plate waste may jeopardize full realization of the nutritional benefits of school meals.

There is no agreed-upon standard by which to judge an acceptable level of plate waste (USGAO, May 1996). Kantor et al. (1997) estimated that food waste at the commercial foodservice and household level accounted for 26 percent of edible food supplies. This figure includes not just plate waste but also any losses before food is served (for example, food that spoils while stored or that is never served). USDA’s Center for Nutrition Policy and Promotion (CNPP) prepares Food Plans that suggest market baskets of food that provide a nutritious diet. Food Plans are calculated at four different price levels: Thrifty, Low Cost, Moderate, and Liberal. The Thrifty Food Plan market basket is used to update food costs for the Food Stamp Program. As part of the calculation of food amounts for the market basket, CNPP incorporates estimates of overall household food waste (again, these include storage losses). These estimates of household waste vary across plans: 5 percent for the Thrifty Food Plan, 10 percent for the Low Cost, 20 percent for the Moderate, and 30 percent for the Liberal (Carlson, 2001). While these figures give some perspective on typical levels of food waste at the consumer level, none of them are estimates of plate waste only. One small study of the home-delivered meal program for seniors indicated that 19 percent of the meal went uneaten (Fogler-Levitt et al., 1995); however, this is a very different program and target audience. Therefore,

the ability to apply this finding to school meals is questionable.

Plate Waste Findings

Our analysis of the past 15 years of literature on plate waste in the NSLP yielded some general findings:

- The School Nutrition Dietary Assessment Study-I (SNDA-I) (school year (SY) 1991-92), a nationwide study, found that NSLP participants waste about 12 percent of the calories in the food that they are served (Burghardt and Devaney, 1993; Devaney et al., 1995). According to Devaney et al., the most comprehensive measure of plate waste is the percentage of total food energy content (calories) selected but not consumed. Plate waste estimates from smaller studies range from 10 to 37 percent, probably indicating both local variation in plate waste and the effects of methodological differences in the studies (USDA, 1992; Reger et al., 1996).
- Girls tend to waste more food and nutrients than do boys (Bark, 1998; Devaney et al., 1995; Reger et al., 1996; USGAO, May 1996).
- Younger children tend to waste a higher proportion of their food and nutrients than do older children (USGAO, May 1996; Dillon and Lane, 1989).
- Plate waste varies by food type, with salad, vegetables, and fruit generally reported to be the most wasted items (Bark, 1998; Reger et al., 1996; USGAO, July 1996; USDA/FNS, 1992; Robichaux and Adams, 1985). Although the nationally representative SNDA-I study found little difference in the percentage wasted of most nutrients, folate, a vitamin found primarily in fresh vegetables and fruit, had the highest waste, at 15 percent (Devaney et al., 1995). This is consistent with the food categories generally reported to be most wasted.

Cost of Plate Waste

No one has estimated the economic costs of plate waste. A simple way to do this is to multiply the plate waste estimate of 12 percent calories from food by \$5.49 billion, the portion of the \$6.2 billion NSLP allocation for fiscal year (FY) 2000 that went to cash payments for meals. This method does not adjust for differences in costs of food items wasted (e.g., more

expensive entrees vs. less expensive side dishes) because these data are not available. The method also assumes that the economic costs of plate waste include the overhead and labor costs of preparing and serving the meals. This simple methodology yields an annual cost of plate waste in the NSLP of over \$600 million. This estimate does not include the costs of the Federal share of State administrative expenses, any wasted commodity entitlements or bonus food, or the private costs of wasted foods purchased by students under the NSLP program. Also, the estimate does not include the value of lost nutrition and health benefits.

Nutrition Benefits of School Meals

In addition to the direct loss of food, plate waste may reduce benefits that children can receive from the NSLP. Healthful eating and regular physical activity help in optimizing physical and cognitive development, maintaining a healthful weight, and reducing risk of some chronic diseases (Johnson and Nicklas, 1999). Because of the large number of school meals served and the considerable contribution of school meals to the diets of school children, school nutrition programs could affect whether children fully obtain these benefits. The benefits of school meals to children may include: (1) immediately improved nutrition, health, and well-being; (2) promotion of healthy growth and development; (3) protection against diseases and chronic health conditions; and (4) development of good eating habits that may be carried through to adulthood. Of course, strategies for reducing plate waste must be careful not to encourage children to eat more than needed, hence promoting obesity. Approaches to plate waste reduction that seem to address this concern are those that emphasize increasing meal flexibility, such as using the offer vs. serve provision for meal service or using strategies to tailor portion sizes to appetites and needs.

Strategies for Reducing Plate Waste

Offer vs. Serve Provision

Research indicates that the offer vs. serve (OVS) provision for meal service (see box), if well-implemented, can decrease plate waste and improve acceptance of nutritious foods (Allaway, 1994). The OVS provision encourages children to make selections of the foods

they prefer. In many schools, its implementation has been coupled with strategies, allowed under other FNS regulations, to tailor serving portions to children's appetites (e.g., self-service bars).¹ As implemented in some school districts (Allaway, 1994; Oregon Department of Education, undated; Martin, 1996), the OVS provision has increased fruit and vegetable consumption, probably by offering more choices.

Although local foodservice authorities have flexibility in how they plan menus to meet Federal nutritional guidelines (see box), NSLP schools serving lunch to senior high school children are required to implement the OVS provision. Local school food authorities may choose to adopt the OVS provision in the lunch program for lower grades as well (that is, elementary, junior high, and middle schools) (USDA/FNS, May 4, 1998). The OVS provision has become standard in junior high and middle schools and is also offered in most elementary schools (around 90 percent as of SY 1997/98) (USDA/FNS, Oct. 2000).

Rescheduling Lunch

Rescheduling lunch so that it follows recess is one strategy that has been shown to reduce plate waste, increase cost savings of the NSLP, and increase the benefits that children receive from the NSLP (Getlinger et al., 1996; Ruppenthal and Hogue, 1977; Ruppenthal, 1978). However, national data from the U.S. Centers for Disease Control and Prevention's (CDC) School Health Policies and Procedures Survey (SHPPS) 2000 indicate that elementary schools are most likely to schedule lunch before recess. Although 96.9 percent of elementary schools provide recess for at least one grade of students, only 18.2 percent of schools schedule recess for half or more of participating classes before lunch (Wechsler et al., 2001).

Adequate time to eat the school meal has also been raised as an issue. In a survey of public school cafeteria managers concerning plate waste in the NSLP, 44 percent reported "not enough time to eat" to be a possible reason for plate waste (USGAO, July 1996). The literature suggests that in most cases children have adequate time to eat their lunches (Sánchez et al., 1999; Rodgers et al., 1999). A study sponsored by the

¹ Self-service and other strategies for tailoring portion size to children's appetites and needs are also permitted in schools that do not elect the OVS provision and appear to reduce plate waste. For more information, see our discussion, "Tailoring Portion Sizes to Appetite," page 5 of this report.

Systems for School Menu Planning and Implementing Offer Versus Serve

Current program regulations allow schools to choose one of five standard systems for their menu planning: (1) Nutrient Standard Menu Planning (NSMP or "NuMenus"), (2) Assisted Nutrient Standard Menu Planning (ASNP or "assisted NuMenus"), (3) the traditional meal pattern, (4) the enhanced meal pattern, and (5) any reasonable approach. Both of the nutrient-based approaches (NSMP and Assisted NSMP) base their planning on a computerized nutritional analysis of the week's menu. The food-based approaches (traditional and enhanced meal pattern options) base their menu planning on minimum component quantities of meat or meat alternate; vegetables and fruits; grains and breads; and milk. Under the "any reasonable approach" option, schools and State agencies may also develop their own alternate approach to menu planning under guidelines established in the regulations.

The OVS provision is implemented somewhat differently in schools using nutrient-based approaches and those using food-based approaches. Under the OVS provision in schools that use the nutrient standard meal planning systems, students must select at least two menu items, one of which must be an entree, and may decline a maximum of two menu items. Under the OVS provision, children in schools that use the food-based menu planning systems must take a full portion of at least three of the five USDA meal pattern items offered in order to get a reimbursable lunch, although they are encouraged to take all five items. Schools that do not implement OVS must serve the complete meal to all students.

National Food Service Management Institute found a small number of cases in junior and senior high schools in which long waiting lines resulted in students having less than 10 minutes to eat (Sánchez et al., 1999). However, effects on plate waste were not assessed.

Lunches that are served very early or very late may also have an impact on plate waste. In a survey of NSLP cafeteria managers (USGAO, July 1996), 42 percent said that one reason for plate waste is that children are "not hungry." Although not specified in this USGAO report, one explanation for children not being hungry at lunch time may well be that lunch was scheduled too early (that is, too soon after breakfast). Dillon and Lane (1989) suggest that delaying

some of the earlier lunch periods might reduce the volume of plate waste. On the other hand, lunch that is scheduled “very late” may increase plate waste if students have access to alternate foods, such as items from vending machines and snack bars or food brought from home. However, only a minority of NSLP cafeteria managers who responded to the survey felt that changing lunch schedules would have an impact on plate waste (USGAO, July 1996). More direct measures of the effects of such changes on plate waste are not available.

Concerns also have been raised about other school scheduling decisions that may discourage children from eating school meals—for example, scheduling competing activities such as club meetings, pep rallies, etc., and block scheduling² of classes and activities (Cline and White, 2000; USDA, 2001a). However, data on the impacts of these school-scheduling decisions on plate waste are not available.

Improving Quality and/or Acceptance of NSLP Food

The ERS literature review uncovered four strategies currently being used to improve the quality, appearance, and/or acceptance of NSLP food:

- **Improving the Selection of Commodities Donated by USDA.** USDA makes commodity food products available to all schools participating in the Federal school meal programs; therefore, commodity improvement potentially benefits all programs. While commodities are generally viewed favorably by NSLP cafeteria managers (USGAO, July 1996), USDA has devoted considerable effort in recent years to further improving the nutritional profile and acceptability of the commodity foods. A small study of the effects of one commodity improvement—increasing the amount of fresh fruits and vegetables made available to schools—indicated that it may be helpful in decreasing plate waste (Ryan et al., 2000). Unfortunately, weaknesses in the study design make it impossible to make firm conclusions. Effects of other changes in commodities on plate waste have not been studied.

² A class-scheduling system, which varies by school, often consists of five daily patterns of classes that may move to different days from one week to the next. Overall, it is less amenable to scheduling changes than more traditional systems.

- **Increasing the Use of Produce and Local Foods.** Some schools are incorporating more fresh produce and local foods into school meal offerings. Case studies of schools that have developed “farm-to-school” programs indicate that such foods may increase participation in school meals and consumption of salad and other vegetables (the food categories most likely to be wasted). However, since this strategy may require changes in operating and purchasing procedures, it may be costly to implement (Azuma and Fisher, 2001).
- **Using Commercial Foodservice Companies and/or Their Products.** An increasing number of schools that participate in the NSLP are using commercial foodservice companies to plan, prepare, and serve school meals (USGAO, August 1996). Although school food authorities who use food service management companies appear to do so primarily for financial reasons, 26 percent of those responding to a USGAO survey indicated that “increasing the nutritional value of meals” was also a motive. Use of branded fast-food items has been cited by cafeteria managers as a strategy for decreasing waste, presumably by increasing acceptance (USGAO, July 1996). A USGAO survey of cafeteria managers indicated that an estimated 13 percent of public schools participating in the NSLP during SY 1995-96 decided to offer fast foods as part of the USDA school meal, up from 2 percent in SY 1990-91.

Use of foodservice management companies by school food authorities is allowed by USDA regulations; however, USDA leaves the decision whether to do so up to local authorities. Similarly, use of brand-name foods, including fast foods, in NSLP and SBP meals is a decision USDA regulations allow local school food authorities to make. Meals including these items, however, must comply with the same nutritional standards as all NSLP and SBP meals. There are no data on the effects of these strategies on plate waste, and their inclusion in this list is not an endorsement. Given their increasing popularity, however, their effects on plate waste and nutritional quality of meals may merit further study.

- **Increasing Student Input.** Student advisory groups offer one way to create improved menus that are acceptable to students, which would likely have some impact on reducing plate waste. All schools have the potential to use such advisory groups, and

USDA regulations encourage school food authorities to involve students—as well as parents—in their programs (7 CFR Ch.II, 210.12 (1-1-00 Edition)). Some schools already have advisory committees: the American School Foodservice Association (ASFSFA) promotes Nutrition Advisory Councils, which it describes as “school clubs that bring students together” and, by involving students, “reinforce the idea that school nutrition programs are for them.” ASFSFA reports that 365 schools nationwide have Nutrition Advisory Councils chartered with ASFSFA (Montague, 2001). This likely underestimates the prevalence of this strategy since many advisory groups operate independently of the ASFSFA program.

Although all these strategies appear to have the potential to reduce plate waste, their effects on waste are unknown.

Other Strategies for Decreasing Plate Waste

Other means besides those mentioned by Congress have been suggested to decrease plate waste. Two additional strategies for which there is evidence of success are nutrition education and increased tailoring of portion size to students’ appetites and needs.

Nutrition Education

This has been cited as a means for improving children’s diets and promoting acceptance of healthful menu items, particularly when coordinated with food-service activities. Liquori et al. (1998) found that a nutrition education program that involved school children in preparing and tasting foods later served in the school cafeteria was associated with decreased plate waste. Although this was a small local program that might not generalize to the Nation as a whole, these results indicate that nutrition education may be a useful strategy for decreasing plate waste.

Tailoring Portion Sizes to Appetite and Needs

Since individual variation in appetite and energy needs is undoubtedly a reason for plate waste, tailoring portion sizes more closely to children’s needs seems likely to decrease plate waste. Under current regulations, two strategies are available to schools for closer tailoring of portion sizes to appetites and needs. The

first is increased customization of serving sizes, which is allowed when schools use nutrient-based meal planning approaches. The second is to allow students to serve themselves (self-service).

Customization of Serving Sizes. USDA’s Food and Nutrition Service sets minimum required serving sizes for children in each of several age/grade categories to whom school meals are served.³ However, when a nutrient-based meal planning approach is used (see box for details), customizing serving sizes for more narrowly defined age groups is allowed as an option. Results of the School Meals Initiative (SMI) Year 1 Implementation Study (USDA/FNS, October 2000) indicate that a larger proportion of the school food services using nutrient-based approaches to meal planning reported that plate waste had decreased compared with those who used food-based approaches. This may be attributable to differences between school districts other than their menu-planning approach. Further investigation would be necessary to establish whether the nutrient-based approach was superior in controlling plate waste, as well as to what extent its benefits could be attributable to customizing portion sizes.

Self-Service. All schools participating in USDA School Meal Programs have the option of allowing students to serve themselves—for example, via self-service bars. In one study of elementary school children in Louisiana, Kerfoot and Fournet (1996) found that use of self-service bars for fruits and vegetables resulted in increased consumption of these foods and decreased plate waste.

Limitations of the Study

In this study, ERS synthesized findings from studies of plate waste in schools participating in the NSLP. The study reviewed factors that may be associated with increased or decreased plate waste, including the effects of (1) using the offer vs. serve provision in meal service, (2) recess scheduling and other meal-scheduling issues, (3) quality and/or acceptance of food, (4) nutrition education, and (5) tailoring portion sizes to appetites and needs. Although there is a consistent body of research on the positive effects on reducing plate waste of the offer vs. serve provision and of scheduling recess before lunch, there is no

³ For example, in the enhanced food-based plan, the age/grade categories are grades K-6 and 7-12, with K-3 as an option.

comparable body of research literature concerning the effects of the other factors. There is some evidence that nutrition education may reduce plate waste, particularly when coupled with exposure to (“tasting”) foods served in the school cafeteria. Strategies for tailoring portion sizes to children’s appetites and needs, such as self-service, also may decrease plate waste without reducing nutritional benefits.

Finally, most plate waste studies predate major changes in the school foodservice environment between 1996 and the present. Among the most important of these are (1) the implementation of USDA’s School Meal Initiative, which modernized the nutritional guidelines for the school meal program and promoted increased nutrition education in schools, and (2) the increase in sale of foods and beverages not part of the Federal school meal programs (“competing foods”). Another issue that has been raised is the trend in school foodservice toward more use of pre-prepared items versus items prepared in the cafeteria kitchen and the potential effects that this has on quality and acceptance of NSLP meals (Azuma and Fisher, 2001).

Conclusions

After reviewing the literature, we conclude that the best available data indicate that approximately 12 percent of calories from foods served as part of the NSLP are wasted, resulting in a direct economic loss of over \$600 million. Plate waste is ubiquitous and unavoidable; a review of data on household and commercial food waste indicate that the amount of food wasted under the NSLP is within the normal range. Nevertheless, to the extent that plate waste can be lowered, this can make program operations more efficient and lower costs. It can also contribute to the program’s success in meeting nutrition objectives. Given the importance of nutrition to learning, productivity, and lifetime health, the failure to meet those objectives may carry greater economic costs than the direct cost of uneaten food.

The offer vs. serve provision is one strategy widely used in schools and may decrease plate waste while maintaining nutritional benefits. However, since it is now used in more than 90 percent of schools, there may be limited opportunity for further improvement using this strategy. For elementary schools, scheduling lunch after recess can also decrease waste. Other strategies, such as nutrition education, expanded use of self-service and customization of portion sizes, and improvement of quality, appearance, and acceptability of foods, may also be useful.

The term plate waste is used mainly in two ways. First, it is an operational term that refers to the volume or percentage of NSLP food that children discard. This information can be used by cafeteria managers and others when deciding what and how much food to order and prepare. Second, the term refers to a set of measurement techniques or methods that use the volume or percentage of plate waste as a marker or benchmark to judge how well certain goals are being reached. These goals may be to determine how well students accept specific low-fat foods over traditional foods or how well they accept NSLP meals in general.

Plate waste in children's school lunches has traditionally been measured via one of three methods: (1) physical measurements (such as weighing discarded food), (2) visual estimates made by trained observers, and (3) food consumption as recalled by children. The three subsections present some of the existing research on children's plate waste by these three measurement techniques. The first method is a direct measure and the latter two are indirect methods (see Comstock et al., 1979, for a more detailed description of the methods).

Physical Measurement of Plate Waste

In general, under this method, a randomly selected set of school lunch trays are taken from the serving line and the edible food items are weighed. Later, after the children have finished eating, the leftovers of each edible food item are weighed. To simplify and speed the data collection, some studies use a mean of the weight for a typical serving size instead of weighing each individual pre-meal serving. Other studies use an aggregate plate waste measure such as one that is taken across school children (waste weighed together for all children, called *aggregate nonselective plate waste*) or across individual food items (waste separated by food category, known as *aggregate selective plate waste*). Whatever the actual procedure, the final plate waste data are generally calculated in terms of the percentage of food that was not consumed:

Percent waste = (Edible waste weight / weight of mean serving size of edible food) * 100.

The primary advantage of this method is that it can provide detailed and accurate plate waste information.

Disadvantages are that it is costly and time consuming, requires space to hold the trays until the food is weighed, and is impractical for samples of over 50-100 children (Comstock et al., 1980).

One example of a plate waste study that used physical measurements was a 1997 study conducted in nine elementary schools in Montana that participated in the NSLP (Bark, 1998). The study found that of the calories and nutrients served in these schools, roughly 25 to 30 percent were wasted. Vegetables were the food item with the greatest waste (42 percent). Overall, girls wasted more food than boys, and students in kindergarten through third grade wasted more vegetables, milk, desserts, and breads and grains than did students in fourth through sixth grade.

Visual Estimates by Trained Observers

Under this method, the observers make judgments about the proportion of average serving sizes that remain on the discarded school lunch trays. For example, observers can use a five-point scale on the proportion of food discarded (e.g., all, 3/4, 1/2, 1/4 or less, none) (Comstock et al., 1980). The advantages of this method include space savings and, arguably, time savings. It is also cleaner and may require fewer people than direct plate waste measures (Comstock et al., 1979). In general, food sharing and spillage may complicate the measurement of plate waste to some extent, though trained observers may be able to estimate and record this slippage (Reger et al., 1996). The primary disadvantage is that the ratings are not made on exact proportions.

A child nutrition study by Abt Associates Inc. for FNS included a plate waste subanalysis of the NSLP (USDA, 1992). Onsite observations at 60 schools (12 children per school) in 20 school foodservice authorities (SFA) were conducted over 5 consecutive days during 1991-92. Results indicate that middle/secondary school students consumed almost 90 percent of their meals, whereas elementary school students wasted more, consuming about 75 percent. Salads, rolls, and milk (in descending order) were wasted more by elementary students than by students in the higher levels.

Reger et al. (1996) assessed plate waste in the NSLP using information from 248 African-American children (50 percent boys), in grades three to six, in a low socioeconomic elementary school in New Orleans in 1993. Two trained observers visually estimated plate waste using a six-point scale. Although boys and girls selected the same number of menu items, girls wasted significantly more of the vegetable servings ($p < 0.01$). Contrary to results in some other studies, this study found that older students (fifth and sixth grades) tended to waste more than younger students (third and fourth grades). Overall, plate waste was roughly 37 percent in this sample, which is relatively high compared with estimates found in other plate waste studies. When observing mean plate waste by food item, salad scored highest (63.4 percent) followed by vegetables (54.3 percent, excluding potatoes) and bread (54.2 percent).

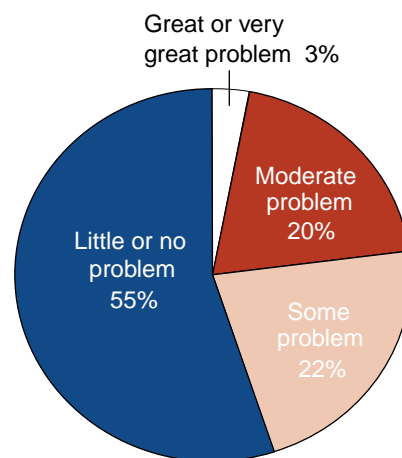
The visual monitoring method has also been used in intervention studies that evaluate the impacts of modifications in school lunch meals. Some examples include analysis of school intervention to switch to reduced-fat entrées (Snyder et al., 1996) and lower fat and higher fiber breakfast foods (Hurd-Crixell and Friedman, 1999).

A related method surveys other professionals, such as cafeteria managers, who are knowledgeable about children's school lunches and have made informal visual observations about plate waste. For example, a General Accounting Office (USGAO) study surveyed a random sample of 2,450 public school cafeteria managers about plate waste in the NSLP during the 1995-96 school year (USGAO, July 1996). Of those surveyed, 80 percent responded (1,967). And of the 90 percent of cafeteria managers who provided an opinion on the extent of plate waste in NSLP, 55 percent perceived it as "little or no problem," 22 percent perceived it as "some problem," and 23 percent believed that it was at least a moderate problem (fig. 1).

Cafeteria managers at elementary schools were more likely to report that plate waste was at least a moderate problem than were the managers at middle or high schools. There were no statistical differences in managers' perception of plate waste by school location or by schools serving different shares of free and reduced-price lunches.

Managers reported that plate waste varied by food type (fig. 2). The estimated average amount of food wasted

Figure 1
Extent to which cafeteria managers perceived plate waste from school lunches as a problem in their school, 1995-96 school year



Note: This figure is based on the responses of the 90 percent of the cafeteria managers who had an opinion on the extent to which plate waste from school lunches was a problem in their school. The remaining 10 percent did not know whether plate waste was a problem.

Source: GAO's analysis of survey data, July 1996.

ranged from 11 percent for milk to 42 percent for cooked vegetables. For each food type, reported waste was highest in elementary schools.

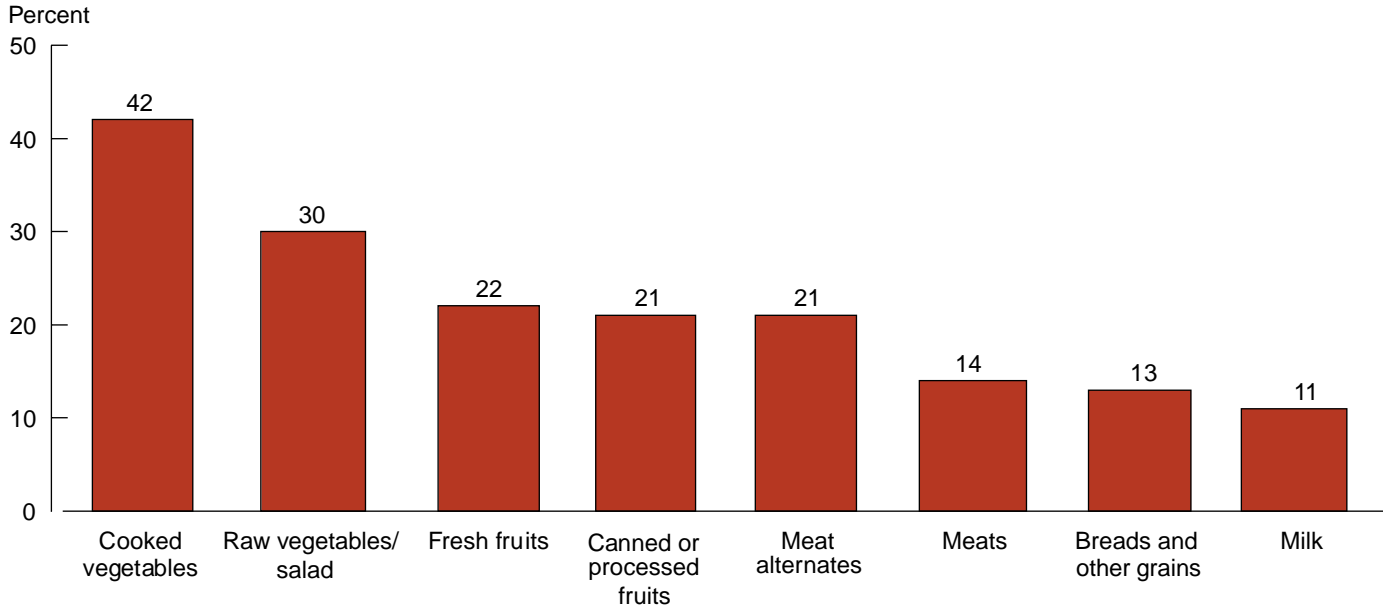
When responding to a list of nine possible reasons for plate waste in their schools, 78 percent of cafeteria managers selected "attention on recess, free time, and socializing," 65 percent selected "do not like that food," 50 percent selected "do not like the way the food looks or tastes," and 44 percent selected "not enough time to eat" (fig. 3).

Food Consumption Recall by Children

The third method is similar to the one just described that uses trained observers or professionals, except that children are requested to rate the amounts of their own discarded food (e.g., of the food they chose, they ate all, most, about half, just tried it, none). The advantages are similar to those for the trained observer method: The food recall method is less expensive, less time consuming, and cleaner than direct physical weighing. The primary disadvantage is that the data were based on children's recall information and were not actual plate waste measurements. This self-estimation is subject to bias (Comstock et al., 1979).

Figure 2

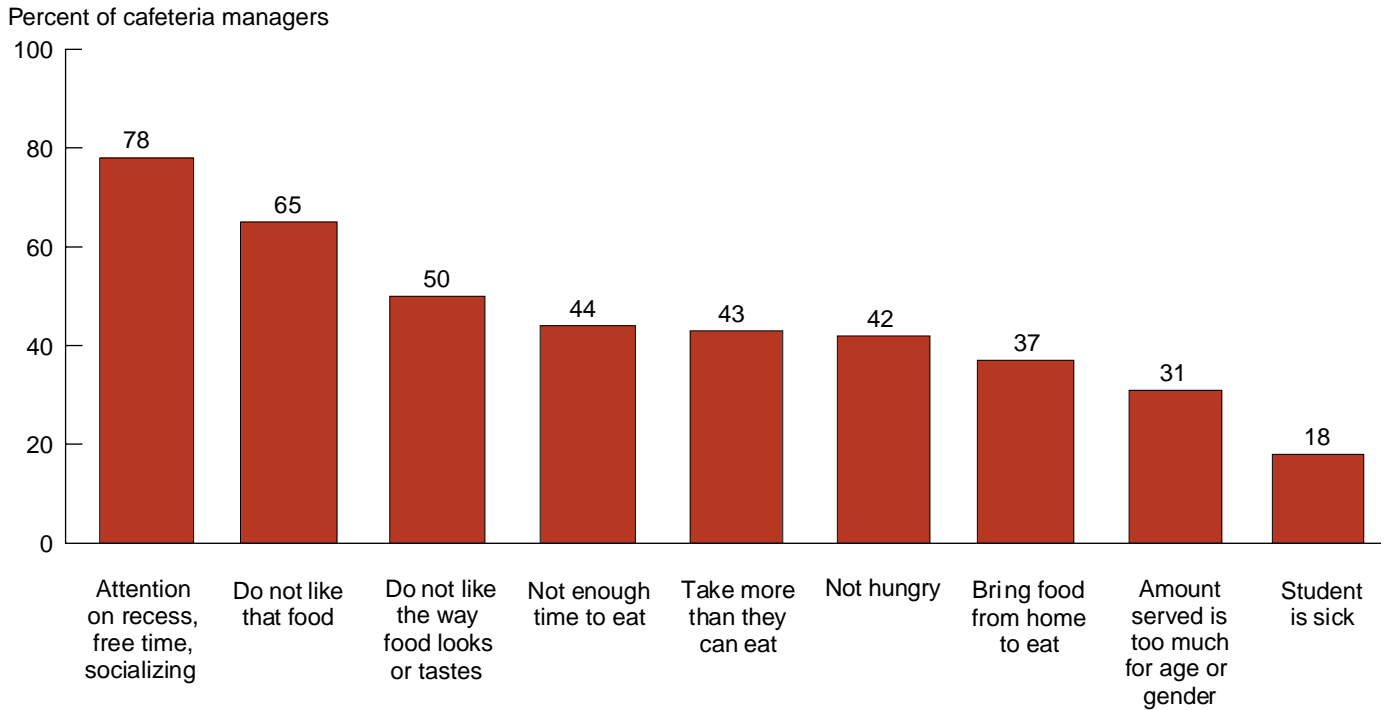
Average amount of food portion wasted by food type



Source: GAO's analysis of survey data, July 1996.

Figure 3

Reasons for plate waste cited by cafeteria managers



Source: GAO's analysis of survey data, July 1996.

One example of a study that used this type of plate waste measurement technique is USDA's SNDA-I study (1993). For the 1991-92 school year, this study interviewed about 3,350 students in grades 1 through 12 in public and private schools across the country and asked them to recall what they ate and drank during the 24-hour period prior to the interview. This study found that students in the NSLP wasted roughly 12 percent of the calories from food served in the NSLP (Burghardt and Devaney, 1993; Devaney et al., 1995). The average waste of individual nutrients ranged from 10 percent for vitamin B₁₂ and cholesterol to 15 percent for folate (Devaney et al., 1995).

A USGAO study (May 1996) extended the SNDA-I by using the same data to evaluate the percentage of selected nutrients (i.e., calories, protein, saturated fat, and total fat) wasted by students with different demographic characteristics. In essence, this study had five key findings (pp. 2-3):

- Students participating in the school lunch program wasted a higher percentage of the nutrients in their lunch than nonparticipants.
- Younger participants (those under 15) wasted a higher percentage of nutrients than older participants. Younger participants also wasted a higher percentage of nutrients than younger nonparticipants.
- Female participants wasted a higher percentage of nutrients than male participants. Furthermore, female participants wasted a higher percentage of nutrients than female nonparticipants.
- Participants in urban schools wasted a larger percentage of protein, saturated fat, and total fat

than participants in suburban schools. USGAO found no difference in the percentage of calories wasted by participants on the basis of school location. Participants in urban schools wasted a higher percentage of the nutrients than nonparticipants in urban schools.

Participants receiving a free school lunch wasted a larger percentage of the nutrients than participants paying full price.

The finding that NSLP participants wasted a higher percentage of nutrients than nonparticipants was expected, as lunches purchased outside of NSLP or brought from home are generally tailored to the preferences of individual children. Although nonparticipants wasted fewer nutrients than participants, nonparticipants did not consume the variety and amount of food necessary to meet one-third of their daily nutritional needs, while participants reached this NSLP program goal.

A fourth method that can provide data on plate waste in children's school lunches is *waste stream analysis*. With this method, researchers essentially sort all solid waste from a school cafeteria to identify the amount and type of waste generated by the cafeteria. For example, waste may be categorized as cardboard, grease, milk cartons, paper, glass, tin cans/foil, plastic, plate waste, and food waste. Waste stream analysis is less appropriate for the purposes of this report and is therefore mentioned only briefly here. It has been used to evaluate the effect of operational factors on the quantity of waste (for example, Hollingsworth et al. (1992) explored alternate milk packaging) and to compare waste composition across foodservice operations (Hollingsworth et al., 1995).

[* indicates a plate waste study.]

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