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Portion Sizes in Dietary Assessment: Issues and Policy Implications

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Accurate estimates of energy and nutrient intake of individuals and populations are contingent on the reliability of information obtained about food intake, food composition, and portion size. This article reviews issues related to the definition, determination, and use of portion sizes in dietary assessment and public education.

Introduction

Data on the food intake of individuals and populations serve as the basis for nutrition monitoring, epidemiologic research, and food and nutrition policies. The conversion of information about food consumption to data about consumption of energy and nutrients first requires an estimation of the amount of each item consumed—its portion or serving size. The concentrations of energy and nutrients in these portions are determined by comparing them to portions of defined size and established energy and nutrient content as provided in tables of food composition. Thus, the accuracy of estimates of energy and nutrient intake depends on the reliability of three distinct data sets: food intake, portion sizes, and food composition. Issues related to the reliability of dietary intake methods and food composition tables have been reviewed elsewhere.[1–5] Here, we review several distinct issues related to the definition, determination, and use of portion sizes in dietary assessment and public education.

Recent U.S. dietary intake surveys have reported a significant decrease in the proportion of energy consumed from fat, along with only a slight increase in overall energy consumption.[6] Surveys also report mean energy intakes below the Recommended Dietary Allowances (RDAs)[7] for large segments of the population,[8] but despite these trends, the prevalence of obesity is rising among both children[9] and adults.[10] Similarly, the U.S. food supply provides 3700 kcal/day per capita,[11] whereas the mean energy intake reported for participants in the third National Health and Nutrition Examination Survey (NHANES III, Phase 1) was 2095 kcal/day,[8] a discrepancy too large to be due entirely to food waste. One likely explanation for such inconsistencies could be the well-documented underreporting of portion size during dietary assessment, sometimes by substantial amounts.

A related problem is that the sizes of "typical" portions defined for the purposes of dietary guidance, food labels, and food frequency surveys differ from one another and are smaller than portions usually consumed by the public. If nutrition objectives for reductions in energy from fat and in obesity are to be achieved by the year 2000,[12] individuals will need to recognize and consume foods in amounts more consistent with energy needs. To help them do so, nutrition professionals will need to find better ways to relate standard portion sizes to amounts typically consumed and to estimate portion sizes more accurately.

Standard Reference Portion Sizes

National surveys of dietary intake, such as the National Food Consumption Survey (NFCS), Continuing Survey of Food Intake of Individuals (CSFII), or the NHANES directly request information about portion size as part of 24-hour dietary recalls or food records. For example, the NFCS asks subjects to report dietary intake in household measures,[13] and NHANES probes portion sizes through comparison to graduated shapes.[14] Food frequency questionnaires (FFQs), however, do not probe portion sizes directly. For FFQs and other purposes, various authorities have developed reference standards based, for the most part, on data from dietary intake surveys. Table 1 presents examples of reference standards currently used for food guides, food labels, and FFQs.

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Table 1. Standard Reference Portion Sizes: Examples

	USDA Pyramid[22]	FDA Food label[28]	Food frequency questionnaires	
			Willett et al.[6,32]	Block et al.[2,33]
Grains and cereals				
Bread	1 slice	1–3 slices[a]	Slice	2 slices
Crackers	3–4 small	5–18[a]	1	3
Rice, cooked	½ cup	1 cup	1 cup	¾ cup
Cereal, ready-to-eat	1 oz	½–1¼ cup[a]	1 cup	1 medium bowl
Cereal, cooked	½ cup	1 cup	1 cup	1 medium bowl
Fruit				
Whole fruit	1 medium	—	1	1 medium
Juice	¾ cup	8 oz	Small glass	6-oz glass
Fresh, frozen, or canned	½ cup	½ cup	½ cup	½ cup
Vegetables				
Raw leafy	1 cup	—	Serving	1 medium bowl
Carrots, raw	½ cup	—	½ or 2–4 sticks	½ cup
Potato	½ cup	—	1 or 1 cup	1 or ½ cup
French fries	10	3 oz	4 oz	¾ cup
Tomato juice	¾ cup	8 oz	Small glass	6 oz
Meat				
Beef	2–3 oz	—	4–6 oz	4 oz
Hamburger	3 oz	—	1 patty	1 medium
Poultry	2–3 oz	—	4–6 oz	2 small or 1 large piece
Fish	2–3 oz	—	3–5 oz	4 oz
Dairy				
Milk	1 cup	1 cup	8 oz	8 oz
Cheese	1.5–2 oz	½–1 slice[a]	1 slice or 1 oz	2 slices or 2 oz
Fats, sweets				
Butter	1 tsp.	1 tbsp	1 pat	2 pats
Cookies	2 medium	1–5[a]	1	3
Doughnuts	½ medium	1	1	1
Alcohol				
Wine	5 oz	—	4 oz	1 medium glass

[a] Standard portion sizes vary by weight and size of items.
[b] Harvard University Health Professionals Follow-up Study, 1990 questionnaire.

Food Guides

Historical Background. For nearly a century, the USDA has published food guides to help the public select healthful diets.[15] In its earliest efforts to suggest portion sizes, the agency recommended that families purchase specific quantities of foods to supply nutrients then known to be essential. Quantities were expressed by weight, volume, or 100-kcal portions; 80,000 kcal (800 100-kcal portions) was the figure used to meet the weekly needs of an average family of two adults and three children. USDA advised families to obtain these portions through specific food purchases, such as 14 lb potatoes, 2 lb turnips, and 14 qt milk per week.[16] Later, USDA specified yearly amounts of foods needed by men and women.[17] Although portion sizes could be estimated from such figures, they were not stated explicitly.

USDA first defined daily portions during World War II. It recommended consumption of one or two daily servings from each of eight food groups, and specified the size of the milk portion ("adults need at least 1 pint").[18] In 1943, USDA issued family food plans that stated both the number and size of servings to be obtained from 11 food groups. Meat, for example, was to be served five to eight times weekly, depending on income, with one pound of ground beef constituting five servings.[19]

The 1958 "Basic Four" was USDA's first guide to define the number and size of servings.[20] There was no research basis at that time to identify average amounts consumed. Instead, portion sizes were designed to meet the 1953 RDAs for energy and nutrient intake. Two daily 2–3-ounce portions from the meat group, for example, were designed to contribute half the RDA for protein; a ½-cup portion of citrus fruit met the RDA for vitamin C.[21] The portion sizes defined in 1958 established a firm and apparently unshakable tradition. They have been retained—with virtually no exceptions—in all subse-

quent USDA guides up to and including the 1992 Food Guide Pyramid.[22]

Food Guide Pyramid. Early USDA guides were designed to encourage the public to consume more of a variety of foods in order to prevent nutrient deficiencies. Beginning in 1979, however, USDA guides also began to address the need to reduce dietary risks for chronic diseases.[15] Soon after, the agency initiated research on an improved guide to help the public meet RDAs as well as reduce chronic disease risks. Eventually, this research led to publication of the 1992 Food Guide Pyramid. In establishing standard portions for both purposes, the agency considered several factors: typical intakes, ease of use, nutrient content, and tradition.[23] In defining typical intake, USDA selected the median portion sizes reported in the 1977–1978 NFCS.[24,25] It considered ease of use by expressing portions in household units that consumers could readily multiply or divide: ½ cup cooked vegetables, 1 ounce of cereal, or 1 slice of bread. It considered nutrient content by defining serving sizes for yogurt and cheese, for example, as providing a similar amount of calcium as a glass of milk.[24]

Tradition, however, appeared to be the major factor governing USDA decisions about portion sizes. Although median portion sizes for several key items in the NFCS were larger than portions suggested in food guides,[26] USDA usually chose to retain sizes used in previous guides. For example, the median NFCS beef serving was 4 oz for adult females and 5–6 oz for males, but USDA chose to retain the traditional 2–3-oz serving size used in the Basic Four. Similarly, the median NFCS serving was 2 slices for bread, and 1 cup for cereals, rice, and pasta, but USDA chose to use the smaller sizes of past guides. USDA stated that in such cases, it did not want to appear to be decreasing the number of daily servings that it had recommended in the past.[24]

Food Labels

Prior to 1990, Food and Drug Administration (FDA) regulations gave manufacturers wide discretion in establishing serving sizes and allowed them to reduce the sizes in order to make the products appear to have less fat, sodium, or sugar.[27] These practices, among others, led Congress to enact the 1990 Nutrition Labeling and Education Act (NLEA), which required uniform serving sizes to be listed on food labels as a basis for stating the product's nutrient content. The NLEA defined serving sizes as the amounts of food commonly consumed per eating occasion, expressed in household measures.

In implementing the NLEA, the FDA issued regulations to establish more realistic and uniform serving sizes for similar food products.[28] The agency intended the label serving sizes to represent amounts of foods commonly consumed. To identify these amounts, FDA first relied, as had USDA, on median amounts reported as consumed in the 1977–1978 NFCS. In addition, the agency considered the mean and mode amounts reported in that survey, as well as more current data from the 1987 to 1988 NFCS, a survey with an unusually low response rate. As a validity check, FDA referred to USDA's 1985 and 1986 CSFIIs even though these surveys applied only to limited population groups.[29] Perhaps because FDA developed its standards from more recent and expanded data, the serving sizes used for the new food labels are, in most cases, larger than those used by USDA in the Food Guide Pyramid (see Table 1). However, FDA specified that these serving sizes were not intended as recommendations for consumption.

Food Frequency Questionnaires

Semiquantitative FFQs, in which respondents report the average frequency of consumption of specific lists of foods during the past day, week, month, or year, are increasingly used to measure dietary intake in epidemiologic studies.[1–4] FFQs are considered most useful for ranking individuals according to food and nutrient intake (in part a reflection of consumption frequency) rather than for quantifying the actual amounts of food they consume, perhaps because FFQ respondents are not asked to state the amount of food they actually eat. Instead, they are asked to indicate their habitual intake in comparison to a predefined portion size. Because respondents generally do not think critically about the portion sizes listed on questionnaires, they have difficulty relating usual intakes to such arbitrary standards.[30,31]

The two most widely used FFQs are those developed by Willett et al.[32] and Block et al.[33] The Willett FFQ was developed through stepwise regression analysis of data obtained by questionnaires from nearly 100,000 women, validated in a small study that compared data from the FFQ and diet records.[1] The questionnaire specifies one standard portion size. Portion sizes on the Block et al. FFQ were derived from median amounts reported in 24-hour dietary recalls obtained from nearly 12,000 adults during NHANES II in 1976–1980. The Block et al. FFQ asks respondents to state whether their usual portion size is small, medium, or large with respect to the reference standard.

Issues

As shown in Table 1, the standard reference portion sizes developed by these various authorities differ

substantially, even when converted to common units. Standards for rice, beef, and doughnuts, for example, differ by at least a factor of two. The USDA Pyramid standard for dry cereal is a weight measure, but FDA and the FFQs use volume measures, even though an ounce of dry cereal may range from ¼ to more than 2 cups, depending on density. Such differences between weight and volume measures have proven especially confusing to consumers.[5] In cases where portions are designated by unit (one potato, three cookies) or by relative size (small, medium, large), weights or volumes are uncertain. In part, these inconsistencies result from differences in the methods used to establish the standards. A more important problem, however, is that standard portions are uniformly smaller than those typically consumed by the public.

Customary Portions

Despite the results of national dietary surveys, some research[34] and considerable anecdotal evidence suggests that standard reference portions are unrealistically small. For example, recent American books for home cooks[35] and professional chefs[36] usually specify 8-oz meat portions as starting ingredients. A recent survey of commercially prepared sandwiches found that they typically contain 5 oz of meat, and sometimes contain up to 7 or 8 oz, explaining in part why they are so high in calories and fat.[37] Restaurant meals, snacks, and take-out food portions are also much larger than reference standards and appear to be increasing in weight and volume.[38,39] For example, a typical bagel, once 2–3 oz, may now weigh 4–7 oz.[40] Restaurant servings of 22–38-oz steaks and fish are no longer unusual, and appear to follow the principle, "bigger is better."[41] These sizes greatly exceed all reference standards. In this context, the terms small, medium, and large become subject to widely varying interpretation; in some movie theaters, a "medium" popcorn contains 16 cups.[42] Movie sodas have increased from 12 to 20 oz within the past decade, and the largest adult serving has increased from 32 to 44 oz (personal communication, 1994). Restaurant owners believe that large portions are not necessarily shared; instead, they are purchased by individuals who consume all of what they are served.[39]

Portion Size Determination: Methodologic Issues

Beginning in the 1930s, and for nearly half a century, portion-size studies were conducted mainly by dietitians.[4] Only recently have epidemiologists and researchers in broader areas of nutrition begun to address the role of portion size in dietary assessment. Throughout the years, researchers have consistently reported that study subjects have great difficulty estimating both the amounts of foods they recall consuming in the past or present, and those that are displayed directly to them. As early as 1942, investigators suggested that inaccuracies in portion-size estimation constituted a principal source of error in diet records.[43] Such errors, which can be very large, have continued to elicit doubts about the nutrient and energy levels reported in dietary surveys.[1–5]

The usual methods for probing portion sizes require study subjects or investigators to weigh foods directly, to estimate weights visually, or to estimate the sizes of food portions via a comparison to visual aids such as household measures, food models, or photographs.

Direct Weighing of Food Portions

Because foods must be weighed prior to consumption, weighing methods for determining portion sizes can only be used with prospective dietary assessments. When scales are calibrated properly, weighing is precise. Weighing can be done by subjects or investigators. Asking subjects to weigh their own foods presents problems, however; they often find weighing so tedious that they compensate by decreasing food intake, sometimes by nearly 15%.[44] Weighing foods outside the home seems to be particularly onerous.[45,46] In some early studies, investigators weighed foods to determine amounts consumed in clinics,[43] school lunch programs,[47] or in cafeteria or other institutional settings[48]; similar studies were conducted somewhat more recently.[49] From the beginning, investigators found large between-individual variations in the correlation between 24-hour dietary recalls and analyses of weighed, duplicate meals, but overall correlations were sufficiently strong to suggest that such difficult methods are unnecessary for group estimates.[50,51] Thus, weighing methods seem most useful for validating more feasible methods.[52]

Visual Estimation of Weights

Because weighing methods are time-consuming and expensive, observers have been trained to estimate by inspection the weights of foods consumed by subjects. Some studies have reported good correlations between such visual estimates and actual weights.[49,53] However, even proponents of visual methods have reported that observers differ in their ability to estimate weights visually,[54] that they tend to overestimate the weights of foods subjects consume but to underestimate plate wastes,[55] and that they make particularly large errors in estimating the sizes of foods high in volume but low in weight.[53]

The results of such visual estimates have been reported as most reliable when the portion sizes were carefully standardized[54] and the observers were well-trained.[53]

Visual Estimation of Sizes

Trained interviewers administering 24-hour recalls or diet histories employ a variety of techniques to help subjects estimate portion sizes. The most frequently used aids are household measures, food models, or photographs.

Household Measures. Although some foods, such as eggs, apples, or soft drinks can be recorded in units, others are often described in volume measures such as cups or tablespoons. Such household measures have the advantage of familiarity, ease of use, and higher levels of cooperation from subjects,[52] and are used in the NFCS and CSFII. Volume measures, however, have long been understood to produce considerable error and individual variability in estimating portion weights,[56] because foods can be packed tightly or loosely and certain foods such as meats and pastries to not conform to measuring devices.[43] Household food measures are not always calibrated accurately and generally have been found to result in significant under- or overestimations of actual portion weights.[4,56,57] Thus, household measures are not accurate for individuals but are considered by some researchers to produce acceptable data for group estimations.[58]

Food Models. Three-dimensional food models closely represent actual foods but are usually of one size and can "direct" subjects to report portion sizes similar to those of the models they are shown.[4] The NHANES probes portion sizes through use of a graduated series of geometric shapes[14]; these were reported to produce more reliable results both within and between individuals in an early study,[59] but a more recent study has reported such models as distracting.[56]

Photographs. Several studies have found two-dimensional pictures of food shapes to be just as effective as three-dimensional models in helping subjects to estimate portion size in studies involving telephone recalls[60] or self-administered dietary surveys.[61] Photographs of portions of various sizes also have been reported to be useful in some studies[62] but poorly correlated to actual measurements in others.[63,64]

Issues

Although weighing methods should be more accurate than any other means for determining portion sizes, they introduce systematic errors and cannot be considered a "gold standard."[65] Because they cannot be used to determine amounts of food consumed in the past, retrospective studies can never be precise. The use of visual aids also yields imprecisions; such aids often are assumed to improve portion-size estimations,[3] but not all studies support this idea.[56,63,64] Differences between serving sizes reported in the 1977–1978 NFCS and 1976–1980 NHANES II have been attributed, in part, to their respective use of household food measures and food models,[66] but studies to date do not establish any one method as better than any other. The reasons for difficulties with estimations of food amounts are uncertain but may be related to poor memory for portion size or other perceptual problems that have "barely been explored."[67]

Factors Influencing Portion Size Estimations

To explain such difficulties, numerous studies have examined the effects of specific characteristics of foods, study subjects, and interviewers on the accuracy of portion-size estimations.

Food Characteristics

Type of Food. Whether the portion sizes of some foods are more reliably estimated than others is uncertain. Some studies have reported particularly high error rates for foods such as cakes,[68] salads, and salad dressings, and butter on toast,[34] amorphous foods such as spaghetti or applesause,[69] or fish, rice, steak, and cheese.[64] These and other studies have reported errors of both under- and overestimation.[53] For example, some studies have reported particularly low error rates for soups[68] or milk.[34] Still others have reported no food-related differences in size estimation.[54] Taken together, studies indicate no consistent association between size estimations and food type.

Size of Food. Over time, a more consistent observation has been that individuals have greater difficulty estimating portion sizes as the size of the portion increases.[68] This trend appears to be independent of body weight.[70] The influence of container size on such estimates is uncertain. Some investigators have reported that the sizes of large containers are more difficult to estimate,[69] but others have reported no differences related to container size.[71]

Subject Characteristics

Age. Early studies suggested that children cannot estimate portion size very accurately, even when prompted with visual aids,[43,47] an effect attributed to immature cognitive skills.[72] However, junior high school and college students also have been reported to have difficulty estimating portion sizes,[68] as have

the elderly.[73] The inability to estimate portion sizes accurately appears independent of age.

Gender. Women have been reported to be better able to estimate portion sizes than men,[69] a skill attributed to their greater experience in measuring food quantities.[68] To date, however, no studies have compared this ability in men and women with equivalent experience in food handling, leaving open the question of gender specificity.

Income. One study found that clients enrolled in a food assistance program consistently overestimated the portion sizes of foods on display.[74] The study did not include a higher-income control group, however; and no studies to date have examined income effects systematically.

Eating Habits. The one other distinct trend in this area is that subjects who usually eat smaller portions tend to overerestimate their size, whereas those who eat larger portions tend to underestimate them.[64] This effect is consistent with what has been called the "flat slope syndrome" by investigators who noticed that subjects tended to overreport low levels of food intake in 24-hour recalls but to underreport high levels.[75,76]

Body Weight. Underweight subjects have been reported to overestimate food intake[77] and overweight subjects to underestimate the amounts of food they eat.[78] Studies that have compared overweight to lean individuals have also reported greater underestimation of food intake.[79,80] These effects could be explained by systematic errors in portion-size estimation. Indeed, patients with anorexia nervosa appear to have an abnormally exaggerated perception of portion size when compared to individuals of normal weight.[81] The results of studies of obese subjects, however, are less clear. Some report overweight individuals as having no particular difficulty with portion-size estimations.[78] However, others have found that overweight subjects make large errors in estimating portion sizes and, therefore, caloric values, but these errors inelude both under- and overestimations.[71,82] Studies that have compared the ability of both overweight and normal-weight individuals to estimate portion sizes have reported no differences related to body weight.[83] Overall, the evidence suggests that difficulties with portion-size estimation are common across all weight classes.

Training. Differences in techniques among interviewers have been shown to influence strongly the ways they record subjects' reports of portion sizes and, therefore, nutrient intake levels on dietary surveys.[84,85] Such studies suggest that training of interviewers is a key variable in dietary intake determinations. Other studies have examined whether it is helpful to train study subjects. Training has been reported to improve the ability to estimate portion sizes when the subjects were students,[69,86] although the training benefits declined after a few weeks.[87] Studies attempting to train individuals enrolled in a counseling program, however, reported little improvement in their abilities to estimate portion sizes.[83,88]

Conclusions

This review suggests that specific characteristics of foods or study subjects do not readily explain difficulties in estimating portion sizes. Instead, such difficulties seem to be spread uniformly among population groups of varying age, gender, social status, body weight, and training. Direct comparisons of studies in this area are difficult, however, as they were conducted with subjects who varied in age, gender, socioeconomic status, body weight, and level of training, and with widely varying foods, probes, and recall or observation methods. Although some research supports the idea that people make greater errors in estimating portion size as the size of the portion increases, the one firm conclusion drawn is that virtually everyone has difficulty estimating portion sizes accurately. This is a problem with important implications for weight maintenance, dietary counseling, and public policy.

Is Portion-Size Information Necessary?

All methods of dietary intake assessment require either a direct probe of portion size, an estimate of size, or referral to a standard size in order to determine energy and nutrient content. The need for accuracy in portion-size determinations is self-evident for individual dietary assessments and, therefore, for group assessments. If the sizes of food portions are estimated incorrectly, caloric intake estimations will also be incorrect. This source of error alone would be sufficient to explain the discrepancy between reported caloric intakes and rates of obesity in the U.S.

The value of portion-size probes in FFQs, however, is a matter of great current debate. Although some investigators have found referral to standard portions to be more effective than the use of food models or photographs,[89] inconsistent results, high error rates, and compliance issues have led others to conclude that the benefits of portion-size probes are insufficient to justify their use in FFQs.[1,90] For example, studies have reported that referrals to standard portion sizes on FFQs lead to underestimations of nutrient intakes when compared to diet records,[91] especially when the portion standard is given as "medium." In such comparisons, a probe for small, medium, and large portions has been found to improve correlations,[92] as has the use of age- and gender-specific portion sizes as standards.[93]

Table 2. Research Priorities to Improve Portion-Size Estimation in Dietary Assessment and Nutrition Education

- Identify the most accurate and efficient method for determining portion sizes in dietary intake surveys of individuals and groups.
- Compare and evaluate existing methods for estimation of portion sizes in 24-hour dietary recalls.
- Compare and evaluate existing methods for quantifying food portions in food frequency questionnaires.
- Determine the extent to which information about portion sizes on food frequency questionnaires improves the validity of dietary assessments.
- Determine whether errors in portion-size estimation affect intake estimates for some nutrients more than others.
- Compare the ways nutritionists, researchers, and study subjects perceive the terms "small," "medium," and "large," as applied to portion size.
- Determine whether body weight affects subjects' perceptions of "small," "medium," and "large," as applied to portion size.
- Determine the level of accuracy with which nutritionists can estimate portion sizes.
- Compare perceptions of nutritionists and study subjects as to the sizes of portions commonly consumed.
- Determine appropriate reference portion sizes for use in dietary guidance, food labels, and food frequency questionnaires.
- Determine why individuals overestimate the size of small portions and underestimate the size of large portions.
- Identify effective ways to educate the public about the relationship of portion size to caloric intake and about portion sizes appropriate for caloric requirements.
- Identify the most effective methods to train nutritionists, researchers, and study subjects to better estimate portion sizes.

On the other hand, within-person variations in portion-size estimations have been reported to exceed between-person variations by as much as a factor of four, to increase the time required to complete frequency forms, and to reduce compliance.[94] Investigators have argued that probing portion sizes on FFQs yields little additional information because variations in food intake are mainly determined by frequency of consumption.[95] Furthermore, study subjects seem to be quite insensitive to changes that are made in the portion sizes stated on questionnaires,[30] supporting the idea that respondents pay little attention to or omit portion size information on these forms.[96] Clearly, this is an area that demands further attention and research.

Policy Implications

The accuracy of information derived from dietary intake surveys is currently an issue of intense professional concern,[97] as is the need to advise the public appropriately about the caloric content of food.[98] Our review suggests that the role of portion-size estimations in dietary assessment deserves more focused and systematic attention than it has received to date. In particular, it suggests an immediate need for development of internally consistent reference standards for portion sizes that can be used for multiple purposes: dietary guidance, food labels, and dietary intake surveys. Standards should provide cues to the public about appropriate portion sizes. Standards that more closely reflect actual intake levels might well help the public to understand better the relationship between food intake, caloric intake, and health.

At issue are historical portion-size standards. Many (if not most) people eat more than a 2–3-oz serving of meat or an ounce of cereal at any one time. This discrepancy between historic standards and actual portion sizes explains why the federal government's advice to eat 6–11 daily servings from the grain group is so widely viewed as difficult to achieve.[99] More consistent and realistic serving-size standards would require reformulation of current diet guides and food labels. Our review suggests that it is time to consider doing so.

Also at issue are questions of method comparisons. Without a gold standard for dietary assessment, studies using any one method to determine portion size must compare results to those obtained by other existing methods, all of which are imprecise. Because current methods are insufficiently accurate, it is understandable that investigators using FFQs find the difficulties of portion- size estimates to outweigh benefits. As others have noted, until better methods for estimating portion sizes are identified, dietary surveys will continue to include errors of indeterminate magnitude and direction.[100]

Thus, our review suggests several areas of research that are needed to address remaining questions about the role of portion sizes in dietary assessment and nutrition education. We list some of these suggestions in Table 2. We believe that more focused attention to this area will help resolve some of these research questions, and that doing so will greatly improve the accuracy of dietary intake methods, knowledge of the role of diet factors in disease causation, and the ability of nutrition professionals to educate individuals and the public about healthful diets.

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