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SURVEY GUIDANCE DOCUMENT

Considerations for the Selection of Portion Size Estimation Methods for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries

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List of Abbreviations

2D	two-dimensional
3D	three-dimensional
FRIL	food, recipe, and ingredient listing
g	gram(s)
kg	kilogram(s)
LMICs	low- and middle-income countries
PSEM	portion size estimation method

Definitions and Usage of Terms

Additional (food) servings (also called "additional helpings"): Any additional amount of a food item served after the first amount is served within the same eating occasion.

Amount consumed (also called "quantity consumed", "portion size consumed", or "serving consumed"): The amount of a food item consumed within an eating occasion, after accounting for leftovers and additional servings. In this document, the amount consumed can also refer to ingredients used in mixed dishes.

Amount served (also called "quantity served", "portion size served", or "serving"): The amount of a food item served on an individual plate, bowl, cup, etc., or eaten without a serving utensil (e.g., eaten directly from the hand) within the same eating occasion. However, the amount served may not always equal the amount consumed, because not all of the food item served may be consumed by the reference person; there may be leftovers. The amount served may be served in more than one serving.

Edible portion: The parts of a food that are typically consumed after all inedible parts are removed, if the food has any. For example, the part of the avocado left after the peel and pit have been removed.

Edible portion factor (also called "edible coefficient"): A numeric value needed during data processing to account for any inedible parts of a given food (e.g., bones, seeds, pits, or peels). During data processing, the edible portion factor is used to convert the amount of food reported as consumed into its equivalent edible weight in grams (e.g., "grams consumed," "grams of ingredient used," or "grams of recipe prepared"). The edible portion factor is calculated as the ratio of the edible portion of a food to the entire food (i.e., the edible portion factor = edible portion ÷ [the edible portion + inedible portion]). The edible portion factor is a value >0 and ≤1 and is equal to 1 when the entire food is edible (i.e., there are no inedible parts). Every food in the food, recipe, and ingredient listing (FRIL) should have an associated edible portion factor listed in the portion size estimation method (PSEM) conversion factor database.

Food: A food that is not mixed with other foods (e.g., banana, groundnuts). For simplicity in language, in this document, we use the term "food" broadly to also refer to beverages. Composite foods, such as bread and cakes, which are prepared with multiple ingredients but often included in food composition tables as a single food item, may also be treated as a single food in the FRIL for the purpose of dietary data collection.

Food form: Refers to the physical form of a food item listed in the FRIL (e.g., whole, sliced, diced, mashed, pureed).

Food item: A term used to refer collectively to foods, beverages, and mixed dishes consumed, as well as to ingredients used to prepare a mixed dish.

Food presentation mode: Refers to how a food item listed in the FRIL is presented and served (e.g., served with or without inedible parts, served on a plate)

Food, recipe, and ingredient listing (FRIL): A comprehensive list of all foods, beverages, recipes, and ingredients—and their relevant descriptive details—that are likely to be encountered during the 24-hour dietary recall interviews carried out across all geographic areas where the survey will be implemented and for all demographic groups that will be included in the survey. The FRIL should list each food, recipe, and ingredient in the state (e.g., raw, boiled, steamed, grilled, fried), form (e.g., whole, sliced, diced, mashed, pureed), and presentation mode (e.g., served with or without inedible parts) in which it is consumed.

Food state: Refers to the preparation state of a food item listed in the FRIL (e.g., raw, boiled, steamed, roasted, grilled, baked, shallow-fried, deep-fried).

Full-size food photographs: Food photographs that depict a series of images of a single food in its natural, whole, unprocessed state at full size (i.e., 100% scale). The unit sizes depicted correspond to different size gradations in which the specified food exists naturally along a continuum from very small to very large (e.g., entire avocados of different sizes).

Graduated portion-size food photographs: Food photographs that depict a series of scaled-down images (i.e., the images are typically presented at <100% scale) of a food or mixed dish in a given state, form, and presentation mode. Food items are typically shown on a plate. An object of known size (e.g., cutlery, such as a spoon, fork, knife, or chopsticks; and/or a ruler) is shown next to the plate to provide a reference for size. The portion sizes depicted in the images for a photographic series correspond to different portion sizes along a continuum from very small to very large.

Group I PSEMs: PSEMs well suited for use in large-scale dietary surveys in low- and middle-income countries (LMICs) because they do not require extensive preparatory work in advance of the survey to develop the tools and aids that need to be used with the PSEM. These PSEMs include direct weight using food replicas; standard unit size; proxy weight using a material that can be shaped, such as playdough; proxy weight using a free-flowing material, such as raw rice; proxy weight using a material that heaps, such as Kinetic Sand®; and calibrated household utensils, such as spoons, scoops, and/or ladles.

Group II PSEMs: PSEMs that are suitable for use in large-scale dietary surveys in some LMIC settings, but their use may be limited because these PSEMs typically require extensive preparatory work in advance of the survey for the development of the necessary tools and aids. These PSEMs include graduated portion-size food photographs, full-size food photographs, two-dimensional (2D) shapes, and three-dimensional (3D) food models.

Homogenous mixed dish: A mixed dish in which all ingredients are more or less evenly distributed. Thus, any serving from the mixed dish would contain similar proportions of the constituent ingredients.

Inedible portion (also called “inedible part” or “‘non-edible part”)**:** The parts of a food that are typically included in the food when served but not consumed. Examples of foods that are commonly served with inedible parts include chicken, fish, and other meat served with bone; groundnuts in the shell; maize on the cob; and fruits with inedible seeds, pits, or peels.

Ingredient: A food that is used in a mixed dish.

Leftovers: The amount of a food item that is served on an individual plate, bowl, cup, etc., within the same eating occasion, but that is not consumed by the reference person in the full quantity served. Leftovers can also be relevant for food items that are eaten directly from the hand (e.g., fruits and commercially packaged snacks).

Mixed dish: A dish, usually with a specific culinary name, that is prepared using two or more ingredients.

Non-homogenous mixed dish: A mixed dish in which ingredients are not evenly distributed. Thus, any serving from the mixed dish would not necessarily contain similar proportions of the constituent ingredients. Typically, non-homogenous mixed dishes refer to dishes in which the ingredients that are not evenly distributed in the mixture are nutrient-dense (e.g., chunks of red meat, fish, or poultry in a stew).

Non-standard recipe (also called a “household recipe” or “unique recipe”): A recipe derived from data collected in the household during the 24-hour dietary recall interview. During the interview, the respondent, or the cook of the mixed dish, provides the details of the mixed dish consumed by the respondent; these include a detailed description of the ingredients and the amounts used, the total amount of the mixed dish prepared, and the amount of the mixed dish consumed.

Outlier PSEMs: PSEMs that are not well suited for use with a large number of food items, given their limited accuracy and/or the difficulty of using the PSEM in the context of a large-scale survey, but that may be used for a very limited selection of food items for which portion sizes may be challenging to estimate using Group I or Group II PSEMs. These PSEMs include the price of the food item (i.e., monetary unit) and food length.

Photographic series: A set of food images depicting different portion or unit sizes of a particular food item (e.g., representing six or eight different portion or unit sizes), which are used for portion size estimation during data collection for a quantitative 24-hour dietary recall survey.

Portion size estimation method (PSEM): A method used to estimate the amount of food, beverage, or mixed dish consumed by survey respondents; the amount of an ingredient used; or the total amount of a mixed dish prepared. As there is no single PSEM that can be used for all food items likely to be encountered in a survey, a set of different PSEMs must be selected for use in a survey. The use of PSEMs in dietary surveys in LMICs often requires the use of equipment, tools, and aids, such as dietary scales, proxy materials (e.g., playdough, raw rice, Kinetic Sand®), household utensils, food photographs, 2D shapes, and 3D food models.

Probe list: A set of questions that should be asked for each item in the FRIL, to be used as a job aid by the enumerator to ensure that adequate relevant details about each food item reported are being collected during the 24-hour dietary recall interview. The probe list will either be in a format that can be hand-carried (possibly laminated), if paper is used for data collection for the dietary survey; or can be programmed into software, if a technology-assisted platform is used for the 24-hour dietary recall data collection.

PSEM conversion factor: A numeric value needed during data processing to convert the amount of food reported as consumed using a pre-determined PSEM into its equivalent edible weight in grams (e.g., "grams consumed," "grams of ingredient used," or "grams of recipe prepared") after accounting for any inedible parts of that food (e.g., bones, seeds, pits, or peels). The PSEM conversion factor for a given food item is calculated by multiplying the "PSEM-specific factor" by the "edible portion factor". Every food item in the FRIL should have an associated PSEM conversion factor listed in the PSEM conversion factor database, for each PSEM assigned to that food item.

PSEM conversion factor database: A survey-specific database that details all of the PSEM conversion factors needed to convert the amounts of foods reported as consumed, which have been estimated using pre-determined PSEMs, into their equivalent weight in grams, after accounting for any inedible parts of those foods (e.g., bones, seeds, pits, or peels). A PSEM conversion factor is needed for each food item included in the FRIL, for each PSEM assigned to the food item.

PSEM list: A list to document which specific PSEMs are assigned to each item in the FRIL. The list should be used as a job aid by the enumerator to ensure that the correct PSEM is used for the food item for which portion size data are being collected during the 24-hour dietary recall interview. The PSEM list either will be in a format that can be hand-carried (possibly laminated), if paper is used for data collection for the dietary survey; or can be programmed into software, if a technology-assisted platform is used for the 24-hour dietary recall data collection.

PSEM-specific factor: A numeric value needed to convert the amount of food reported as consumed, estimated using a pre-determined PSEM, into its equivalent weight in grams (e.g., "grams consumed," "grams of ingredient used," or "grams of recipe prepared") before accounting for any inedible parts of that food (e.g., bones, seeds, pits, or peels). Every food item in the FRIL should have an associated PSEM-specific factor listed in the PSEM conversion factor database, for each PSEM assigned to that food item.

Recipe: A description of a mixed dish that provides the list of ingredients used to prepare the mixed dish, along with a detailed description of all ingredients used (including any processing and cooking methods applied to each ingredient before adding the ingredient to the mixed dish). The cooking methods applied to the mixed dish itself (if the dish is cooked) are also included as part of the recipe information. In dietary surveys, a recipe includes information on the quantity (in grams) of each ingredient used to prepare the mixed dish (in the form added to the mixed dish, which is typically raw) and the final quantity of the mixed dish once it is fully prepared and/or cooked.

Standard recipe (also called a "pre-defined recipe")**:** An "average" recipe that aims to reflect the way that a mixed dish is usually prepared by respondents in a survey area. Standard recipes can be used for mixed dishes that are known to be prepared similarly across a defined survey area (in terms of the ingredients used, the preparation methods for those ingredients and the mixed dish itself, and the relative proportion of each ingredient used in the

mixed dish). Standard recipes are also typically used when survey respondents report consuming mixed dishes prepared outside the home (e.g., by vendors or in restaurants or in “ready meals” purchased from stores).

Substitution factor: An additional conversion factor (i.e., numeric value) that is required during data processing to translate the portion size reported as consumed, as depicted in a graduated portion-size food photograph or by a food replica, into the portion size of the substitution food item consumed.

Substitutions: Refers to using a PSEM developed for use with a specific food item to estimate the portion size consumed for a set of similar food items that are not represented or depicted (e.g., use of graduated portion-size food photographs depicting cooked spinach to assess the amount of cooked kale consumed). Survey planners can consider the use of substitutions when using direct weight and graduated portion-size food photographs as PSEMs.

1 Introduction

Estimating the amounts of foods and mixed dishes consumed by a survey respondent—technically referred to as "portion size estimation"—is one of the most challenging aspects of quantitative 24-hour dietary recall data collection. Error in portion size estimation is one important contributor to measurement error in dietary data. Thus, the selection of portion size estimation methods (PSEMs) and training of field staff to apply the methods correctly are critical considerations in the planning, design, training, and implementation of a quantitative 24-hour dietary recall survey.

A quantitative 24-hour dietary recall is a retrospective, memory-based dietary assessment method; the actual foods and mixed dishes consumed are usually not physically available during the recall interview. Therefore, it is not feasible to determine the quantity of every item consumed directly using a dietary scale and recording the amounts consumed in grams as needed for data analysis. Instead, a range of indirect PSEMs are used to aid the respondent to visualize and estimate the amount of each food and mixed dish consumed and the amount of each ingredient used in recipes.

PSEMs do not all have the same level of accuracy, and not all methods can be applied to all food items. The most appropriate choice of PSEM for a given food item depends mostly on the state and form in which the food item was consumed, the presentation of the food item when served, and how the amount consumed is easiest for the respondent to visualize and report to the enumerator. Context-specific factors should also be considered, such as the ability to procure the necessary equipment, tools, and aids required for use of the PSEM and the amount of time and resources available to devote to preparing, pre-testing, and, possibly, validating the PSEM before beginning data collection for the survey.

This guidance document outlines considerations for the selection and assignment of appropriate PSEMs for use in a large-scale quantitative 24-hour dietary recall survey in a low- or middle-income country. We describe PSEMs that are suitable for use in large-scale dietary surveys (Section 2); provide guidance on how to select and assign the most appropriate set of PSEMs to use in a survey (Section 3); and outline key tasks and considerations for operationalizing the set of PSEMs selected for use in the survey context (Section 4).

We note that the most appropriate PSEM to use for a given food item will not be the same across all contexts. The specific constraints, challenges, and considerations related to the use of different PSEMs are likely to vary by survey context. Likewise, the survey respondents to be targeted across different survey contexts are likely to have varying degrees of ease of use with each PSEM. The guidance provided in this document is therefore not intended to be prescriptive, but only to highlight key considerations for selecting the most appropriate PSEMs for use in the context of a large-scale quantitative 24-hour dietary recall survey in a low- or middle-income country.

2 PSEMs Suitable for Use in Large-Scale Quantitative 24-Hour Dietary Recall Surveys

A wide range of PSEMs are well-established for use in dietary surveys in low- and middle-income countries (LMICs). These include the use of known standard unit sizes (e.g., a bottle of soda), household utensils with a pre-determined volume (e.g., spoons, scoops, and/or ladles), food photographs (i.e., graduated portion-size and full-size food photographs), two-dimensional (2D) shapes such as drawings, printouts, or cardboard cut-outs, and three-dimensional (3D) food models made from wood, plastic, papier mâché, foam rubber, or other durable materials. Hands-on interactive approaches and tools for portion size estimation are also commonly used in dietary surveys in LMICs. Examples include the use of food replicas, playdough that can be easily molded into different sizes and shapes to estimate the amount of variously shaped solid food items consumed, raw rice to estimate the amount of "pourable" food items consumed, and Kinetic Sand®[1] to estimate the amount of food items that heap.

To help survey planners select the PSEMs that are the most appropriate for use in their survey context, we have grouped these commonly used PSEMs into two groups according to the amount of time and resources required to adopt the method for use in a large-scale survey.

In addition to these two groups of commonly used PSEMs, we also describe a set of Outlier PSEMs, which include lesser-used methods such as food length and monetary unit (i.e., market price). These Outlier PSEMs have important limitations that need to be considered before adopting them for use in a large-scale dietary survey, but because of the very specific nature of certain food items, the use of these outlier methods may nonetheless be warranted for a limited set of specific foods in LMIC contexts.

2.1 Group I PSEMs

Group I PSEMs have the advantage of not requiring extensive preparatory work in advance of the survey to develop the tools and aids that need to be used with the PSEM.

Group I PSEMs include the following methods:

- Direct weight using food replicas;
- Standard unit size where respondents report a uniform unit consumed, and, if relevant, multiples or fractions of the selected unit;
- Proxy weight using a material that can be shaped into different sizes and shapes, such as playdough;
- Proxy weight using a free-flowing material that is pourable, such as raw rice;
- Proxy weight using a material that heaps, such as Kinetic Sand®; and
- Calibrated household utensils, such as spoons, scoops, and/or ladles.

The use of direct weight using food replicas and proxy weight using playdough, raw rice, or Kinetic Sand® involves the respondent presenting to the enumerator the portion size of the food item consumed. The use of direct weight and proxy weight are similar in terms of the cognitive process required by the respondent but differ in the choice of material used for estimating the portion size. A food replica is typically an exact representation of a food item (or a very similar food item), whereas proxy materials are typically used to represent a variety of different food items. The flexibility and relative ease of use of proxy materials enable all types of foods to be represented—including oddly shaped and amorphous foods—making these PSEMs appropriate for use with a wide

[1] Kinetic Sand® is a non-toxic commercial product made with sand and polymers. It mimics the physical properties of wet sand; it has a loose texture, is flexible, does not stick on hands, and does not dry out.

array of food items. The use of direct weight using food replicas is limited by the logistics of preparing and transporting the food item represented by the replica, and so, as a matter of practicality, direct weight using food replicas is typically used as a PSEM for a very limited selection of food items.

Standard unit size and calibrated household utensils involve a different set of steps than proxy materials or direct weight as PSEMs. These PSEMs do not entail the respondent using a proxy material or a food replica to show the portion size of the food item consumed, but instead require the respondent to report a unit size (i.e., select a uniform-sized food item or a specific utensil) and report the number (and/or fraction, in the case of standard unit size) of the selected unit that represents the portion size consumed.

The use of standard unit size should be limited to use with food items that occur in uniform sizes or a very narrow range of sizes, such as commercially packaged items (e.g., commercial bread slices, cookies, bouillon cubes) and natural foods that occur in largely uniform size and shape (e.g., cherry tomatoes, eggs) that can be easily counted. The use of calibrated spoons, scoops, and/or ladles as a PSEM should be limited to food items that can be visualized by the respondents with spoons, scoops, and/or ladles and are consumed in relatively small quantities for which the number of servings can be easily counted (e.g., 5 spoons of oil). Furthermore, the use of calibrated household utensils as a PSEM should be limited to free-flowing food items that do not heap (e.g., liquid foods such as oils, thin soups, thin sauces), and for which the assumption can be made that the utensil is filled to the brim.

All Group I PSEMs (except direct weight and proxy weight using Kinetic Sand®) typically allow for multiples of a unit to be reported. In addition, when using standard unit size as a PSEM, fractions of selected standard units must be allowed to be reported. However, in many survey contexts, fractional reporting of portion sizes can present cognitive difficulties for both the respondents and the enumerators, thus increasing the risk of error in the portion size data collected, especially in lower-literacy environments. For this reason, survey planners should always consider the survey context carefully when determining which PSEMs are appropriate to use. When fractional reporting is determined not to be feasible to implement, then standard unit size should not be used as a PSEM in the survey.

2.2 Group II PSEMs

Group II PSEMs typically require extensive preparatory work in advance of the survey to develop the necessary tools or aids to be used with the PSEM, unless they have already been developed for a previous survey. Group II PSEMs are suitable for use in large-scale dietary surveys in select LMIC settings, depending on the time and resources available.

Group II PSEMs include the following methods:

- Graduated portion-size food photographs depicting multiple portion sizes for a given food item;
- Full-size food photographs depicting multiple unit sizes of a single food in a whole, unprocessed state;
- 2D shapes depicting multiple unit sizes for a given food item; and
- 3D food models depicting multiple unit sizes for a given food item.

The use of Group II PSEMs entails the enumerator presenting multiple pre-determined portion or unit sizes of a food item to a respondent using photographs (graduated portion-size or full-size food images)[2], 2D shapes, or 3D food models, from which the respondent is asked to select the portion size (or unit size, in the case of full-size food photographs, 2D shapes, and 3D food models) that most closely approximates the amount consumed (or the unit size served in the case full-size food photographs, 2D shapes, and 3D food models).

[2] For detailed guidance on the development of food photographs, refer to Vossenaar M, Crispim SP, Lubowa A, Deitchler M, Moursi M, and Arimond M. 2020. *Guidance for the Development of Food Photographs for Portion Size Estimation in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries*. Washington, DC and Curitiba, Brazil: *Intake* – Center for Dietary Assessment/FHI Solutions and Department of Nutrition, Federal University of Paraná, Available at: Intake.org.

Graduated portion-size food photographs depict a series of portion sizes that increase along a continuum for a given food item in a single state, form, and presentation mode. The food items are typically not depicted at full size; rather, an object of a known size (e.g., cutlery, such as a spoon, fork, knife, or chopsticks; and/or a ruler) is included in each image in the photographic series to provide a reference for size. Full-size food photographs, on the other hand, depict a series of different unit sizes of a single food, each at 100% scale, with the food typically shown in a whole, unprocessed state and in sizes in which the food naturally exists (e.g., entire avocados of different sizes). Within a quantitative 24-hour recall dietary survey either graduated portion-size food photographs or life-size photographs or a combination of both can be used to estimate amounts consumed, but only one type of food photograph should be used for any food item in a given state, form, and presentation mode. 2D shapes are drawings, print-outs, or cardboard cut-outs of shapes (e.g., circles, triangles, rectangles) that reflect the 2-D contour of a given food item and are made in several different sizes in which the food item is typically served to depict a range of standard unit sizes at 100% scale. 3D food models are made from wood, plastic, papier mâché, foam rubber, or other durable materials to look very similar to the food item they are meant to represent and are always made at 100% scale. Like 2D shapes, the sizes depicted by the 3D food models typically reflect a range of standard unit sizes of the food item depicted.

The development of Group II PSEMs requires significant effort. First, the specific food items to represent must be selected, after which the portion sizes (or unit sizes in the case of full-size food photographs, 2D shapes, and 3D food models) to depict for each food item must be determined. To determine the most appropriate portion sizes to represent with graduated portion-size food photographs, existing high-quality quantitative 24-hour dietary recall data collected from the same (or very similar) demographic group in the same (or very similar) geographic area during a similar season as planned for the survey are typically needed. For other Group II PSEMs, the unit sizes to depict are typically developed to reflect the unit sizes of how the food item naturally exists (full-size food photographs) or how the food item is served (2D shapes and 3D food models). Careful work is then required to develop high-quality food photographs, 2D shapes, or 3D food models for the portion sizes (or unit sizes) to be represented for each food item selected for use with the respective PSEM.[3]

When resources permit, graduated portion-size food photographs can be developed to cover a wide variety of food items. Their use should, however, be limited to food items that can be presented in the intended portion sizes. For this reason, graduated portion-size food photographs should not be developed for foods presented with inedible parts. Full-size food photographs, 2D shapes, and 3D food models are typically developed for a limited selection of food items that meet certain criteria. The use of full-size food photographs should be reserved for single foods that can vary in size but are very similar in shape across sizes. 2D shapes are only suitable for food items that have a consistent 2D contour across size, do not vary in thickness, and do not include any inedible parts. And the use of 3D food models is limited by the logistics required for their use in the field.

The use of full-size food photographs, 2D shapes, and 3D food models requires allowing respondents to report multiples and fractions of the selected units for accurate portion size estimation. This is because the unit sizes depicted do not necessarily correspond to the range of portion sizes commonly consumed for that given food item. If the use of fractional reporting is considered unfeasible in the survey context due to the numeracy level of respondents or enumerators, then the use of full-size food photographs, 2D shapes, and 3D food models should not be among the PSEMs considered for use in the survey.

Graduated portion-size food photographs can also be operationalized to allow the respondent to report multiples and/or fractions of portion sizes depicted. Alternatively, respondents can be allowed to report a different portion size than those depicted. For example, the respondent may be allowed to indicate if the portion size consumed was smaller than the smallest portion size depicted, larger than the largest portion size depicted, or a quantity in-between two of the portion sizes depicted in the photographic series.

[3] Guidance on the development of food photographs, 2D shapes, and 3D food models for portion size estimation is beyond the scope of this document.

In addition, graduated portion-size food photographs can be operationalized to allow the use of "substitutions". Substitutions refer to using a PSEM developed for a specific food item to estimate the portion size consumed for a set of similar food items that are not represented or depicted. Substitutions can also be relevant to consider for a very limited number of items when using the direct weight of food replicas as a PSEM (a Group I PSEM).

2.3 Summary of Group I and Group II PSEMs

Table 1 provides summary information for the Group I and Group II PSEMs, outlining the equipment, tools, and aids required for each PSEM, the key steps involved to collect portion-size data using the PSEM, the key advantages and disadvantages associated with the use of each PSEM, and the amount of preparatory work in advance of the survey required for each PSEM. To supplement this information, a more detailed narrative description of each Group I and Group II PSEM is provided in Annex 1.[4]

Given their relative simplicity, ease of use, and applicability for a wide variety of food items, in most LMIC contexts, *Intake* recommends using Group I PSEMs (direct weight using food replicas; standard unit size; proxy weight using a material such as playdough; proxy weight using a material such as raw rice; proxy weight using a material such as Kinetic Sand®; and calibrated household utensils) to estimate the portion size of the vast majority of food items likely to be encountered in a dietary survey.

[4] Outlier PSEMs are not described further beyond Section 2.4, since their use is only appropriate for a very limited set of food items, and given that these PSEMs should only be used with an abundance of caution and clear recognition of the limitations of the methods for accurate portion size estimation in the context of a large-scale survey.

Table 1. PSEMs Recommended for Use in Large-Scale Quantitative 24-Hour Dietary Recall Surveys in LMICs

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group I PSEMs*:* Methods that do not require extensive preparatory work in advance of the survey						
1. **Direct weight** using food replicas	Food replicas High-quality digital dietary scales (along with high-quality batteries and certified standard weights for scale testing) Commonly used plates and bowls Utensils to scoop the replica Storage containers	The food replica of the actual food consumed is placed on a plate or in a bowl to represent the amount consumed. Ideally, the same plate or bowl used by the respondent is used when estimating the portion size consumed. Depending on survey operationalization, substitutions may be allowed.[D]	The food replica that represents the amount consumed is weighed on a digital dietary scale and the weight is recorded to the nearest gram. If relevant, substitutions are recorded.	Food replicas allow a vivid, realistic visualization of the amount consumed, especially when using the plate or bowl used for eating by the survey respondent. There is no need to convert the amount recorded into the equivalent weight in grams, therefore the PSEM conversion factor is set as 1.	Logistically burdensome to prepare and carry food replicas. Can be used for only a very limited selection of food items. Need for a high-quality digital dietary scale. The respondents and/or enumerators may find it difficult to use substitutions.	The food replicas should be prepared as usually consumed in the survey area. Depending on the food and storage conditions, the food replicas may need to be replaced regularly.[E] If substitutions are allowed, an additional conversion will be required (referred to as a "substitution factor") to translate the portion size reported using the food replica into the amount of the actual food item consumed.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

D Whether and for what foods the use of "substitutions" is allowed depends on the survey context; these decisions must be made before data collection.

E Salting can be used to preserve foods that spoil quickly, but some foods do not require salting to be preserved and, for other foods, salt should not be used, as this can cause the consistency of the food to change (e.g., sweet potatoes).

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group I PSEMs*: Methods that do not require extensive preparatory work in advance of the survey*						
2. **Standard unit size** (each unit corresponds to a known weight)	None[F]	A food item that occurs in uniform size units is reported. The number (multiples) and/or fractions consumed of the selected unit are reported.	The code of the selected standard unit size is recorded. The number and/or fractions of units reported is recorded.	No special equipment, tools, or aids are required.	Can only be used for food items that exist in uniform sizes (e.g., specific varieties of fruits). Assumes there is no substantial variation in unit sizes across the survey area. Fractions of standard unit sizes may be difficult for respondents to report and/or for enumerators to record.	Specific food items with standard units sizes must be selected and the uniformity of portion sizes confirmed (e.g., survey planners would need to confirm if the size of a slice of commercial white bread varies by brand). The corresponding weight of each standard unit size must be determined in advance of the survey.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

F Although not required, photographs can be used to confirm that the food item reported is the same as the one for which the PSEM was developed. This verification should be done during the "second pass" of the 24-hour dietary recall interview, when descriptive details for the food item are collected (e.g., the brand of a commercial food).

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group I PSEMs*:* Methods that do not require extensive preparatory work in advance of the survey						
3. **Proxy weight using a material that can be shaped** (e.g., playdough)[G]	Playdough (or other suitable proxy material) High-quality digital dietary scales (along with high-quality batteries and certified standard weights for scale testing) Commonly used plates, bowls, and pots Storage containers	A piece of playdough is modeled into the size and shape of the food item consumed to represent the amount consumed, and is placed on a plate or in a bowl or pot. Ideally, the same plate, bowl or pot used by the respondent is used when estimating the portion size consumed. If relevant, multiples of uniform unit sizes molded are reported.	The playdough is weighed on a digital dietary scale and the weight is recorded to the nearest gram. If relevant, the number of uniform unit sizes reported is recorded.	Relative ease of visualizing the portion size representing the amount consumed, especially when using the plate, bowl, or pot used for eating by the survey respondent. Flexible in shape, allowing oddly shaped items and amorphous foods to be represented. Can be used for many food items (including for mixed dishes and ingredients used).	Playdough needs to maintain a stable density throughout data collection for the PSEM conversion factors compiled to correctly translate the amount reported as consumed into a gram unit measurement of food consumed. Playdough can dry out, change in texture, become stiff and/or sticky, and mold. The density of the playdough must be monitored regularly throughout data collection, and it may periodically need to be replaced. The playdough must be carried by enumerators. High-quality playdough may be difficult to procure. Need for a high-quality digital dietary scale.	The density of the playdough and all food items estimated using this PSEM must be determined.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

G High-quality playdough is the most suitable proxy material to use for this PSEM because it is easy to mold and has been used extensively in different settings without major challenges.

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group I PSEMs: Methods that do not require extensive preparatory work in advance of the survey						
4. **Proxy weight using a free-flowing material that is pourable**[H] (e.g., raw rice)[I]	Raw rice (or other suitable proxy material) High-quality digital dietary scales (along with high-quality batteries and certified standard weights for scale testing) Commonly used cups, bowls, and pots Utensils to scoop the raw rice Storage containers	The raw rice is poured into a cup, bowl, or pot to represent the amount consumed. Ideally, the same cup, bowl, or pot used by the respondent is used when estimating the portion size consumed. If relevant, multiples of uniform unit sizes poured are reported.	The raw rice is weighed on a digital dietary scale and the weight is recorded to the nearest gram. If relevant, the number of uniform unit sizes reported is recorded.	Relative ease of visualizing the portion size representing the amount consumed, especially when using the cup, bowl, or pot used for eating by the survey respondent. Can be used for many food items (including for mixed dishes and ingredients used).	The density of the raw rice must remain constant. The raw rice must be carried by enumerators. Need for a high-quality digital dietary scale.	The density of the raw rice and all food items estimated using this PSEM must be determined.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

H This PSEM is similar to "volume by proxy material" in which the respondent uses a proxy material (e.g., raw rice) to represent the amount of the food item consumed and the volume is measured. The difference is that *Intake* recommends weighing the amount of proxy material using a dietary scale (and recording the weight in grams) instead of using a cylinder to measure the volume of the proxy material (and recording the volume in ml) because taking the weight measurement of the proxy material is easier, faster, and less prone to error than taking a measure of the volume of the proxy material.

I Raw rice is the most suitable proxy material to use for this PSEM because it is easy to handle, readily available, safe to use, and retains a constant density when stored and handled properly. The use of water for this PSEM is discouraged because it is cumbersome to carry and in many settings, it may not be ethical, culturally appropriate, or practical to request that water be supplied by the household, especially if water is scarce.

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group I PSEMs*:* Methods that do not require extensive preparatory work in advance of the survey						
5. **Proxy weight using a material that heaps** (e.g., Kinetic Sand®)[J]	Kinetic Sand® (or other suitable proxy material) High-quality digital dietary scales (along with high-quality batteries and certified standard weights for scale testing) Commonly used spoons, scoops, and/or ladles; and a cup or bowl Storage containers	The Kinetic Sand® is scooped with a spoon, scoop, or ladle into a cup or bowl to represent the amount consumed. Ideally, the same spoon, scoop, or ladle used by the respondent is used when estimating the portion size consumed.	The Kinetic Sand® is weighed on a digital dietary scale and the weight is recorded to the nearest gram.	Relative ease of visualizing the portion size representing the amount consumed, especially when using the spoon, scoop, or ladle used for serving by the survey respondent. Can be used for many food items (including for mixed dishes and ingredients used) consumed in small quantities.	Can only be used for food items consumed in small quantities and that can be visualized using spoons, scoops, and/or ladles.[K] The density of the Kinetic Sand® must remain constant. The Kinetic Sand® must be carried by the enumerators. Kinetic Sand® may be difficult to procure. Need for a high-quality digital dietary scale.	The density of the Kinetic Sand® and all food items estimated using this PSEM must be determined.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

J Kinetic Sand® is the most suitable proxy material to use for this PSEM because it is easy to handle, safe to use, retains a constant density, and heaps well. However, Kinetic Sand® can be expensive and difficult to procure in some settings.

K Because of the variability that is possible in the level of packing by respondents when using Kinetic Sand® as a proxy material, *Intake* recommends only using Kinetic Sand® for scooping and heaping and not for any molding of shapes. Kinetic Sand® is therefore not recommended for use as a proxy material to use for the PSEM "proxy weight using a material that can be shaped."

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group I PSEMs*:* Methods that do not require extensive preparatory work in advance of the survey						
6. **Calibrated household utensils** (e.g., spoons, scoops, and/or ladles)[L]	Set of spoons, scoops, and/or ladles of a range of sizes with a pre-determined volume	A spoon, scoop, or ladle most similar to the one used by the respondent is selected from a range of sizes. If relevant, the number (multiples) of the selected unit are reported.	The code of the spoon, scoop, or ladle selected is recorded. The number of units reported is recorded.	A useful way to estimate very small amounts of liquid food items consumed.	Can only be used for liquids consumed in small amounts for which a level, filled to the brim measure can be assumed.	Information on commonly used utensils in the survey area has to be collected. The volume of all utensils must be determined in advance of the survey. The density of all food items estimated using this method must be determined.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

L This PSEM may also be referred to as "household measures," which typically includes the use of calibrated bowls and cups. However, the PSEM described here is only intended to be used for liquid food items typically consumed in small quantities. We do not include the use of bowls and cups among calibrated household utensils to be used as a PSEM because of the different considerations the use of bowls and cups require for operationalizing this PSEM.

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group II PSEMs*:* Methods that require extensive preparatory work in advance of the survey						
7. **Graduated portion-size food photographs** depicting multiple portion sizes for a given food item	Photographic series (each image corresponds to a known weight of the depicted food item)	The image that most closely represents the amount of food item consumed is selected from a set of images in a photographic series. Depending on survey operationalization, the number (multiples) and/or fractions of the selected portion size or a portion sizes not depicted is reported. Depending on survey operationalization, substitutions may be allowed.[D]	The code of the image selected is recorded (or if relevant, the code that corresponds to a portion size not depicted). If relevant, the number and/or fraction of the selected image is recorded. If relevant, substitutions are recorded.	Relative ease of use during the 24-hour dietary recall interview. Can be used for a wide variety of food items.	Requires investment to determine the range of portion sizes to depict for a given food item and to prepare high-quality photographs. Limited to settings that have well-developed and validated graduated portion-size food photographs or have the resources available to develop them. The food photographs must be carried by the enumerators. Fractions of portion sizes depicted and portion sizes not depicted may be difficult for respondents to report and/or for enumerators to record. The respondents and/or enumerators may find it difficult to use substitutions.	Food photographs must be developed. This work entails determining the appropriate portion sizes to represent in each photographic series, creating the images, etc. The corresponding weight of the food depicted in each photographic series must be clearly documented. If substitutions are allowed, an additional conversion will be required (referred to as a "substitution factor") to translate the portion size reported for the food item depicted into the amount of the actual food item consumed.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

D Whether and for what foods the use of "substitutions" is allowed depends on the survey context; these decisions must be made before data collection.

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group II PSEMs*:* Methods that require extensive preparatory work in advance of the survey						
8. **Full-size food photographs** depicting multiple unit sizes of a single food in a whole, unprocessed state	Photographic series (each photograph corresponds to a known weight of the depicted food)	The image that most closely represents the unit size of the food served is selected from a set of images in photographic series. The number (multiples) and/or fractions consumed of the selected unit size depicted are reported.	The code of the image selected is recorded. The number and/or fraction of the selected image is recorded.	Relative ease of use during the 24-hour dietary recall interview.	Requires investment to determine the range of sizes to depict for a given food and to prepare high-quality photographs. Limited to single foods in a whole, unprocessed state. The food photographs must be carried by the enumerators. Fractions of unit sizes depicted may be difficult for respondents to report and/or for enumerators to record.	Food photographs must be developed. This work entails determining the appropriate unit sizes to represent in each photographic series, creating the images, etc. The corresponding weight of the food depicted in each photographic series must be clearly documented.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group II PSEMs*:* Methods that require extensive preparatory work in advance of the survey						
9. **2D shapes** depicting multiple unit sizes for a given food item	2D shapes, such as drawings, photographs, or cardboard cutouts (each shape with a given area [e.g., length and width in the case of a square or rectangular shape] corresponds to a known weight of a given food item)	The 2D shape that most closely represents the unit size of the food served is selected from a range of sizes. The number (multiples) and/or fractions consumed of the selected unit size depicted are reported.	The code of the 2D shape selected is recorded. The number and/or fraction of the selected 2D shape is recorded.	Relative ease of use during the 24-hour dietary recall interview.	There are a limited number of food items that have a specific shape without variation in thickness. Requires investment to determine the range of sizes to represent for a given food and to create high-quality 2D shapes. The 2D shapes must be carried by the enumerators. Fractions of unit sizes represented by 2D shapes may be difficult for respondents to report and/or for enumerators to record. Visualizing 2D shapes may be conceptually harder than visualizing 3D shapes.	The uniformity of the thickness of selected food items must be confirmed. Food shapes must be developed. This work entails determining the appropriate unit sizes to represent for a given food item, creating the images or cut-outs, etc. The corresponding weight of the food item depicted in each 2D shape must be clearly documented.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to **Table 2** for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to **Table 3** for considerations related to the use of each PSEM with food items that may include inedible parts.

PSEM	Equipment, tools, and aids required[A]	Use of PSEM during the 24-hour dietary recall interview		Advantages	Disadvantages	Preparatory work required in advance of the survey
		Steps to be undertaken by the respondent[B]	Steps to be undertaken and recorded by the enumerator[C]			
Group II PSEMs*:* Methods that require extensive preparatory work in advance of the survey						
10. **3D food models** depicting multiple unit sizes for a given food item	3D food models of variable sizes for a given food item, made from plastic or other durable material (each model corresponds to a known weight of a given food item)	The 3D food model that most closely represents the unit size of the food served is selected from a range of sizes. The number (multiples) and/or fractions consumed of the selected unit size depicted are reported.	The code of the 3D food model selected is recorded. The number and/or fraction of the selected 3D food model is recorded.	Ease of visualizing the unit size served. Relative ease of use during the 24-hour dietary recall interview.	Requires investment to determine the range of sizes to represent for a given food item and to create the 3D food models. Limited to settings that have the resources to develop high-quality 3D food models. There is a practical limitation to the number of 3D food models that can be created and carried by enumerators. Fractions of unit sizes represented by 3D food models may be difficult for respondents to report and/or for enumerators to record.	3D food models must be developed. This work entails determining the appropriate unit sizes to represent for a given food item and creating the models. The corresponding weight of the food item depicted in each 3D model must be pre-determined and clearly documented.

A In addition to the tools and aids listed in this table, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL to guide the enumerator during the 24-hour dietary recall interview.

B For simplicity, we refer to food items consumed, but several PSEMs can also be used to estimate the amount of an ingredient used and the total amount of a mixed dish prepared. Refer to Table 2 for details about the suitability of different PSEMs for collecting data on standard and non-standard recipes.

C For food items for which amounts consumed can be estimated with the inedible portions included (e.g., chicken, fish, and other meat served with bone), the enumerator must always record if inedible parts were included or not when estimating the amount consumed. Refer to Table 3 for considerations related to the use of each PSEM with food items that may include inedible parts.

2.4 Outlier PSEMs

In any large-scale survey, there may be a small number of food items that will require the use of different PSEMs than those listed as Group I or Group II PSEMs. Examples include the price of the food item (i.e., monetary unit) and food length. We refer to these PSEMs as Outlier PSEMs because they are not well suited for use with a large number of food items, given their limited accuracy and/or the difficulty of using the PSEM in the context of a large-scale survey.

The use of monetary units as a PSEM can be used in contexts where it is easier for the respondent to recall the amount paid for a food item than to estimate the amount consumed using other PSEMs. For example, a respondent may report having spent 2 USD on onions used for a mixed dish, and in the given setting, this corresponds to 500 g of onions. Use of monetary units as a PSEM is not usually practical for use in a large-scale dietary survey as the method requires determining the cost of the food item for which the PSEM will be used and assuming a standard price per volume or weight of that food item across the geographic areas to be sampled for the survey. Even in the context of a small-scale survey, it is often necessary to collect price data for a given food item for many geographic areas, as the price of a food item will typically vary according to geographic location and/or market type. But doing so is usually not practical in the case of a large-scale survey, given the extensive amount of price data that would likely need to be collected across geography and market types for any given food item.

The use of linear measurement as a PSEM involves the respondent representing the length of the food item consumed the previous day using a string (which is then measured by the enumerator) or a measuring tape. This PSEM considers only one dimension of the food item consumed and therefore lacks accuracy. Linear measurement should only be used as a PSEM for an extremely limited number of very specific foods, for which the length of the food item consumed may vary, but for which other dimensions of the food item do not vary substantively (e.g., sugar cane).

3 Selecting and Assigning PSEMs for Use in a Dietary Survey

There is no single "gold standard" PSEM that can be used to estimate the amount consumed for all types of food items. The appropriateness of a given method for portion size estimation depends largely on the state and form in which the food item was consumed, as well as the presentation of the food item when served. Given the variety of food items that are likely to be reported as consumed and the variable characteristics of these food items, multiple PSEMs will need to be selected for use in any given survey.

3.1 General Considerations for the Selection and Assignment of PSEMs

Contextual appropriateness of a PSEM for use in a given survey can be determined by the feasibility of use in the local context, the equipment required for use of the method (i.e., local availability), the extent of preparatory work required to use the PSEM (e.g., to develop tools and aids such as food photographs), and whether the PSEM has been used successfully before with a similar population and among the specific demographic groups to be targeted for the survey. In addition, methodological aspects inherent in the use of some PSEMs (e.g., the need to allow for the reporting of multiples and fractions of selected units) are also critical to consider, to ensure that all steps required for the use of a given PSEM are feasible in a particular survey context.

When selecting the set of PSEM to use in a survey, the overall number of different PSEMs to be used requires careful consideration. The greater the number of PSEMs used, the greater the complexity of data collection, thereby increasing the risk for error in data collection. Also, because nearly all PSEMs require conversion of the amount reported as consumed by the respondent into a gram unit weight equivalent of the food item consumed, the use of a large number of different PSEMs increases the complexity of work required to compile the PSEM conversion factor database for the survey (see Box 1 for further details). In most contexts, the total number of PSEMs to be used in a large-scale survey can be kept to five or less for the vast majority of food items. However, in some survey contexts, there may be a small number of food items that require additional PSEMs.

The assignment of PSEMs should take place as part of pre-survey activities before survey tools are developed, to allow for the PSEMs to be pre-tested for feasibility and ease of use before enumerators are trained. Which PSEM to use for a given food item should not be determined by the enumerators at the time of data collection during the administration of the 24-hour dietary recall interview with the respondent, unless the food item reported is missing in the survey databases compiled before beginning data collection, and therefore has no assigned PSEM.

The food, recipe, and ingredient listing (FRIL) developed during pre-survey activities[5] provides the framework for assigning PSEMs to each food item. The FRIL is a comprehensive list of all the foods and beverages consumed as individual items or in mixed dishes, and ingredients used to prepare mixed dishes, that are likely to be encountered during the 24-hour dietary recall survey. Each food item listed in the FRIL should have a separate line for each variation of that item likely to be reported as consumed during the survey, including the particular state and form of the food item and its mode of presentation.[6] These descriptive details will have implications for

[5] For further guidance on pre-survey activities required for a quantitative 24-hour dietary recall survey, refer to Vossenaar M, Arimond M, Deitchler M, Lubowa A, Hotz C, and Moursi M. 2020. *An Overview of the Main Pre-Survey Tasks Required for Large-Scale Quantitative 24-Hour Recall Dietary Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[6] Relevant descriptive details tend to vary by food group. Examples include variety/type/color; state (e.g., fresh, dried); maturity (ripe, unripe); part (e.g., seed, flesh, with or without bones); mechanical processing (e.g., grated, chopped, sliced, pounded); other processing (e.g., fermented, brined, smoked, frozen, canned); cooking methods (boiled, roasted, shallow-fried, deep-fried); additions (e.g., salted, added sugar); brand, fortification, and enrichment (for commercial products); and the presentation mode or the way in which a food or ingredient is served and consumed (e.g., chicken leg eaten on the bone; chicken leg cut off the bone before eating).

how respondents might best estimate the portion size consumed. Each food item listed in the FRIL should be assigned a PSEM based on how best respondents are expected to be able to visualize and estimate the amount consumed.

To determine which PSEM to assign for each food item, it is useful to consider:

- the consistency of the food item (e.g., solid, semi-liquid, fluid);
- the form of the food item (e.g., whole, sliced, diced, mashed, pureed);
- the state of the food item (e.g., raw, boiled, steamed, roasted, grilled, baked, fried);
- the size of the food item and the range of portion sizes usually consumed;
- the presentation of the food item when served (e.g., served with or without inedible parts); and
- how the amount consumed is easiest for the respondent to visualize and report to the enumerator.

To promote standardization in data collection methods and minimize survey cost and the potential for error among enumerators, *Intake* recommends that a single PSEM be assigned for each item in the FRIL (i.e., to each food item in a given state, form, and presentation mode). When needed, a limited selection of additional PSEMs can also be assigned to a given food item. For example, a can or bottle of soda may be reported as consumed by a respondent for which standard unit size as a PSEM is well suited, or a glass of soda may be reported as consumed for which proxy weight using a free-flowing material is well suited as a PSEM. To guide the enumerator as to which PSEM should be used for a given food item, a list of the PSEMs assigned to each item in the FRIL should be developed. This PSEM list should include details on which PSEM is assigned for all variations of a given food item in terms of the state and the form of the food item, as well as in terms of how the food item may be served. When using electronic data collection methods, the PSEM list can typically be uploaded or integrated into the software application. When using paper for data collection, the probe list is hand-carried and possibly laminated.

3.2 Considerations for the Assignment of PSEMs to Mixed Dishes

When assigning PSEMs to mixed dishes, the following considerations are also important. For a mixed dish reported during the 24-hour dietary recall interview for which a "standard recipe" is available, the only portion size information that needs to be collected is the amount of the mixed dish consumed by the respondent. When a standard recipe is not available, the enumerator must collect additional information during the 24-hour dietary recall interview to derive a "non-standard recipe". This includes details on the ingredients, the amount of each ingredient used, and the total quantity of the mixed dish prepared. Once a non-standard recipe has been derived, the amount of the mixed dish consumed by the respondent must also be collected. To avoid later complications with processing the non-standard recipe data collected, the same PSEM (e.g., proxy weight using raw rice) should be used for estimating the quantity of the final mixed dish prepared and the quantity of the mixed dish consumed by the respondent.[7] Few PSEMs are suitable to estimate the quantity of the final mixed dish prepared because this is typically a large amount; the best option is often to use a proxy material such as raw rice, which is readily available and can be carried by enumerators in large quantities.

A further consideration when assigning PSEMs to mixed dishes is whether ingredients are more or less evenly distributed such that any serving from that mixed dish would contain similar proportions of the constituent ingredients (i.e., a homogenous mixed dish).[8] For non-homogenous mixed dishes that include nutrient-dense ingredients that can be picked out (e.g., chunks of red meat, fish, or poultry in a stew),[9] survey planners may decide that the amount of nutrient-dense ingredients should be estimated separately from the amount consumed of the homogenous part of the mixed dish (e.g., the remaining broth, sauce, or rice mixture). If this is done, a PSEM will need to be assigned to each such nutrient-dense ingredient in the non-homogenous mixed dish, and a separate PSEM will need to be assigned to the remaining homogenous mixture to estimate the amount consumed. And where a non-standard recipe is collected, the total amount of the homogenous mixture prepared would also need to be estimated.

The suitability of each Group I and Group II PSEM to estimate standard and non-standard recipes for homogenous and non-homogenous mixed dishes is summarized in Table 2.

[7] In situations in which different PSEMs are used for estimating the total amount of the mixed dish prepared and the amount of the mixed dish consumed, depending on the PSEMs used to collect this information, survey staff may need to prepare the non-standard recipe reported by the respondent to collect the density information needed for the non-standard recipe, to calculate ingredient proportions, and to convert them into a gram unit weight.

[8] For example, in maize porridge the flour, sugar, and milk are all evenly dispersed and cannot be isolated at the point of serving. Another example is a dish of minced meat sauce with finely chopped tomatoes and onions.

[9] For example, large pieces of chicken prepared in a rice mixture, whole hard-boiled eggs in a curry sauce, or a large fish stewed with broth and vegetables. If the meat or egg portion is typically served separately from the broth or sauce (even if some broth or sauce is added later) or if a serving of these dishes allows for a choice of the amount of meat or egg, such that the nutrient-dense portion is not always proportional to the amount of broth or sauce prepared, it is considered a non-homogenous dish.

Table 2. Suitability of Different PSEMs for Standard and Non-Standard Recipes

PSEM	Standard Recipe[A]			Non-standard Recipe[B]		
	Homogenous mixed dish[C]	Non-homogenous mixed dish[D]		Homogenous mixed dish[C]	Non-homogenous mixed dish[D]	
		The amount consumed of the entire mixed dish is estimated[E]	The amount consumed of the remaining homogenous mixture[F]		The amount consumed of the entire mixed dish is estimated[E]	The amount consumed of the remaining homogenous mixture[F]
Group I PSEMs: Methods that do not require extensive preparatory work in advance of the survey						
1. **Direct weight** using food replicas	Possible	Possible	Not possible	Not possible	Not possible	Not possible
2. **Standard unit size** (each unit corresponds to a known weight)	Possible	Possible	Not possible	Not possible	Not possible	Not possible
3. **Proxy weight using a material that can be shaped** (e.g., playdough)	Possible	Possible	Possible	Possible with caveats[G,H]	Possible with caveats[G,H]	Possible with caveats[G,H]
4. **Proxy weight using a free-flowing material** that is pourable (e.g., raw rice)	Possible	Possible	Possible	Possible with caveats[G,H]	Possible with caveats[G,H]	Possible with caveats[G,H]
5. **Proxy weight using a material that heaps** (e.g., Kinetic Sand®)	Possible	Possible	Possible	Possible with caveats[G,H]	Possible with caveats[G,H]	Possible with caveats[G,H]
6. **Calibrated household utensils** (e.g., spoons, scoops, and/or ladles)	Possible	Possible	Possible	Possible with caveats[G,H]	Possible with caveats[G,H]	Possible with caveats[G,H]

A A standard recipe is an "average" recipe that aims to reflect the way that mixed dishes are usually prepared by respondents in a survey area.

B A non-standard recipe is derived from data collected in the household, where the respondent (or the cook of the mixed dish in the household) provides the details of the mixed dish consumed by the respondent. This is typically done as part of the 24-hour dietary recall interview carried out during the survey.

C In a homogenous mixed dish, the ingredients are more or less evenly distributed such that any serving from that mixed dish would contain similar proportions of the constituent ingredients.

D In a non-homogenous mixed dish, one or more of the nutrient-dense ingredients are not evenly distributed in the mixture.

E Survey planners may decide that the amount of non-homogenous dishes consumed should be estimated for the entire dish (i.e., the amount consumed of nutrient-dense ingredients are not estimated separately).

F Survey planners may decide that the amount consumed of nutrient-dense ingredients should be estimated separately from the amount consumed of the homogenous part of the mixed dish. A separate PSEM will be needed for each nutrient-dense ingredient and for the remaining mixture. This column indicates if each PSEM is suitable to estimate the amount consumed of the remaining homogenous mixture of such a dish.

G The total amount of the prepared mixed dish (or the remaining homogenous mixture) is needed to calculate the amount of each ingredient consumed, accounting for water loss. The total amount (i.e., volume) of the prepared mixed dish (or the remaining homogenous mixture) may be larger than the amount of proxy material carried by the enumerator.

H This PSEM requires a measure of the density of the mixed dish (or the remaining homogenous mixture) to convert the amount of proxy material recorded by the enumerator into the corresponding amount in grams of the mixed dish. It is not possible to collect the density of a non-standard recipe (or the remaining homogenous mixture) in advance of the survey.

PSEM	Standard Recipe[A]			Non-standard Recipe[B]		
	Homogenous mixed dish[C]	Non-homogenous mixed dish[D]		Homogenous mixed dish[C]	Non-homogenous mixed dish[D]	
		The amount consumed of the entire mixed dish is estimated[E]	The amount consumed of the remaining homogenous mixture[F]		The amount consumed of the entire mixed dish is estimated[E]	The amount consumed of the remaining homogenous mixture[F]
Group II PSEMs: Methods that require extensive preparatory work in advance of the survey						
7. **Graduated portion-size food photographs** depicting multiple portion sizes for a given food item	Possible	Possible	Not possible	Not possible	Not possible	Not possible
8. **Full-size food photographs** depicting multiple unit sizes of a single food in a whole, unprocessed state	Not possible	Not possible	Not possible	Not possible	Not possible	Not possible
9. **2D shapes** depicting multiple unit sizes for a given food item	Possible	Possible	Not possible	Not possible	Not possible	Not possible
10. **3D food models** depicting multiple unit sizes for a given food item	Possible	Possible	Not possible	Not possible	Not possible	Not possible

A A standard recipe is an "average" recipe that aims to reflect the way that mixed dishes are usually prepared by respondents in a survey area.

B A non-standard recipe is derived from data collected in the household, where the respondent (or the cook of the mixed dish in the household) provides the details of the mixed dish consumed by the respondent. This is typically done as part of the 24-hour dietary recall interview carried out during the survey.

C In a homogenous mixed dish, the ingredients are more or less evenly distributed such that any serving from that mixed dish would contain similar proportions of the constituent ingredients.

D In a non-homogenous mixed dish, one or more of the nutrient-dense ingredients are not evenly distributed in the mixture.

E Survey planners may decide that the amount of non-homogenous dishes consumed should be estimated for the entire dish (i.e., the amount consumed of nutrient-dense ingredients are not estimated separately).

F Survey planners may decide that the amount consumed of nutrient-dense ingredients should be estimated separately from the amount consumed of the homogenous part of the mixed dish. A separate PSEM will be needed for each nutrient-dense ingredient and for the remaining mixture. This column indicates if each PSEM is suitable to estimate the amount consumed of the remaining homogenous mixture of such a dish.

3.3 Considerations Related to the Compilation of PSEM Conversion Factors

The analysis of dietary data requires the use of PSEM conversion factors to convert the amount of a given food item estimated as consumed into the equivalent grams of edible food consumed (see Box 1). The PSEM conversion factor for a given food item is determined by: i.) the PSEM used for estimating the amount of the food item consumed; and ii.) whether the portion size of the food item consumed was estimated with or without the inedible parts included. The formula for calculating a PSEM conversion factor thus consists of two components: i.) a PSEM-specific factor; and ii.) an edible portion factor. Because the selection of PSEMs for use in a given survey impacts the information that will need to be compiled to convert the dietary data collected into gram units of the edible amount consumed, the complexities associated with the compilation and calculation of PSEM conversion factors should be considered by survey planners when selecting the set of PSEMs to be used in a survey, which PSEMs to assign to each food item, and how to adapt each PSEM selected for use in the survey.

When assigning PSEMs to food items in the FRIL, survey planners must consider how the necessary data to derive the PSEM-specific factor for the food item will be obtained. When standard unit size is selected as a PSEM, the corresponding weight of each standard unit for the food item must be pre-determined; when using a proxy material or calibrated household utensils as a PSEM, density data for the food items estimated with those PSEMs will be needed; in addition, when using a proxy material as a PSEM, the density of the proxy material will also be needed; and when using calibrated household utensils as a PSEM, the volume of the utensils must be pre-determined. When using Group II PSEMs, the corresponding weight of the food depicted in each food image, and by each 2D shape, and 3D food model must be pre-determined. Some data needed to compile the relevant PSEM-specific factor may be challenging to collate, in which case, survey planners may determine that it is necessary to assign a different PSEM to that food item. For example, for some food items, there may be no reliable published density values, and collecting primary density data may not be feasible. Data needs for the compilation of the PSEM-specific factor for a given food item are among the pre-survey work requirements described for each PSEM in the last column of Table 1.

When assigning PSEMs to food items in the FRIL, it is also essential that survey planners consider for which variations of foods listed in the FRIL (e.g., by state, form, and presentation mode) an inedible portion (e.g., bones, seeds, pits, or peels) might be included for the food, as visualized by the respondent for portion size estimation. This may be the case if the inedible parts of the food are removed during eating (e.g., chicken leg served on the bone). Survey planners may decide, in some cases, that different PSEMs are more appropriate than others for a given food, depending on whether the respondent is reporting the portion size with or without the inedible portion included. Key considerations related to the use of each Group I and Group II PSEM for estimating foods with or without inedible portions included are summarized in Table 3.

Box 1. Overview Description of a PSEM Conversion Factor Database

A PSEM conversion factor database is a compilation of all the PSEM conversion factors needed to convert the amount of foods, mixed dishes, and ingredients (collectively referred to as food items) estimated to have been consumed using a pre-determined PSEM into the equivalent grams of edible food consumed. Work to compile the PSEM conversion factor database for a survey is typically completed before collecting data for the survey. The PSEM conversion factor for a given food item is calculated by multiplying the "PSEM-specific factor" by the "edible portion factor". If survey planners allow the use of substitutions when using direct weight of food replicas or graduated portion-size food photographs as PSEMs, then an additional conversion (referred to as a "substitution factor") is required.

To analyze the dietary data collected, all food items reported as consumed by survey respondents need to be converted into a common, gram unit measurement. To do so requires using a PSEM conversion factor that is appropriate to the PSEM used and the food item reported as consumed. A unique PSEM conversion factor is needed for each food item included in the FRIL, for each PSEM assigned to a given food item.

The "PSEM-specific factor" relates directly to the PSEM used to estimate the amount consumed. The PSEM-specific factor that is needed for a given PSEM depends on the unit with which that PSEM collects information about the portion size consumed (e.g., unit size in grams, grams of proxy material, volume of the calibrated household utensil, grams assigned to a depicted portion or unit size).

The "edible portion factor" is needed to account for any portion of a food that is not consumed. This is most typically the case for foods that are easier for respondents to visualize when the inedible portions are included. Examples of foods that have inedible parts include chicken, fish, and other meat served with bone, groundnuts in the shell, maize on the cob, and fruits with inedible seeds, pits, or peels. All foods must have an edible portion factor to convert the quantity estimated as consumed into the gram unit weight of the edible portion. In cases where the food did not include any inedible parts, then the edible portion factor is 1.

The actual use of the PSEM conversion factor to obtain grams of food consumed by respondents takes place in the data-processing stage. Data processing can be done after the survey is complete or, depending on the software, may be able to occur instantly when using electronic data collection. The latter has the advantage of allowing for quality checks during data collection.

Box 2 provides step by step instructions for how to calculate a PSEM conversion factor and apply this to the amount reported as consumed for a given food item, and a given PSEM. Box 3 provides step by step instructions for how to calculate a PSEM conversion factor and apply this to the amount reported as consumed for a "substitution" food item.

NOTE For detailed guidance on how to compile and collect data for a PSEM conversion factor database see Vossenaar M, Hotz C, Arsenault J, Deitchler M, Arimond M, Lubowa A, and Moursi M. Forthcoming. *How to Compile the Portion Size Estimation Method Conversion Factor Database for a Quantitative 24-Hour Dietary Recall Surveys in a Low- or Middle-Income Country*. Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions. Available at Intake.org.

Box 2. Example to Show How to Calculate and Use PSEM Conversion Factors

Food item, PSEM used, and amount reported	Reported food item:	Grilled chicken leg **with** a bone (inedible parts included)	Grilled chicken leg **without** a bone (no inedible parts included)
	PSEM used:	Proxy weight using playdough	Proxy weight using playdough
	Amount reported as consumed:	156 g of playdough	156 g of playdough
Data needed to calculate the PSEM conversion factor	Density of playdough:	1.4 g/ml	1.4 g/ml
	Density of the food item:	0.8 g/ml	0.9 g/ml
PSEM conversion factor calculation	PSEM-specific factor:	$^1/_{1.4}$ x 0.8 = 0.57	$^1/_{1.4}$ x 0.9 = 0.64
	Edible portion factor:	0.7	1.0
	PSEM conversion factor:	0.57 x 0.7 = 0.40	0.64 x 1.0 = 0.64
Step by step calculation to derive the amount consumed	Amount of food reported as consumed (including inedible portion):	156 g x ($^1/_{1.4}$ g/ml) x 0.8 g/ml = 89 g	156 g x ($^1/_{1.4}$ g/ml) x 0.9 g/ml = 100 g
	Amount of food consumed (edible portion):	89 g x 0.7 = 62 g	100 g x 1.0 = 100 g
Calculation using the PSEM conversion factor	Amount of food consumed (edible portion):	156 x 0.40 = 62 g	156 x 0.64 = 100 g

Box 3. Example to Show How to Calculate and Use a Substitution Factor

Food item, PSEM used, and substitution food item	Reported food item:	Grilled **chicken** leg without bone (no inedible parts included)	Grilled **duck** leg without bone (no inedible parts included)
	PSEM used:	Graduated portion-size food photograph	Graduated portion-size food photograph
	Depicted food item:	Grilled chicken leg without bone (no inedible parts included)	Grilled chicken leg without bone (no inedible parts included)
Data needed to calculate the PSEM conversion factor and the substitution factor	The corresponding amount of the food item depicted (grams):	230 g (as depicted in photograph C)	230 g (as depicted in photograph C)
	Density of the reported food item:	0.90 g/ml	0.83 g/ml
	Density of the depicted food item:	0.90 g/ml	0.90 g/ml
PSEM conversion factor calculation	PSEM-specific factor:	230	230
	Edible portion factor:	1.0	1.0
	PSEM conversion factor	230 x 1 = 230	230 x 1 = 230
	Substitution factor:	1 (no substitution is used)	$0.83/0.90$ = 0.922
Step by step calculation to derive the amount consumed	Amount of food consumed (edible portion)	230 x 1.0 X 1 = 230 g	230 x 1.0 x $0.83/0.90$ = 212 g
Calculation using the PSEM conversion factor and the substitution factor	Amount of food (edible portion)	230 x 1 = 230 g	230 x 0.922 = 212 g

Table 3. Considerations for the Use of PSEMs for Food Items That May Include Inedible Parts

PSEM	Considerations for the food item represented by the PSEM	Considerations for how the amount consumed is reported by the respondent
Group I PSEMs*:* Methods that do not require extensive preparatory work in advance of the survey		
1. **Direct weight** using food replicas	The food replica should not include any inedible parts.	The PSEM is only appropriate to use if the respondent reported serving the food item with the inedible parts excluded (if the food item has any).
2. **Standard unit size** (each unit corresponds to a known weight)	Standard unit sizes that pertain to a given food item can include or exclude inedible parts, based on the state, form, and presentation mode of the food item that is being considered for the use of standard unit size as a PSEM.	Food items can be estimated with inedible parts included or excluded.[A]
3. **Proxy weight using a material that can be shaped** (e.g., playdough)	Not relevant.	Food items can be molded with inedible parts included or excluded.[A]
4. **Proxy weight using a free-flowing material** that is pourable (e.g., raw rice)	Not relevant.	Food items can be molded with inedible parts included or excluded.[A]
5. **Proxy weight using a material that heaps** (e.g., Kinetic Sand®)	Not relevant.	Not relevant. This PSEM should only be used for small quantities of food items that can be visualized with spoons, scoops, and/or ladles. Such food items do not typically include inedible parts.
6. **Calibrated household utensils** (e.g., spoons, scoops, and/or ladles)	Not relevant.	Not relevant. This PSEM should only be used for liquid food items. Such food items do not typically include inedible parts.

A If the food item is estimated with inedible parts included, an edible portion factor for the food item must be compiled. If the food item is estimated without inedible parts included, the edible portion factor is set as 1.

PSEM	Considerations for the food item represented by the PSEM	Considerations for how the amount consumed is reported by the respondent
Group II PSEMs*:* Methods that require extensive preparatory work in advance of the survey		
7. **Graduated portion-size food photographs** depicting multiple portion sizes for a given food item	The series of portion sizes depicted in a photographic series for a given food item should not include inedible parts.	The PSEM is only appropriate to use if the respondent reported serving the food item with the inedible parts excluded (if the food item has any).
8. **Full-size food photographs** depicting multiple unit sizes of a single food in a whole, unprocessed state	The series of images in a photographic series for a given food depict different unit sizes of a given food with inedible parts included or excluded, based on how that food naturally occurs in its whole, unprocessed state.	If the food image represented includes inedible parts, the PSEM is only appropriate to use for the food if the respondent reported serving the food with inedible parts included.[B] If the food image represented excludes inedible parts, the PSEM is only appropriate to use if the respondent reported serving the food with the inedible parts excluded.
9. **2D shapes** depicting multiple unit sizes for a given food item	The 2D shape should not include any inedible parts.	The PSEM is only appropriate to use if the respondent reported serving the food item with the inedible parts excluded (if the food item has any).
10. **3D food models** depicting multiple unit sizes for a given food item	The series of unit sizes depicted for a given food item can include or exclude inedible parts, based on how that food is typically served and consumed in the given state, form, and presentation mode represented in the 3D food model.	If the food image represented includes inedible parts, the PSEM is only appropriate to use if the respondent reported serving the food with inedible parts included.[B] If the food image represented excludes inedible parts, the PSEM is only appropriate to use if the respondent reported serving the food with the inedible parts excluded.

B If the food item is represented with inedible parts included, an edible portion factor for the food item must be compiled.

3.4 Types of Food Items for Which Group I and Group II PSEMs Are Well Suited

Table 4 provides a summary of the types of food items and lists example food items for which each Group I and Group II PSEM is well suited. For a detailed description of each PSEM, including the appropriateness for use with different food items and related considerations and precautions for use of the PSEM, refer to Annex 1.

Table 4. Types and Examples of Food Items That Are Suitable for Each PSEM

PSEM	Types of food items for which the PSEM is well suited	Example food items
Group I PSEMs: Methods that do not require extensive preparatory work in advance of the survey		
1. **Direct weight** using food replicas[A]	Foods and mixed dishes with a standard recipe[B,C] that are widely consumed and are likely to contribute a significant proportion of energy or nutrient intakes among the survey population (i.e., staple foods).	Stiff porridges prepared from cereal, roots, and tuber flour (e.g., ugali, nshima, ubwali, posho, gari) Mashed tubers, roots, and plantain commonly consumed as staples (e.g., matooke, potatoes, pounded yam, fufu, injera)
2. **Standard unit size** (each unit corresponds to a known weight)	Commercially packaged foods of a specified type and brand that typically occur in a single serving and standard size	Factory-sliced bread, bread buns, rolls, scones, biscuits, cookies, muffins, cupcakes, doughnuts Canned beverages (e.g., soda, fruit juices, beer) Table packs of sugar, salt, ketchup Bouillon cubes, curry powders, and other packaged condiments
	Specified varieties of fruits, vegetables, and eggs that exist in more or less uniform sizes and are typically consumed in quantities of units that can be easily counted	Fruits (e.g., grapes, raspberries, gooseberries, lemon guavas, lime fruit, loquats, plums, olives, planet fruits, apples, bananas, oranges, jack fruit, many wild fruits) Vegetables (e.g., okra, chilies, peppers) Chicken eggs
	Home- and vendor-prepared ready-to-eat mixed dishes with a standard recipe[B,C] that are sold or served in specified sizes and shapes by fast food outlets, street vendors, etc.	Samosas, mandazi/tumbua, shawarmas, pancakes, chapati, eggrolls Burgers, wraps, ice-cream scoops from a given fast-food chain Vegetable bundles sold in fresh food markets

A This PSEM is not suitable for food items that are typically served with inedible parts.

B Standard recipes are "average" recipes that aim to reflect the way that mixed dishes are usually prepared by respondents in a survey area.

C When a standard recipe is available, this PSEM is suitable for homogenous mixed dishes and for non-homogenous mixed dishes for which the amount consumed is estimated for the entire dish (i.e., the amount consumed of nutrient-dense ingredients are not estimated separately).

PSEM	Types of food items for which the PSEM is well suited	Example food items
Group I PSEMs: Methods that do not require extensive preparatory work in advance of the survey		
3. **Proxy weight using a material that can be shaped** (e.g., playdough)	A vast array of oddly shaped foods that do not have a uniform size	Roots and tubers (e.g., potatoes, cassava, yams) Pieces of red meat, chicken, and fish Baked and fried dough foods (e.g., fried dough, dumplings) Whole small fruits and vegetables (e.g., strawberries, apples, bananas, tomatoes) Slices or chunks of larger fruits and vegetables (e.g., papaya, watermelon)
	A variety of mixed dishes with a standard[B,D] or non-standard recipe[E,F,G]	Stiff porridges (e.g., ugali, nshima, gari) Mashed roots, tubers, and plantains
4. **Proxy weight using a free-flowing material that is pourable** (e.g., raw rice)	Liquid foods and mixed dishes with a standard[B,D] or non-standard recipe [E,F] such as beverages and broths	Milk, tea, coffee, fruit juices, alcoholic drinks, broth, cooking oils
	Free-flowing semi-liquid foods and mixed dishes with a standard[B,D] or non-standard recipe [E,F]	Thin cereal and root porridges, soups, sauces, gravies, and stews
	Dry free-flowing solid ingredients used in non-standard recipes	Grains (e.g., maize, rice, wheat), legumes (e.g., beans, lentils, peas), seeds (e.g., sesame, squash, sunflower seeds), flours, powdered milk, sugar, salt
	Chopped, diced, sliced, or grated ingredients used in non-standard recipes	Leaves, tubers, fruits, and vegetables (e.g., diced carrots, cassava, diced/sliced cabbages)

B Standard recipes are "average" recipes that aim to reflect the way that mixed dishes are usually prepared by respondents in a survey area.

D When a standard recipe is available, this PSEM is suitable for homogenous or non-homogenous mixed dishes for which the amount consumed is either estimated for the entire dish or for the nutrient-dense ingredients separately.

E A non-standard recipe is derived from data collected in the household, where the respondent (or the cook of the mixed dish in the household) provides the details of the mixed dish consumed by the respondent. This is typically done as part of the 24-hour dietary recall interview carried out during the survey.

F When a standard recipe is not available, this PSEM is suitable for homogenous or non-homogenous mixed dishes for which the amount consumed is either estimated for the entire dish or for the nutrient-dense ingredients separately.

G The amount of proxy material carried by enumerators may be insufficient for estimating the total amount of a non-standard recipe prepared.

PSEM	Types of food items for which the PSEM is well suited	Example food items
Group I PSEMs: Methods that do not require extensive preparatory work in advance of the survey		
5. **Proxy weight using a material that heaps** (e.g., Kinetic Sand®)[A]	Small amounts of foods that can most easily be visualized with the use of spoons, scoops, and/or ladles and can be heaped in variable amounts	Infant formula powder, powdered milk, sugar, coffee powder, flours, salt
	Small quantities of semi-liquid or semi-solid mixed dishes with a standard[B,D] or non-standard recipe [E,F,G]	Thin cereal and root porridges, and thick sauces
6. **Calibrated household utensils** (e.g., spoons, scoops, and/or ladles)[A]	Free-flowing liquid foods and ingredients used in a non-standard recipe[E] or consumed in small quantities	Cooking oil
	Small quantities of free-flowing liquid mixed dishes with a standard[B,D] or a non-standard recipe[E,F,H]	Thin soups, broths

A This PSEM is not suitable for food items that are typically served with inedible parts.

B Standard recipes are "average" recipes that aim to reflect the way that mixed dishes are usually prepared by respondents in a survey area.

D When a standard recipe is available, this PSEM is suitable for homogenous or non-homogenous mixed dishes for which the amount consumed is either estimated for the entire dish or for the nutrient-dense ingredients separately.

E A non-standard recipe is derived from data collected in the household, where the respondent (or the cook of the mixed dish in the household) provides the details of the mixed dish consumed by the respondent. This is typically done as part of the 24-hour dietary recall interview carried out during the survey.

F When a standard recipe is not available, this PSEM is suitable for homogenous or non-homogenous mixed dishes for which the amount consumed is either estimated for the entire dish or for the nutrient-dense ingredients separately.

G The amount of proxy material carried by enumerators may be insufficient for estimating the total amount of a non-standard recipe prepared.

H The use of calibrated household utensils is usually not appropriate to estimate the total amount of a non-standard recipe prepared.

PSEM	Types of food items for which the PSEM is well suited	Examples food items
Group II PSEMs: Methods that require extensive preparatory work in advance of the survey		
7. **Graduated portion-size food photographs** depicting multiple portion sizes for a given food item[A]	A wide variety of foods and mixed dishes with a standard recipe,[B,C] especially those typically served on plates	Solid or semi-solid staples, vegetables, legumes, meats, fish, desserts
8. **Full-size food photographs** depicting multiple unit sizes of a single food in a whole, unprocessed state	Single foods that are uniformly shaped but exist in a range of sizes and are typically consumed in an unprocessed, natural state and form (or for which the amount of ingredient used in mixed dishes is estimated before processing)	Fruits, vegetables, roots, and tubers, (e.g., bananas, mangoes, avocados, apples, onions, peppers, eggplants, beets, turnips, potatoes)
9. **2D shapes depicting** multiple unit sizes for a given food item[A]	Foods and mixed dishes with a standard recipe[B,C] that are flat, do not vary in thickness, and have a specific 2D contour	Flatbreads (e.g., roti, chapatti, naan bread), tortillas
10. **3D food models** depicting multiple unit sizes for a given food item	Foods and mixed dishes with a standard recipe[B,C] that are widely consumed and that have a definite shape that varies both in size and thickness	Whole fruits and vegetables (e.g., banana, avocados, mangoes, zucchini, eggplant, sweet potato)

A This PSEM is not suitable for food items that are typically served with inedible parts.

B Standard recipes are "average" recipes that aim to reflect the way that mixed dishes are usually prepared by respondents in a survey area.

C When a standard recipe is available, this PSEM is suitable for homogenous mixed dishes or non-homogenous mixed dishes for which the amount consumed is estimated for the entire dish (i.e., the amount consumed of nutrient-dense ingredients are not estimated separately).

4 Operationalizing the PSEMs Selected for Use in a Dietary Survey

Once the PSEMs to be used in a survey have been selected, a set of tasks must be carried out to operationalize each PSEM for use in the specific context of the survey. The set of required tasks include: i.) adapting the selected PSEMs for use in the local context; ii.) making decisions on how to account for leftovers and additional servings during data collection; iii.) identifying if individual plates/bowls should be distributed to aid with portion-size estimation in contexts where shared plate eating is common; iv.) procuring the equipment required for use of the selected PSEMs in the survey; v.) preparing tools and aids for collecting data with the selected PSEMs; and vi.) pre-testing the selected PSEMs for feasibility in the survey context. Each of these tasks is described in more detail below.

4.1 Adapting PSEMs for Use in the Local Context

While all Group I and Group II PSEMs are appropriate for use in large-scale dietary surveys in LMICs, there are specific constraints and challenges related to the use of each PSEM that require special consideration to ensure appropriate adaptation for use in the local context. The specific survey context and demographic groups to be targeted for a survey should always be considered when deciding how to adapt the PSEMs selected so as not to introduce additional error due to the cognitive difficulties of reporting and/or recording the amounts estimated as consumed. All decisions related to how to adapt the PSEMs for operationalization should be made before enumerator training. PSEMs may need to be adapted further after pre-testing and/or survey piloting, but all decisions about how to adapt PSEMs for use in a given survey must be finalized before data collection begins; these decisions cannot be made by the enumerators during the 24-hour dietary recall interview. The various adaptations that should be considered when operationalizing a PSEM for use in a given survey are described below in Sections 4.1.1 through 4.1.5. Summary information is provided in Table 5 to indicate whether each possible adaptation is required, possible with careful consideration, strongly discouraged, or not relevant, for each Group I and Group II PSEM.

4.1.1 Allowing the Reporting of Multiples of the Selected Units

Most Group I and Group II PSEMs can be operationalized in such a way that the respondent is allowed to report multiples of the selected units consumed.

Among Group I PSEMs, the use of multiples is required with the use of standard unit size and calibrated household utensils and can also be used when using playdough and raw rice as a proxy material for estimating portion size. When using a proxy material, the use of multiples should only be allowed when multiple units of the same size and shape are reported, but the respondent only molded or poured the amount of proxy material to represent a single unit (e.g., two same-sized cups of coffee). Allowing the reporting of multiple units should not be necessary and is strongly discouraged with the use of direct weight as a PSEM and when using Kinetic Sand® as a proxy material for portion size estimation.[10]

Among Group II PSEMs, the use of multiples is required for full-size food photographs, 2D shapes, and 3D food models. Graduated portion-size food photographs can also be operationalized to allow the respondent to report multiples of portion sizes depicted; however, doing so is optional with the use of this PSEM.

[10] Although multiple spoons of Kinetic Sand® can be scooped by the respondent, a single weight measurement of the total amount of proxy material scooped is recorded. Since a single, total weight value is recorded, we do not refer to these as "multiple units".

4.1.2 Allowing the Reporting of Fractions of the Selected Units

Although most Group I and Group II PSEMs can theoretically be operationalized in such a way that the respondent is allowed to report fractions of selected units consumed, due to the higher-level numeracy skills required by respondents and enumerators for fractional reporting to be implemented well, *Intake* recommends the use of fractional reporting only for those PSEMs for which its use is fundamentally important to accurate portion size estimation, i.e., standard unit size, full-size food photographs, 2D shapes, and 3D food models. The use of fractional reporting can also be used with graduated portion-size food photographs, although its use is optional in this case. Fractional reporting is strongly discouraged with the use of all other PSEMs.

Before committing to the use of any PSEM that requires the use of fractional reporting, we strongly recommend that the feasibility of fractional reporting and the recording of fractional portion size data be confirmed through careful pre-testing. When considered feasible, we recommend that the enumerator training include focused sessions to ensure that all enumerators are highly proficient at correctly recording data that involves fractional units. *Intake* also recommends limiting the use of fractions to halves, thirds, or fourths, as smaller fractions may be challenging to visualize, report, and record. Moreover, such small fractions are unlikely to meaningfully affect the estimated portion size.

Because allowing for the use of fractional unit reporting is imperative for accurate portion-size estimation when using standard unit size, full-size food photographs, 2D shapes, and 3D food models, in contexts where fractional reporting of unit sizes is determined by survey planners to not be feasible, none of these PSEMs should be used in the survey. In such contexts, only PSEMs that do not require the use of fractional unit reporting should be selected for use in the survey.

4.1.3 Allowing the Reporting of Portion Sizes That Are Not Depicted

Graduated portion-size food photographs can be operationalized in such a way that the respondent is allowed to indicate if the portion size consumed falls in-between two different portion sizes presented, or if the portion size consumed was smaller than the smallest or larger than the largest portion depicted. This the only PSEM that can be operationalized in this way.

Survey planners must decide in advance of data collection whether reporting portion sizes not depicted will be allowed during data collection when graduated portion-size food photographs have been selected as a PSEM for use in a survey. If non-depicted portion size reporting is allowed, and a respondent reports that a portion size falls in-between two different portion sizes presented, the assumption is that the reported portion size is the mid-point quantity of the two portion sizes depicted. If the PSEM is operationalized to allow for respondents to report a portion size smaller than the smallest portion depicted or larger than the largest portion size, survey planners must decide in advance of data collection, what is the portion size associated with “smaller than what is depicted” and “larger than what is depicted”. The assumptions made can, in some cases, result in significant error.

4.1.4 Allowing the Reporting of Multiples and/or Fractions and Portion Sizes That Are Not Depicted

Due to the complexity of operationalization, the use of multiple and/or fractional reporting should not be allowed in combination with the reporting of portion sizes not depicted. Conceptually, the cognitive process for reporting multiples and fractions is different from the cognitive process for reporting portion sizes not depicted; and, mathematically, they may not result in the same portion size. Deciding whether to use allow the use of multiples and/or fractions, or portions sizes that are not depicted, or neither, is an operational consideration that is only relevant to the use of graduated portion-size photographs as a PSEM. How survey planners decide to operationalize the use of the graduated portion-size food photographs should depend on the numeracy level of both the respondents targeted for the survey and the enumerators collecting the dietary data, as well as on the quality of the food photographs to be used (i.e., how the portion sizes depicted were derived and the range of portion sizes depicted for a given food item).

4.1.5 Allowing the Use of "Substitutions"

Substitutions refer to using a PSEM developed for use with a specific food item to estimate portion sizes of a set of similar food items that are not depicted (e.g., use of graduated portion-size food photographs depicting cooked spinach to assess the amount of cooked kale consumed). The only PSEMs for which substitutions are relevant to consider are direct weight and graduated portion-size food photographs. Given that practical constraints limit the number of food replicas and food photographs that can be developed, survey planners can consider allowing the use of substitutions with these PSEMs, even though substitutions bring additional complexity to the compilation of the PSEM conversion factor database and to processing the dietary data collected for analysis.

Substitutions should only be considered for the actual food item represented by a food replica or depicted in a photographic series for a graduated portion-size food photograph if:

- The substitution item looks very similar to the actual food item in terms of shape, color, and consistency.
- The substitution item is classified in the same food group (e.g., vegetables, dairy) as the actual food item.
- The substitution and actual food item are served similarly (i.e., served whole on a plate, served in squares).
- The substitution and actual food item both have no inedible parts.
- The substitution and actual food item are typically consumed in similar portion sizes (this is only relevant to graduated portion-size food photographs).

When substitutions are considered for use with mixed dishes, the actual food item represented by the food replica or depicted in a graduated portion-size food photograph should also be a mixed dish. The use of substitutions should only be considered for mixed dishes that have the same mandatory ingredients (e.g., maize flour in maize porridge),[11] but for which one or more major (e.g., sugar in maize porridge)[12] or minor ingredients (e.g., cinnamon in maize porridge)[13] may vary. In addition, substitutions should only be considered when both the actual mixed dish and the substitution mixed dish are homogenous and for which a standard recipe has been developed.

As noted earlier, the use of substitutions can have complex downstream implications for data processing. An additional conversions factor (referred to as the "substitution factor") is required to translate the portion size represented in the food photographs or by the food replica into the portion size of the substitution food item consumed.

Because the incorrect use of substitutions can lead to large errors in portion size estimation, *Intake* recommends avoiding the use of substitutions, when possible. For this same reason, we advise against using substitutions for foods that are very prominent in the local diet (i.e., widely consumed and nutritionally relevant). All allowed substitutions must be determined in advance of data collection.

[11] "Mandatory ingredients" are the primary constituents of a mixed dish and often give the dish its name. An example is maize flour in "maize porridge" or orange fruit in "orange juice".

[12] "Major ingredients" are optional ingredients that may or may not be added to a mixed dish depending on choice and availability. These ingredients alter the nutrient content of the dish but do not change the basic nature of the dish.

[13] "Minor ingredients or flavorings" are optional ingredients added in small quantities that are judged inconsequential to the overall nutrient content of the mixed dish.

Table 5. Overview of Allowed Adaptations for Operationalization for Each PSEM

PSEM	Allow the respondent to report multiples of the selected unit	Allow the respondent to report fractions of the selected unit[A]	Allow the respondent to report a portion size that is not depicted[B]	Allow the use of "substitutions"[C]
Group I PSEMs: Methods that do not require extensive preparatory work in advance of the survey				
1. **Direct weight** using food replicas	Strongly discouraged	Strongly discouraged	Not relevant	Possible, with careful consideration
2. **Standard unit size** (each unit corresponds to a known weight)	Required	Required	Not relevant	Not relevant
3. **Proxy weight using a material that can be shaped** (e.g., playdough)	Possible, when multiple units of the same size and shape are reported[D]	Strongly discouraged	Not relevant	Not relevant
4. **Proxy weight using a free-flowing material that is pourable** (e.g., raw rice)	Possible, when multiple units of the same quantity are reported[E]	Strongly discouraged	Not relevant	Not relevant
5. **Proxy weight using a material that heaps** (e.g., Kinetic Sand®)	Strongly discouraged[F]	Strongly discouraged	Not relevant	Not relevant
6. **Calibrated household utensils** (e.g., spoons, scoops, and/or ladles)	Required	Strongly discouraged	Not relevant	Not relevant
Group II PSEMs: Methods that require extensive preparatory work in advance of the survey				
7. **Graduated portion-size food photographs** depicting multiple portion sizes for a given food item	Possible, with careful consideration	Possible, with careful consideration	Possible, with careful consideration[G]	Possible, with careful consideration
8. **Full-size food photographs** depicting multiple unit sizes of a single food in a whole, unprocessed state	Required	Required	Not relevant	Not relevant
9. **2D shapes** depicting multiple unit sizes for a given food item	Required	Required	Not relevant	Not relevant
10. **3D food models** depicting multiple unit sizes for a given food item	Required	Required	Not relevant	Not relevant

A The use of fractions should be limited to halves, thirds, or fourths, as smaller fractions may be challenging to visualize and report and are unlikely to meaningfully affect the estimated portion size.

B The respondent is allowed to indicate if the portion size consumed falls between two different portion sizes presented or if the portion size consumed was smaller than the smallest or larger than the largest portion depicted.

C The respondent is allowed to use the PSEM for the food depicted to report amounts of similar foods consumed.

D For food items for which multiple same-size and -shape units were consumed, but the respondent only molded the amount of proxy material to represent a single unit.

E For food items for which multiple same-quantity units were consumed, but the respondent only poured the amount of proxy material to represent a single unit.

F Although multiple spoons of Kinetic Sand® can be scooped by the respondent, a single weight measurement of the total amount of proxy material scooped is recorded. Since a single, total weight value is recorded, we do not refer to these as "multiple units".

G Allowing respondents to report multiple and/or fractional reporting in combination with portion sizes not depicted should not be allowed. Conceptually, the cognitive process for reporting multiples and fractions is different from the cognitive process for reporting portion sizes not depicted; and, mathematically, they may not result in the same portion size.

4.2 Accounting for Leftovers and Additional Servings

A critical consideration during the collection of quantitative dietary data is ensuring that any possible leftovers and additional servings are accounted for in the estimation of the amount of the food item consumed. A food leftover refers to the amount of a food item that is served in an eating occasion but is not consumed. An additional food serving refers to the amount of a food item served after the first amount is served within the same eating occasion. Failure to account for potential leftovers and additional servings is a common error in 24-hour dietary recall data collection and can be an important source of error leading to under- or overestimation of food and nutrient intakes, especially among young children who often do not consume the food items they are offered in their entirety.

Different data collection approaches can be used during the 24-hour dietary recall interview to account for leftovers and additional servings. The most appropriate data collection approach to use will vary according to the PSEM assigned to the food item for which the amount consumed is being estimated (as summarized in Table 6) and the state, form, and presentation mode in which the food item was consumed.

One data collection approach used to account for leftovers and additional servings entails systematically asking the respondent to report the amount served (first serving) and then—if relevant—the amount not consumed (i.e., the amount "leftover"). Next—if relevant—the respondent should be asked to report the amount of the next additional serving, and—once again, if relevant—the amount leftover, and so on. When using this approach, the respondent is only asked to report amounts that s/he would have seen (i.e., the amount initially served, what was left on the plate at the end of the eating occasion, etc.). The advantage of this data collection approach—referred to as an "iterative approach"—is that the respondent is not burdened with any mental calculations of trying to subtract any leftovers or add any additional servings. This data collection approach can be used for all Group I PSEMs, except for calibrated household utensils. The iterative approach is the preferred method to use with direct weight and all PSEMs using a proxy material. However, the approach cannot be used with Group II PSEMs. When using direct weight and a proxy material, the amount served and the amount leftover can be visually represented by the respondent with the food replica or proxy material; an illustration of this approach is provided in Annex 2.

An alternative data collection approach—referred to as a "direct approach"—entails asking the respondent to only report an estimate of the amount consumed without using an iterative probing process. When this approach is used, the enumerator will need to remind the respondent at the outset to consider any potential leftovers and any additional servings when reporting the amount consumed. After the respondent reports the amount consumed, the enumerator confirms with the respondent that the amount estimated accounted for any leftovers and/or additional servings within the same eating occasion. This data collection approach is preferred when using standard unit size and is the only feasible approach to use with calibrated household utensils and all Group II PSEMs (i.e., food photographs, 2D shapes, and 3D food models). The direct approach can also be used with any PSEM or for any food item for which survey planners consider that the iterative probing process described above is too difficult or laborious to implement well.

For standardization purposes, the same method for accounting for leftovers and additional servings should be used by all enumerators and with all respondents for a given PSEM and food item in a given state, form, and presentation mode. Decisions on the method to employ need to be made in advance of enumerator training and should be documented as a reference for enumerators to use during data collection.

Table 6. How to Account for Leftovers and Additional Servings with Each PSEM

PSEM	Iterative approach to derive the amount consumed[A]	Direct approach to estimate the amount consumed[B]
Group I PSEMs: Methods that do not require extensive preparatory work in advance of the survey		
1. **Direct weight** using food replicas	Preferred	Possible
2. **Standard unit size** (each unit corresponds to a known weight)	Possible[C]	Preferred
3. **Proxy weight using a material that can be shaped** (e.g., playdough)	Preferred	Possible
4. **Proxy weight using a free-flowing material that is pourable** (e.g., raw rice)	Preferred	Possible
5. **Proxy weight using a material that heaps** (e.g., Kinetic Sand®)	Preferred	Possible
6. **Calibrated household utensils** (e.g., spoons, scoops, and/or ladles)	Not relevant	Required
Group II PSEMs: Methods that require extensive preparatory work in advance of the survey		
7. **Graduated portion-size food photographs** depicting multiple portion sizes for a given food item	Not relevant	Required
8. **Full-size food photographs** depicting multiple unit sizes of a single food in a whole, unprocessed state	Not relevant	Required
9. **2D shapes** depicting multiple unit sizes for a given food item	Not relevant	Required
10. **3D food models** depicting multiple unit sizes for a given food item	Not relevant	Required

A During the 24-hour dietary recall interview, an iterative approach is used to derive the amount consumed (i.e., the respondent reports the amount served and the amount of leftovers, if any; then, if relevant, the amount of the next additional serving, if any, and the amount of leftovers, and so on).

B During the 24-hour dietary recall interview, a direct approach is used to derive the amount consumed by asking the respondent the amount actually consumed without estimating amounts of leftovers or additional servings separately (although the respondent is reminded to consider them both at the outset of portion size estimation and afterward as a means of confirmation).

C Although the amounts of leftovers cannot be visually represented by the respondent, an iterative probing process to derive the amount consumed can still be used.

The concept of leftovers and additional servings is not relevant for food items for which the respondent ate from a shared plate or a common pot. What is left on a shared plate or in a common pot is not considered a "leftover" for portion size estimation because what remains is communal and not a leftover belonging to the individual respondent. In settings where shared plate eating is commonly practiced, the enumerator should first confirm if the reported food item was consumed from a shared plate or common pot; or from an individual plate or bowl. To estimate the portion size of a food item consumed from a shared plate or a common pot, the respondent should be asked to report only the portion size of the food item that s/he consumed, inclusive of all servings at the same eating occasion, with no regard for what was left on the shared plate or in the common pot. To avoid having to ask the respondent to estimate portion sizes based on what was taken and consumed from a shared plate or a common pot, survey planners may wish to consider distributing individual plates or bowls to the selected respondents in advance of the survey, so that the respondent can use them during the reference day for the 24-hour dietary recall interview (as described in Section 4.3).

4.3 Distribution of Plates and Bowls Where Shared Plate Eating Is Common

Portion size estimation is especially complex in settings where eating from shared plates or a common pot is common. Even where adults may eat from an individual plate, eating from shared plates may be common among young children. Strategies, such as pre-training respondents before the day of reference for the dietary recall interview and providing individual plates and/or bowls to respondents for use on the day of reference for dietary data collection can be especially helpful in a survey context where eating from shared plates is common.

During pre-training, respondents are given details on what they will be asked to recall during the 24-hour dietary recall interview (i.e., details on all food items consumed in and outside the household over a specified period, as well recipe information) and how they will be asked to recall this information. Individual plates and/or bowls can also be provided to all respondents during the pre-training, for use on the reference day for the 24-hour dietary recall interview, to aid the respondent to visualize the portion size of food consumed. The pre-training also provides an opportunity to introduce respondents to the PSEMs that will be used during the 24-hour dietary recall interview. An essential component of pre-training is advising and motivating respondents not to change their diet on the day of reference for the 24-hour dietary recall interview, even though they are being asked to change their behavior by eating off an individual plate or bowl.

4.4 Procurement of Equipment

All PSEMs, except standard unit size, require the use of equipment (as shown in the second column of Table 1). Several Group I PSEMs (i.e., direct weight and use of proxy materials) require the use of high-quality digital dietary scales,[14] along with high-quality batteries, and certified standard weights to test the accuracy and precision of the scales throughout data collection.[15] When using playdough and/or Kinetic Sand®, *Intake* recommends procuring a high-quality, commercial product (see Annex 1 for further recommended specifications for the playdough and Kinetic Sand® to use as PSEMs). When using rice, the same variety of rice should be procured for all enumerators for the duration of the survey. Additional equipment required in the field when using Group I PSEMs (except standard unit size) include: commonly used cups, bowls, and/or pots (needed when using all Group I PSEMs methods except standard unit size); commonly used spoons, scoops, and/or ladles (needed when using a proxy material that heaps and calibrated household measures); utensils to scoop (needed when using direct weight and a pourable proxy material); and storage containers (needed when using all Group I PSEMs methods except standard unit size).

All equipment required for use of the selected PSEMs must be procured well in advance of the survey. In some contexts, dietary scales, playdough, and Kinetic Sand® will need to be ordered from outside the country where the survey will be carried out. International procurement can be complicated by longer than expected shipping time and delays at customs. This possibility should be accounted for in the timeline planned for any data collection that requires the use of dietary scales and playdough. Other materials, such as cups, bowls, and pots; and spoons, scoops, and/or ladles should be procured locally.

4.5 Preparing Tools and Aids for Data Collection

To guide the enumerator during the 24-hour dietary recall interview, a PSEM list should be developed by survey planners to specify the PSEMs assigned to each item in the FRIL. The PSEM list should be organized by food item and should include specified details of each food item (i.e., the particular state and form, as well as the

[14] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[15] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

presentation mode). The PSEM list is intended for use as a job aid by enumerators to ensure that the correct PSEM is used for each food item for which data on portion sizes are being collected during the 24-hour dietary recall interview.

The PSEM list should be provided for use in enumerator training and carried as an aid (possibly laminated) during data collection. When using technology-assisted platforms for 24-hour dietary recall data collection, only the PSEM(s) assigned to the reported food item should be displayed, bypassing the need for a PSEM list to be carried as a survey aid.

When using direct weight, food replicas will need to be prepared by the survey staff. Depending on the food item prepared and food storage conditions, the food replicas may need to be replaced regularly throughout data collection. A stable supply of the relevant ingredients (with no variation in quality or variety) is needed.

In addition, as described in Section 2.2, Group II PSEMs (i.e., food photographs, 2D shapes, and 3D food models) require extensive preparatory work in advance of the survey to develop the required tools and aids for portion size estimation. Once the materials are developed (e.g., the printing of photograph books, making of 2D shapes and 3D food models), they need to be produced in sufficient numbers for all enumerators to have at least one copy. The logistics of preparing these materials should be planned carefully, with sufficient time allowed for the development, pre-testing (and possibly validation, if resources allow), and then making any necessary adaptations before enumerator training. This work can require several months.

4.6 Pre-testing PSEMs for Feasibility

4.6.1 Pre-Testing New PSEMs

If a PSEM that has not been used in previous dietary surveys in the country is proposed for use in the survey, the PSEM should be tested for feasibility and ease of use, first by survey staff and then, with subjects who have similar characteristics to the survey respondents to be targeted for the survey. It is also ideal for any new PSEM to be validated against a gold standard (i.e., the weight of observed portion sizes consumed). Validation refers to the formal statistical assessment of the level of agreement between reported consumption of a given food item as estimated using a given PSEM and the amount of that food item actually consumed (i.e., the weighed portion size of the food item observed to have been consumed).

4.6.2 Pre-Testing the Full Set of PSEMs Selected for a Survey

Before finalizing the list of PSEMs to be used in the survey, there should also be some pre-testing of the full set of PSEMs among subjects with similar characteristics to the survey respondents to be targeted for the survey, to ensure that each of the identified PSEMs (regardless of whether they have been used in previous surveys) are feasible for use with the type of food items assigned. The pre-testing should also confirm the feasibility of those aspects of each PSEM selected for use that can present cognitive difficulties and which can be particularly challenging in lower-literacy environments, such as the reporting and recording of fractional units (as required for standard unit size, full-size food photographs, 2D shapes, and 3D food models). The pre-testing of each PSEM should include a wide selection of food items, with varying consistency and form (where this is relevant) and across a range of commonly consumed portion sizes.

Subjects for the pre-testing should be selected from geographic areas that are not selected for data collection for the survey but that are part of the geography to be represented by the survey. Additionally, the subjects for the pre-testing should ideally be of the same age and sex as the respondents to be targeted for the survey.

The pre-testing of PSEMs is ideally done by field supervisors after they have been trained but in advance of enumerator training. Further testing and refinement of PSEMs can be done during field practice sessions for enumerators, which should take place during their training and the piloting of the survey, although any changes made to the operationalization, adaptation, or selection and assignment of PSEMs should be minimal at this stage.

Annex 1. Detailed Description of PSEMs

Group I PSEMs

1. Direct Weight Using Food Replicas

Description of the PSEM

When using direct weight as a PSEM, the respondent is shown a real food item that is an exact or very close replica of what the respondent reports having consumed the previous day. This is the most realistic way for the respondent to visualize the amount consumed. To estimate the amount consumed, the enumerator weighs the amount of food replica that the respondent indicates represents the amount of the food item consumed the previous day.

To avoid confusion for the respondent during the 24-hour dietary recall interview and prevent the need for conversion factors during data processing, the food replicas used must match the food item reported in terms of the type, state (e.g., cooked, raw), and form (e.g., whole, mashed, pureed), as well as presentation mode. For example, raw bananas should not be used to estimate the amount of cooked bananas consumed. Direct weight should not be used to estimate amounts of food items that are typically presented with inedible parts.

Types of food items for which this PSEM is well suited

Although direct weight can be assigned as a PSEM for a wide array of food items, in practice the use of this PSEM is limited because the logistics required for the preparation of food replicas is considerable and because food replicas are cumbersome for enumerators to carry in the field. The use of direct weight is therefore recommended for a very limited number of staple foods that are widely consumed and are likely to contribute a significant proportion of energy and/or nutrient intakes among the survey population.

The types of food items that are well suited to be estimated using direct weight include commonly consumed mixed dishes that have no inedible parts for which a standard recipe has been developed. These should be homogenous mixed dishes or non-homogenous mixed dishes for which survey planners have decided it is appropriate to estimate the amount consumed of the entire mixed dish (i.e., the amount of nutrient-dense ingredients consumed are not estimated separately from other parts of the mixed dish).

Examples of food items that are well suited for estimating amounts consumed with direct weight include stiff porridges prepared from cereal, roots and tuber flour (e.g., staples such as ugali, nshima, ubwali, posho, gari) and mashed tubers, roots, and plantains commonly consumed as staples (e.g., matooke, potatoes, pounded yam, fufu, injera).

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that the food item reported by the respondent is the same as the food replica being used to estimate the amount consumed—or an allowed similar one (referred to as a "substitution"). While doing so is straightforward for a single food, the process can be more complex for mixed dishes, especially when substitutions are allowed.

Food items estimated using direct weight are usually consumed from an individual plate or bowl. The enumerator should ask if the respondent can bring out the exact type of plate or bowl from which the food item was consumed. Using the same size and shape of plate or bowl provides the respondent with the most realistic opportunity to visually recollect the portion size consumed. Using a plate or bowl that is sized or shaped differently than the plate or bowl from which the food item was consumed is likely to reduce the accuracy of portion size estimation by the respondent. In case a respondent cannot provide the plate or bowl from which the food item was

consumed, all enumerators should be provided with a set of commonly used plates and bowls in the survey area for use when needed during data collection.

The plate or bowl selected by the respondent should be placed on a digital dietary scale and the scale should be tarred (to account for the weight of the plate or bowl). The enumerator should present the food replica to the respondent and guide the respondent to scoop, pour, or otherwise serve the food item onto the selected plate or bowl. The respondent should present the amount of the food replica that is equivalent to the amount of the food item that s/he recalls having consumed.

As is the case for all PSEMs, when using direct weight, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food item represents the amount consumed. When using direct weight as the PSEM, the respondent can either: i). be probed using an iterative approach to derive the amount consumed (i.e., the respondent reports the amount served and the amount of leftovers, if any; then, if relevant, the amount of the next additional serving, if any, and the amount of leftovers, and so on) or; ii). be asked to report directly the amount actually consumed without estimating amounts of leftovers or additional servings separately. When the second approach is used, the respondent is reminded to consider all leftovers and additional servings, both at the outset of portion size estimation and afterward as a means of confirmation.

The enumerator should record the weight of the food replica that represents the amount of the food item consumed in grams. The food replica used should then be returned to a sealed container for storage until the next use. All utensils used should be cleaned for further use, stored by the enumerator, or returned to the respondent.

Equipment, tools, and aids required

- Food replicas: Preparation guides should be developed for each food replica to be used, to ensure that the preparation of a given food replica is standardized and consistent throughout the survey period and across all survey teams. The preparation guide should include a detailed ingredient list to support the logistics of procuring all necessary ingredients (including salt for preservation, if relevant). The amount of food replica carried by each enumerator should exceed the largest portion likely to be encountered in the survey.
- Storage containers: Food replicas must be stored in a sealed plastic bag or sealed container throughout data collection to prevent spilling and spoilage. The containers should have sufficient capacity to securely hold the amount of food replica required for each enumerator to carry during data collection.
- Digital dietary scales: Direct weight requires the use of high-quality dietary scales that meet the specifications recommended by *Intake*. Essential features include electronic with digital readout, a maximum weight capacity ranging from 10 kg to 15 kg (or 5 kg if non-standard recipes are not collected during the 24-hour dietary recall interview), 1 gram display increments, and a precision of 1% across the load range.[16] Dietary scales require high-quality batteries and certified standard weights for scale testing.[17]
- Commonly used utensils: Plates and bowls that are common in the survey area should be carried by the enumerator (in case the respondent cannot provide these). Enumerators should also carry utensils to scoop the food replica.

Considerations and precautions for operationalization

Considerable preparation is required for the use of food replicas, which can present challenges for large-scale surveys. The replicas must be prepared in advance of data collection and carried by enumerators in sealed

[16] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[17] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

containers. Salting can be used to preserve foods that spoil quickly (e.g., broths, sauces, salads), but not all foods require salting to be preserved. For some foods, salt should not be used as its use can cause the consistency of the food to change (e.g., sweet potatoes). Care should also be taken to preserve the color of the food item used as the food replica.

Food replicas usually last about one week; therefore, repeated preparations of the food replicas will be required throughout data collection for the survey. Ensuring an adequate supply of ingredients and the use of consistent methods for the preparation of food replicas can be challenging, as field teams move through different and sometimes remote locations for data collection.

During the 24-hour dietary recall interview, real food items may be encountered in the household, which the respondent reported consuming during the reference day for the 24-hour dietary recall. Although respondents may suggest using the food that they have in their home to estimate the amount consumed, foods available in the respondent's home should never be used for portion size estimation for a dietary survey. Touching foods that are in the respondent's home could potentially cause contamination. Also, if any sickness were to occur later among any member of the respondent's household, the enumerator could be blamed for those illnesses. Furthermore, enumerators should only use food replicas for portion size estimation; food replicas should never be consumed by enumerators or gifted to respondents.

In any given survey, enumerators are generally only able to carry one or two food replicas during data collection. Therefore, survey planners may wish to consider using food replicas to estimate the amount consumed of very similar food items (referred to as "substitutions"). For example, cooked fava beans could be used to estimate the amount of cooked kidney beans consumed. Allowing the use of substitutions with direct weight as a PSEM requires careful consideration because of the added complexity that doing so entails for the 24-hour dietary recall interview and the complex downstream implications for data processing. When allowed, the number of permitted substitutions should be limited, and strict selection criteria must be set for the selection of the substitute food items. In addition, the PSEM list used to aid the enumerator during the 24-hour dietary recall interview must list each of the allowed substitutions.

When using direct weight as a PSEM, the use of multiples and fractional reporting of unit sizes is strongly discouraged.

Figure 1. The Use of Direct Weight for Portion Size Estimation

Photo credit: Marieke Vossenaar

2. Standard Unit Size

Description of the PSEM

When using standard unit size as a PSEM, the respondent is asked to report a uniform unit consumed and, if relevant, the number of multiples and/or fractions consumed of the selected unit size. The enumerator records the number and/or fractions of the standard unit size of the food item consumed (e.g., $2^1/_2$ plums).

The use of this PSEM is limited to food items that occur in uniform sizes and shapes, or a very narrow range of sizes and shapes, that can be easily counted (e.g., commercially packed into single-serving units). When using this PSEM, the enumerator must ensure that the food item being reported is the food item intended to be estimated using this method. This is important because the size and shape of commercial food items can vary by type and/or brand, and the size of naturally occurring food items can vary among different varieties of a given food item (e.g., different varieties of guavas).

Types of food items for which this PSEM is well suited

Standard unit size can be assigned as a PSEM for a wide array of naturally occurring and commercial food items that exist in roughly uniform sizes and shapes and are typically consumed in units that can be easily counted. Examples of suitable naturally occurring foods for which standard unit size is an appropriate PSEM include certain types of fruits (e.g., grapes, raspberries, gooseberries, lemon guavas, lime fruit, loquats, plums, olives, oranges, jack fruit, and many wild fruits), vegetables (e.g., okra, chilies, and peppers), and chicken eggs. Sometimes the sizes of a given food item will differ by variety; in such cases, different standard unit sizes should be pre-determined for each variety with which this PSEM will be used and detail about the specific variety consumed must be collected to ensure correct data processing (i.e., to ensure that the correct PSEM conversion factor is applied).

There is virtually an unlimited number of commercial food items that are packed into a single size and shape or standard weight single-serving units. The most ubiquitous food items are baked and fried dough foods such as factory-sliced bread, bread buns, rolls, scones, biscuits, cookies, muffins, cupcakes, and doughnuts. Other examples of commercial foods include several canned and bottled alcoholic or nonalcoholic beverages (e.g., soda, fruit juices, beers); condiments such as table packs of sugar, salt, and ketchup; and cooking condiments (e.g., bouillon cubes and curry powders). The size and shape of a commercially produced packaged food item can vary between brands, and even within the same brand for different presentation modes. In such cases, different standard unit sizes should be pre-determined for each brand, and if relevant for each presentation mode, with which this PSEM will be used. Details about the specific brand and presentation mode consumed must be collected to ensure correct data processing (i.e., to ensure that the correct PSEM conversion factor is applied).

There are also several home- and vendor-prepared ready-to-eat mixed dishes that are served or sold in specified sizes and shapes for which standard unit size can be assigned as a PSEM. Standard unit size can be used for mixed dishes when it has been confirmed that the given food item exists in uniform portion sizes and a standard recipe has been developed for use in the survey. These should be homogenous mixed dishes or non-homogenous for which survey planners have decided it is appropriate to estimate the amount consumed of the entire mixed dish, i.e., without dividing the mixed dish into separate components. Examples of mixed dishes that are well suited for estimating amounts consumed with standard unit size as the PSEM include hamburgers from a given fast-food chain that have a uniform size. Further examples include specific types of ice-cream scoops, samosas, mandazi/tumbua, shawarmas, pancakes, chapati, eggrolls, and standardized fresh vegetable bundles sold in fresh food markets.

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that standard unit size is the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and

presentation mode of the food item. This verification should be done during the "second pass" of the 24-hour dietary recall interview when descriptive details for the food item (e.g., the brand of commercial food, the variety of guava) are collected. To facilitate this process, a food type photograph of the specific brand/variety of food items intended to be used with this PSEM can be prepared by survey planners in advance of the survey and carried by enumerators during data collection. The enumerator can show the food type photograph of a food item to the respondent to confirm that the food item pictured is indeed the food item that the respondent consumed. The purpose of the food type photograph is to confirm that the respondent and the enumerator have a common understanding about the food item the respondent is reporting to have consumed; it is not used for portion size estimation.

As for all PSEMs, when collecting data on portion size for food items that could potentially include an inedible portion, it is essential for enumerators to always ask the respondent whether the portion size estimation for the food item includes an inedible portion so that the appropriate inedible portion factor can be applied. Knowing whether a food item could potentially include an inedible portion is facilitated by the use of a PSEM list that includes all relevant variations of a food item and specifies if each one includes an inedible portion.

As is the case for all PSEMs, when using standard unit size, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food item represents the amount consumed. When using standard unit size as the PSEM, the preferred approach is to ask the respondent to report the amount actually consumed directly, without estimating amounts of leftovers or additional servings separately. When this approach is used, the respondent is reminded to consider all leftovers and additional servings, both at the outset of portion size estimation and afterward as a means of confirmation. It is also possible to use an iterative approach to derive the amount consumed. The respondent is probed to report the amount served, and then, if any, the amount of leftover or, if any, the amount of any additional serving, and so on.

Once the standard unit size has been identified, the respondent is asked to report the number and/or fractions of units of the food item consumed. The enumerator then records the number and/or fractions of the food item reported as consumed (e.g., $2^1/_2$ plums).

Equipment, tools, and aids required

- No equipment is needed.
- Optionally, food type photographs can be developed for use during the "second pass" of the 24-hour dietary recall to help confirm with the respondent that the reported food item corresponds to the item for which a standard unit was established (e.g., the same variety or brand).

Considerations and precautions for operationalization

A critical consideration when using standard unit size is the selection of specific food items for which this PSEM can be used. This selection should take place as part of preparatory work in advance of the survey before enumerators are trained. The following steps should be taken to confirm the applicability of standard unit size as a PSEM for a given food item:

- Confirm the uniformity of unit sizes of the given food item (e.g., if a slice of commercial white bread varies by brand). Note the following considerations when carrying out this step:
    i. Although some food items exist in uniform sizes irrespective of variety (e.g., several types of fruit berries), sizes of some food items may vary significantly across varieties (e.g., wild guava varieties are often smaller than farm-produced guavas). Therefore, different standard unit sizes will need to be assigned to each variety, and the variety reported will need to be recorded for specific data processing.
    ii. Unit sizes for a specific food item may vary between brands. Therefore, different standard unit sizes will need to be assigned to each brand, and the specific brand reported will need to be recorded for data processing.

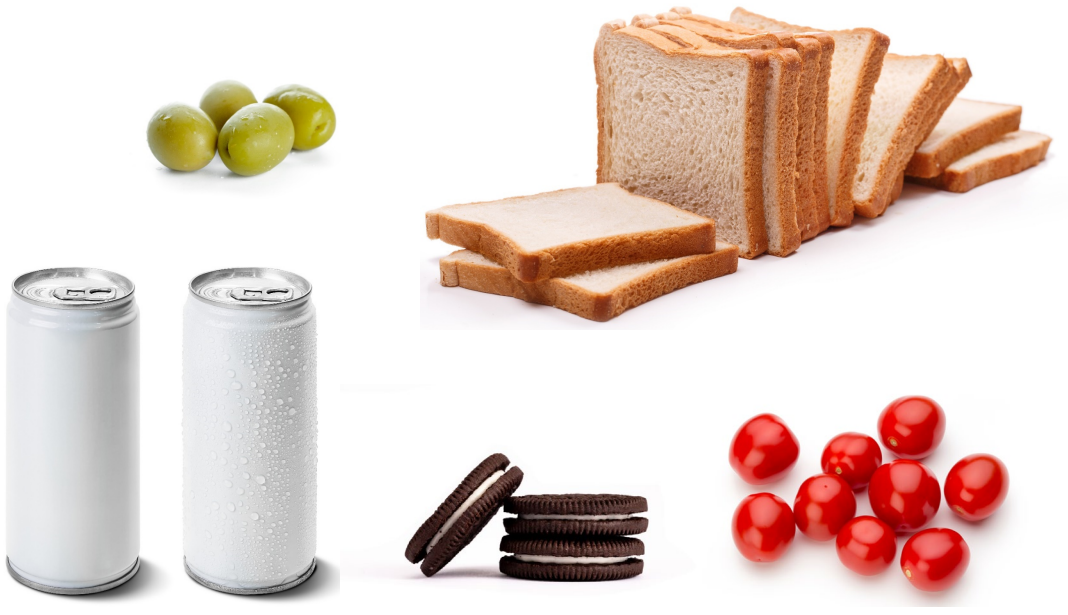
iii. Unit sizes for a specific type and brand of commercial food items may vary by presentation mode (e.g., different sizes of soda bottles and/or cans). Therefore, different standard unit sizes will need to be assigned to each presentation mode, and the presentation mode reported will need to be recorded for specific data processing.

- Confirm that the number of units typically consumed is sufficiently low so that the respondent can easily count and report the number of units consumed (e.g., fewer than 10 units).
- Confirm that the number of different varieties or brands of a given food item for which the unit size varies is manageable and that they can be identified with the use of relevant probes and possibly the use of a food type photograph.

Because of possible variations in unit sizes, objective descriptors for variety and/or brand that can be reported by the respondent should be identified and included in the probe list used by enumerators to obtain the full description of the food item. These are needed so that the enumerator can verify that the food item reported is the food item intended to be estimated using this PSEM.

The use of standard unit sizes requires the use of multiples and fractions of the selected units to be reported to ensure accurate portion size estimation. Reporting fractions can present cognitive difficulties for both respondents and enumerators, thus increasing the risk of error, especially in lower-literacy environments. Survey planners should always consider the survey context carefully to determine whether fractional unit reporting is feasible. If deemed feasible, the use of fractions should be limited to halves, thirds, or fourths, as smaller fractions may be challenging to visualize and report and are unlikely to meaningfully affect the estimated portion size. For example, a respondent may be allowed to report ½ slice of bread, but not $^1/_5$ of a slice. If fractional reporting is not deemed feasible for the survey context, then the use of standard unit size as a PSEM should not be considered for use in the survey.

Figure 2. The Use of Standard Unit Size for Portion Size Estimation



3. Proxy Weight Using a Material That Can Be Shaped

Description of the PSEM

When using proxy weight using a material that can be shaped as a PSEM, the respondent is shown a clay-like substance (e.g., playdough) that can be molded into different shapes and sizes and is asked to use the proxy material to visually represent the amount of the food item consumed. The weight in grams of the proxy material, which represents in volume the amount of the actual food item consumed, is measured using a digital dietary scale and the weight is recorded in grams.

Proxy materials are commonly used in quantitative 24-hour dietary recall surveys because they can be used to represent a large array of food items. This PSEM is well suited for a wide selection of solid food items and is especially useful to use for oddly shaped food items that do not have a uniform unit size.

The material most readily used as a proxy for this PSEM, and therefore recommended by *Intake*, is commercial playdough because it is easy to mold, safe to use, and retains a consistent density for a long duration if optimally handled and stored.

Types of food items for which this PSEM is well suited

Proxy weight using a material that can be shaped can be assigned as a PSEM for a wide array of food items that exist or can be cut in various odd shapes and sizes. Examples include roots and tubers (e.g., potatoes, cassava, yams); pieces of red meat, chicken, or fish; baked and fried dough foods that are not made in a standard unit size (e.g., fried dough, dumplings); and fruits and vegetables. This PSEM is equally suitable for molding whole fruits and vegetables that are relatively small (e.g., strawberries, apples, bananas, tomatoes) as well as larger fruits and vegetables cut into oddly shaped slices or chunks (e.g., papaya, watermelon).

This PSEM is also well suited to estimate the amount consumed of solid mixed dishes for which a standard recipe has been developed or for which a non-standard recipe is collected during the 24-hour dietary recall interview, although the amount of proxy material carried by the enumerator may not be sufficient to estimate the total amount of the prepared mixed dish, as needed for a non-standard recipe. These can be homogenous or non-homogenous mixed dishes that may or may not be divided into separate components when amounts consumed (and amounts prepared, in the case of non-standard recipes) are estimated. Examples of mixed dishes for which this PSEM is well suited include solid porridge preparations such as ugali or nshima in Eastern and Southern Africa or gari in West African countries, as well as mashed roots, tubers, and plantains.

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that a proxy material that can be shaped (e.g., playdough) is the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the state, form, and presentation of the food item as reported by the respondent.

If the amount reported as consumed by the respondent is larger than the available amount of proxy material available (e.g., for the total amount of a non-standard recipe prepared), an alternative PSEM should also be considered. Likewise, for food items for which multiple units of different sizes were consumed and for which the number of units consumed is too large to be molded or counted easily, a different PSEM should be considered.

Food items estimated using a proxy material that can be molded are often consumed from an individual plate or bowl. The enumerator should ask if the respondent can bring out the exact type of plate or bowl from which the food item was consumed. Using the same size and shape of plate or bowl provides the respondent with the most realistic opportunity to visually recollect the portion size consumed. Using a plate or bowl that is sized or shaped differently than the plate or bowl from which the food item was consumed is likely to reduce the accuracy of portion size estimation by the respondent. In case a respondent cannot provide the plate or bowl from which the

food item was consumed, all enumerators should be provided with a set of plates and bowls commonly used in the survey area for use when needed during data collection.

The plate or bowl selected by the respondent should be placed on a digital dietary scale, and the scale should be tarred (to account for the weight of the plate or bowl). The enumerator should guide the respondent to place the amount of proxy material onto the selected plate or bowl. The amount of proxy material placed should be equivalent to the amount of the food item that s/he recalled having consumed (i.e., the volume of the proxy material corresponds to the amount of the food item consumed).

For food items for which a single unit was consumed, the enumerator should guide the respondent to mold the proxy material into the shape and size that is equivalent to the amount consumed the previous day. For food items for which multiple single units were consumed, the enumerator should determine if all the units were the same size and shape. If all the units consumed were of the same size and shape, the respondent only needs to mold one unit. The enumerator should then determine the weight of the one unit and record the number of units reported as consumed. During data processing, the weight of one is multiplied by the number of pieces consumed to obtain the total weight of the proxy material. If the units are of different sizes, the respondent is asked to mold each unit separately. Once all units have been molded, the enumerator determines the aggregated weight of the proxy material used.

As with all PSEMs, when collecting data on portion sizes for food items that could potentially include an inedible portion, it is essential for enumerators to always ask the respondent whether the portion size estimation for the food item includes an inedible portion. This information must be recorded to ensure that the appropriate edible portion factor can be applied during data processing. An edible portion factor equal to 1 is set if there are no inedible portions. Knowing whether a food item could potentially include an inedible portion is facilitated by the use of a PSEM list that includes all relevant variations of a food item and specifies if each one includes an inedible portion.

As is the case for all PSEMs, when using proxy weight with a material that can be shaped, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food item represents the amount consumed. When using this PSEM, the respondent can either: i.) be probed using an iterative approach to derive the amount consumed (i.e., the respondent reports the amount served and the amount of leftovers, if any; then, if relevant, the amount of the next additional serving, if any, and the amount of leftovers, and so on) or ii.) be asked to report directly the amount actually consumed without estimating amounts of leftovers or additional servings separately. When the second approach is used, the respondent is reminded to consider all leftovers and additional servings both at the outset of portion size estimation and afterward as a means of confirmation.

Once the respondent has completed molding the proxy material to represent the amount of the food item consumed, the enumerator should record the weight in grams of the total amount of the proxy material that was molded, including any multiple units reported, if relevant. The proxy material used should then be returned to a sealed container for storage until the next use. All utensils used should be cleaned for further use, stored by the enumerator, or returned to the respondent.

Equipment, tools, and aids required

- Proxy material that can be shaped: The amount of proxy material carried by each enumerator should exceed the largest portion likely to be encountered in the survey. Each enumerator should typically carry at least 1.5 kg -2.0 kg of playdough or other proxy material. However, this amount is not necessarily sufficient for estimating the total amount of a non-standard recipe prepared.
- Digital dietary scales: This PSEM requires the use of high-quality dietary scales that meet the specifications recommended by *Intake*. Essential features include electronic with digital readout, a maximum weight capacity ranging from 10 kg to 15 kg (or 5 kg if non-standard recipes are not collected during the 24-hour

recall interview), 1 gram display increments, and a precision of 1% across the load range.[18] Dietary scales require high-quality batteries and certified standard weights for scale testing.[19]

- Storage containers: The density of the proxy material used must remain consistent throughout the survey to ensure accurate conversions to the equivalent weight of foods. Therefore, when not in use, the material should be stored in a sealed plastic bag or sealed container from the time of purchase and throughout the survey. The storage container for the proxy material should have sufficient capacity to carry 0.5 kg more than the amount of playdough allocated to each enumerator.
- Commonly used utensils: Plates, bowls, and pots (for non-standard recipe collection) common in the survey area should be carried by the enumerator (in case the respondent cannot provide these).

Considerations and precautions for operationalization

It is not feasible to use this PSEM to estimate large portion sizes consumed (e.g., a whole watermelon) because of the limited amount of playdough the enumerator is likely to be carrying. Similarly, the amount of playdough carried by enumerators is unlikely to be sufficient for estimating the total amount of a non-standard recipe prepared.

The proxy material that is selected for use with this PSEM must be user-friendly and easy to mold in different shapes and sizes. It should have a texture that is soft and pliable but not too dry and crumbly or too moist and sticky. The proxy material must also be non-toxic and safe to handle for both children and adults and should not cause damage (e.g., stain a tablecloth) when being used.

The consistency and density of the proxy material must remain consistent when used under different environmental conditions (e.g., variations in temperature or humidity) and user practices (i.e., how hard the respondent compresses the playdough when molding the shape). The density of the proxy material should be monitored regularly by determining the weight of a fixed volume. When density changes, the proxy material needs to be replaced, or the conversion of the playdough food model to the gram unit weight of the food item consumed will be erroneous. It is therefore critical that ample proxy material is available to allow for the replacement of the proxy material as needed throughout data collection. The expiry date of commercial proxy materials should also be monitored and considered during procurement.

While it is technically feasible to use many different proxy materials (e.g., modeling clay, home-made playdough), commercial playdough is generally recommended because it is easy to mold and has been used extensively in different settings without major challenges. Because Kinetic Sand® can be compressed to different extents depending on how hard the respondent compresses and the weight of the modeled food will vary depending on how hard the sand is pressed, *Intake* does not recommend the use of Kinetic Sand® for molding shapes—only for use as a proxy material for foods that heap and are consumed in small quantities. Within a given survey, a single type of proxy material that can be shaped should be used by all enumerators.

Intake recommends procuring high-quality, commercial playdough such as Play-Doh® with a proven safety record and user-friendly properties. Although playdough can be made with a simple recipe, it is challenging to standardize the recipe and to keep moisture content consistent. Commercially available playdough includes various ingredients that make it smooth instead of sticky, along with antimicrobial agents and preservatives that increase the shelf life. Moreover, it is packaged in sealable containers.

The color for playdough should preferably be white. The use of white-colored playdough can help respondents to more realistically visualize amounts consumed for foods that are naturally white such as white-fleshed varieties of cassava, sweet potatoes, and maize—common staple foods in many LMICs. If white playdough cannot be

[18] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[19] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

procured, light colors of playdough should be preferred over dark colors. Different colors of playdough should never be mixed.

When using this PSEM to estimate the amount of a food item consumed, respondents are typically allowed to mold a single shape and then report having consumed multiple units (provided the units consumed were of a uniform in size and shape). Allowing for the reporting of fractions of molded shapes is strongly discouraged.

Figure 3. The Use of Playdough for Portion Size Estimation

Photo credit: Marieke Vossenaar

4. Proxy Weight Using a Free-Flowing Material That is Pourable

Description of the PSEM

When using proxy weight with a free-flowing material as a PSEM, the respondent is shown a free-flowing dry item (e.g., raw rice) to aid the respondent in visually representing the amount of the food item consumed. During the 24-hour dietary recall interview, the respondent is guided to use the proxy material as if it were the actual food item consumed and to pour the proxy material into a cup, bowl, or pot. The weight of the proxy material, which represents in volume the amount of the actual food item consumed, is measured using a digital dietary scale and the weight is recorded in grams.

Proxy materials are commonly used in quantitative 24-hour dietary recall surveys because they can be used to represent a large array of food items. This PSEM is well suited to estimate amounts of "pourable" (i.e., liquid, semi-liquid, semi-solid or free-flowing solid) food items consumed.

The material most readily used as a proxy material for this PSEM, and therefore recommended by *Intake*, is raw rice because it is easy to handle, readily available, safe to use, and retains a constant density when handled and stored properly.

Types of food items for which this PSEM is well suited

Proxy weight using a free-flowing material can be assigned as a PSEM for a large selection of "pourable" food items. The PSEM can be used for estimating the amount of liquids consumed, such as beverages, broths, and cooking oils. This PSEM is also well suited for a variety of dry free-flowing solid food items, many of which are commonly used as ingredients in mixed dishes. Examples include a variety of grains (e.g., maize, rice, wheat), legumes (e.g., beans, lentils, peas), seeds (e.g., sesame seeds, squash seeds, sunflower seeds), flours, powdered milk, and sugar. This PSEM is equally applicable for estimating amounts of chopped, diced, sliced, or grated fresh foods such as leaves, tubers, cabbages, fruits, and vegetables (e.g., diced carrots, sliced cassava, diced/sliced cabbage).

Additionally, this PSEM is well suited to estimate the amount consumed of mixed dishes (e.g., thin cereal and root porridges, soups, sauces, gravies, stews) for which a standard recipe has been developed or for which a non-standard recipe is collected during the 24-hour dietary recall interview. These can be homogenous or non-homogenous mixed dishes that may or may not be divided into separate components when the amounts consumed (and amounts prepared, in the case of non-standard recipes) are estimated. The use of a readily available proxy material such as raw rice allows for estimating large amounts of a food item consumed. For this reason, the use of a free-flowing proxy material is often the most suitable PSEM for estimating amounts of free-flowing ingredients used, the total amount of the prepared mixed dish, and the amount of the mixed dish consumed by the respondent for non-standard recipes.

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that a free-flowing proxy material is the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and presentation mode of the food item.

Food items typically estimated using a free-flowing proxy material are often served and consumed from an individual cup or bowl; sometimes they are prepared in a pot. The enumerator should ask if the respondent can bring out the exact type of cup or bowl from which the food item was consumed, and if collecting data for a non-standard recipe, the exact type of pot used to prepare the mixed dish. Using the same size and shape cup or bowl from which the food item was consumed (or pot in which the mixed dish was prepared) provides the respondent with the most realistic opportunity to visually recollect the portion size consumed (and the total amount of mixed dish prepared). Using a cup or bowl that is sized or shaped differently than the one from which the food item was consumed (or a different size or shape of pot than the pot in which the mixed dish was

prepared) is likely to reduce the accuracy of portion size estimation (and estimation of the amount of mixed dish prepared) by the respondent. In case a respondent cannot provide the cup or bowl from which the food item was consumed (or the pot in which the mixed dish was prepared), all enumerators should be provided with a set of cups, bowls, and pots commonly used in the survey area for use when needed during data collection

The cup, bowl, or pot selected by the respondent should be placed on the digital dietary scale, and the scale should be tarred (to account for the weight of the cup, bowl, or pot). The enumerator should guide the respondent in pouring the amount of proxy material into the selected cup or bowl that is equivalent to the amount of the food item that s/he recalled having consumed (i.e., the volume of the proxy material corresponds to the amount of the food item consumed). If a non-standard recipe is being collected, data also need to be collected on the amount of the mixed dish prepared. The pot selected by the respondent should be placed on the digital dietary scale and the scale should be tarred (to account for the weight of the pot). The enumerator should guide the respondent to pour the amount of proxy material into the selected pot that is equivalent to the amount of the mixed dish prepared (i.e., the volume of the proxy material corresponds to the amount of the mixed dish prepared).

As with all PSEMs, when collecting data on portion size for food items that could potentially include an inedible portion, it is essential for enumerators to always ask the respondent whether the portion size estimation for the food item includes an inedible portion. This information must be recorded to ensure that the appropriate edible portion factor can be applied during data processing. An edible portion factor equal to 1 is set if there are no inedible portions. Knowing whether a food item could potentially include an inedible portion is facilitated by the use of a PSEM list that includes all relevant variations of a food item and specifies if each one includes an inedible portion.

As is the case for all PSEMs, when using proxy weight with a free-flowing material, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food item represents the amount consumed. When using proxy weight with a free-flowing material as the PSEM, the respondent can either: i.) be either probed using an iterative approach to derive the amount consumed (i.e., the respondent reports the amount served and the amount of leftovers, if any; then, if relevant, the amount of the next additional serving, if any, and the amount of leftovers, and so on); or ii.) be asked to report directly the amount actually consumed without estimating amounts of leftovers or additional servings separately. When this second approach is used, the respondent is reminded to consider all leftovers and additional servings, both at the outset of portion size estimation and afterward as a means of confirmation.

Once the respondent has completed pouring the proxy material to represent the amount of the food item consumed (or the amount of the mixed dish prepared), the enumerator should record the weight of the proxy material that was poured in grams, including any multiple units reported, if relevant. The proxy material used should then be returned to a sealed container for storage until the next use. All utensils used should be cleaned for further use, stored by the enumerator, or returned to the respondent.

Equipment, tools, and aids required

- Free-flowing proxy material: The amount of proxy material carried by each enumerator should exceed the largest portion likely to be encountered in the survey and should be sufficient to estimate the total amount of a prepared mixed dish. Each enumerator should carry approximately 3-5 kg of raw rice or other acceptable dry proxy material.
- Digital dietary scales: This PSEM requires the use of high-quality dietary scales that meet the specifications recommended by *Intake*. Essential features include electronic with digital readout, a maximum weight capacity ranging from 10 kg to 15 kg (or 5 kg if non-standard recipes are not collected during the 24-hour

dietary recall interview), 1 gram display increments, and a precision of 1% across the load range.[20] Dietary scales require high-quality batteries and certified standard weights for scale testing.[21]

- Storage containers: The density of the proxy material used must remain consistent throughout the survey to ensure accurate conversions to the equivalent weight of foods. Therefore, the proxy material should be stored in a sealed plastic bag or sealed container, when not in use, from the time of purchase and throughout the survey. The container for the proxy material should have more than the necessary capacity to carry the amount of each dry proxy material assigned to each enumerator.
- Commonly used utensils: Cups and bowls, and pots (for non-standard recipe collection) common in the survey area should be carried by the enumerator (in case the respondent cannot provide these). Enumerators should also carry utensils to scoop the raw rice.

Considerations and precautions for operationalization

The amount of proxy material provided per enumerator should exceed the largest portion likely to be encountered in the survey. For example, each enumerator may carry 3-5 kg of raw rice. This amount of raw rice is likely to be sufficient for estimating the total amount of any non-standard recipe prepared.

The consistency and density of the proxy material must remain constant for the duration of the survey. As such, care should be taken to protect the proxy material in sealed containers when not in use. The expiry date of a commercial proxy material should also be monitored and considered during procurement.

The proxy material selected for use with this PSEM should be safe and clean (i.e., not toxic), easy to handle (i.e., avoid sugar and flours), and not cause damage (e.g., stain a tablecloth) when being used. Ideally, the proxy material should not be edible in the form used. Enumerators may encounter children or other household members who ask to be given some of the proxy material to eat. This can be avoided by using the proxy material in the raw form; using the proxy material in the raw form is also recommended because foods in a raw, uncooked form typically have a more constant density.

While it is technically feasible to select among many different proxy materials (e.g., raw grains, raw lentils, raw beans), raw rice is generally recommended because it has been used extensively in different settings without major challenges. Within a given survey, a single type of free-flowing proxy material (e.g., a single variety of raw rice) should be used by all enumerators.

When using this PSEM to estimate the amount of a food item consumed, respondents are typically allowed to pour a given amount of the proxy material and then report having consumed one or multiple units (provided the units consumed were uniform in size and shape, i.e., the same volume). Allowing for the reporting of fractions of the amount proxy material poured is strongly discouraged.

[20] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[21] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

Figure 4. The Use of Raw Rice for Portion Size Estimation

Photo credit: Marieke Vossenaar

5. Proxy Weight Using a Material That Heaps

Description of the PSEM

When using proxy weight using a material that heaps as a PSEM, the respondent is shown a proxy material that can be heaped (e.g., Kinetic Sand®) to aid the respondent in visually representing the amount of the food item consumed. During the 24-hour dietary recall interview, the respondent is guided to use the proxy material as if it were the actual food item consumed and to scoop or heap the proxy material with a spoon, scoop, or ladle and then transfer the proxy material into a cup or bowl so that it can be weighed. Multiple spoons, scoops, or ladles of the proxy material can be scooped or heaped and transferred into a cup or bowl. The weight of the total proxy material in the cup or bowl, which represents in volume the amount of the actual food item consumed, is measured using a digital dietary scale and the weight is recorded in grams.

This PSEM is well suited to estimate amounts of "pourable" food items consumed in small quantities that typically heap (e.g., a scoop of infant formula powder).

The material most readily used as a proxy material for this PSEM, and therefore recommended by *Intake*, is Kinetic Sand® because it is easy to handle, safe to use, retains a constant density, and heaps well. However, Kinetic Sand® can be expensive and difficult to procure in some settings.

Types of food items for which this PSEM is well suited

Proxy weight using a material that heaps can be assigned as a PSEM for a large selection of "pourable" food items that heap. Using Kinetic Sand® as a proxy material allows for estimating small amounts of food items that can most easily be visualized with spoons, scoops, and/or ladles and can be heaped in variable amounts. These food items typically do not include inedible parts. This PSEM is well suited for dry, powdery foods typically consumed or used as ingredients in small quantities, such as infant formula powder, powdered milk, sugar, coffee powder, flours, and salt.

This PSEM is also well suited to estimate the amounts of small quantities of semi-liquid or semi-solid mixed dishes for which a standard recipe has been developed or for which a non-standard recipe is collected during the 24-hour dietary recall interview (although this PSEM is only suitable for estimating small amounts). These can be homogenous or non-homogenous mixed dishes that may or may not be divided into separate components when amounts consumed (and amounts prepared, in the case of non-standard recipes) are estimated. Examples include thin cereal and root porridges, soups, sauces, gravies, and stews.

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that a proxy material that heaps is the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and presentation mode of the food item.

Food items for which the amount consumed is estimated using a proxy material like Kinetic Sand® (i.e., a proxy material that heaps) should be able to be easily visualized by the respondent with the use of a spoon, scoop, and/or ladle. The enumerator should ask if the respondent can bring out the exact type of spoon, scoop, or ladle used to serve or consume the reported food item. Using the same size and shape spoon, scoop, or ladle provides the respondent with the most realistic opportunity to visually recollect the portion size consumed. Using a spoon, scoop, or ladle that is sized or shaped differently than the spoon, scoop, or ladle from which the food item was consumed is likely to reduce the accuracy of portion size estimation by the respondent. In case a respondent cannot provide the spoon, scoop, or ladle from which the food item was consumed, all enumerators should be provided with a set of spoons, scoops, and/or ladles commonly used in the survey area for use when needed during data collection.

The respondent should identify the most similar spoon, scoop or ladle in their home or from the selection provided by the enumerator. A bowl or cup should be placed on the digital dietary scale and the scale should be tarred (to account for the weight of the bowl or cup). Then the enumerator should guide the respondent to use the selected spoon, scoop, or ladle to scoop or heap the amount (i.e., volume) of the proxy material that is equivalent to the amount of the food item consumed and then transfer the proxy material into the bowl or cup on the scale. If more than one spoonful was consumed, then multiple spoonfuls should be transferred to the bowl or cup.

Food items estimated using this PSEM typically do not include inedible parts. Therefore, provided the PSEM has been assigned appropriately to the food items, as specified in the FRIL, there is no need to probe for potential inedible portions.

As is the case for all PSEMs, when using proxy weight with materials that heap, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food item represents the amount consumed. When using proxy weight with a material that heaps as the PSEM, the respondent can either: i.) be probed using an iterative approach to derive the amount consumed (i.e., the respondent reports the amount served and the amount of leftovers, if any; then, if relevant, the amount of the next additional serving, if any, and the amount of leftovers, and so on); or ii.) be asked to report directly the amount actually consumed without estimating amounts of leftovers or additional servings separately. When this second approach is used, the respondent is reminded to consider all leftovers and additional servings, both at the outset of portion size estimation and afterward as a means of confirmation.

Once the respondent has completed scooping or heaping the proxy material and transferring it into a cup or bowl to represent the amount of the food item consumed, the enumerator should record the weight of the proxy material in grams. The proxy material used should then be returned to a sealed container for storage until the next use. All utensils used should be cleaned for further use, stored by the enumerator, or returned to the respondent.

Equipment, tools, and aids required

- Proxy material that heaps: The amount of proxy material carried by each enumerator should exceed the largest portion likely to be encountered in the survey. Each enumerator should carry approximately 0.5 kg of Kinetic Sand®. However, this amount is not necessarily sufficient for estimating the total amount of a non-standard recipe prepared.
- Digital dietary scales: This PSEM requires the use of high-quality dietary scales that meet the specifications recommended by *Intake*. Essential features include electronic with digital readout, a maximum weight capacity ranging from 10 kg to 15 kg (or 5 kg if non-standard recipes are not collected during the 24-hour dietary recall interview), 1 gram display increments, and a precision of 1% across the load range.[22] Dietary scales require high-quality batteries and certified standard weights for scale testing.[23]
- Storage containers: The density of the proxy material used must remain consistent throughout the survey to ensure accurate conversions to the equivalent weight of the foods estimated as consumed. Therefore, the proxy material should be stored in a sealed plastic bag or sealed container, when not in use, from the time of purchase and throughout the survey. The container should have more than the necessary capacity to carry the amount of proxy material assigned to each enumerator.
- Commonly used utensils: Spoons, scoops, and/or ladles common in the survey area should be carried by the enumerator (in case the respondent cannot provide these) and a cup or bowl should also be carried by the enumerator to weigh the proxy material.

[22] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[23] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

Considerations and precautions for operationalization

The amount of proxy material provided per enumerator should exceed the largest portion likely to be encountered in the survey. For example, each enumerator may carry 0.5 kg of Kinetic Sand®. However, this amount of Kinetic Sand® is unlikely to be sufficient for estimating the total amount of a non-standard recipe prepared.

The consistency and density of the proxy material must remain constant for the duration of the survey. As such, care should be taken to protect the proxy material in sealed containers when not in use. The expiry date of a commercial proxy material should also be monitored and considered during procurement.

The proxy material selected for use as a PSEM should be safe and clean (i.e., not toxic), easy to handle (i.e., avoid sugar and flours), and should not cause damage (e.g., stain a tablecloth) when being used.

While it is technically feasible to select among many different proxy materials, Kinetic Sand® is generally recommended because it does not absorb moisture, is easy to handle and heaps well. Within a given survey, a single type of proxy material that can be heaped should be used by all enumerators. Kinetic Sand® is a relatively new product that works similarly to playdough but is looser in texture (like wet sand), more flexible, and can be heaped. It is not sticky and does not dry out. When Kinetic Sand® is used, care must be taken to always firmly pack the Kinetic Sand® when depicting the amount of a food item consumed to ensure that the weight of the food depicted can be estimated without excess error (i.e., the weight of the modeled food will vary depending on how hard the sand is pressed). As such, *Intake* recommends using Kinetic Sand® only to scoop or heap with a spoon, scoop, and/or ladle rather than to mold shapes (as is done with playdough). Kinetic Sand® is not readily available in many LMICs, can be expensive, and may need to be procured from abroad.

When using this PSEM to estimate the amount of a food item consumed, allowing for the reporting of multiples and/or fractions of the amount of proxy material scooped or heaped is strongly discouraged. Although multiple spoons of Kinetic Sand® can be scooped by the respondent, a single weight measurement of the total amount of proxy material scooped is recorded. Since a single, total weight value is recorded, we do not refer to these as "multiple units".

Figure 5. The Use of Kinetic Sand® for Portion Size Estimation

Photo credit: Marieke Vossenaar

6. Calibrated Household Utensils

Description of the PSEM

When using calibrated household utensils as a PSEM, the respondent is shown commonly used household utensils such as spoons, scoops, and/or ladles for which the volume of each utensil has been pre-determined by survey planners (referred to as "calibrated" household utensils) and is asked to select the type and size of calibrated household utensil in which the amount of the reported food item consumed can be most easily visualized. The respondent is asked to report the amount of the food item consumed as the number of units of the selected utensil (e.g., 3 size A spoons of yogurt, 2 size D scoops of soup). The enumerator then records the number of units of the selected utensil reported. The use of this PSEM is limited to liquid food items consumed in small quantities for which the amounts consumed can be visualized with spoons, scoops, and/or ladles and the amount consumed can be well-estimated as a level, whole-unit measurement of the selected spoon, scoop, or ladle.

Types of food items for which this PSEM is well suited

Calibrated household utensils can be assigned as the PSEM for food items that can be visualized with spoons, scoops, and/or ladles, either because the relevant utensil was used to scoop an ingredient or to serve or consume the reported food item. This PSEM is well suited for food items consumed in relatively small quantities for which the number of servings used or consumed can be counted easily. Examples include free-flowing food items commonly used as ingredients for non-standard recipes (e.g., cooking oil). The use of calibrated household utensils assumes a level measurement was used or consumed with the selected utensil for the food item reported; therefore, the use of this PSEM should be limited to liquid food items that do not heap (i.e., liquids food items such as oils, thin soups, thin sauces) and for which the assumption can be made that the utensils are filled to the brim.

This PSEM can also be used to estimate amounts of liquid mixed dishes for which a standard recipe has been developed or for which a non-standard recipe is collected during the 24-hour dietary recall interview (although this PSEM is only suitable for estimating small amounts). These can be homogenous or non-homogenous mixed dishes that may or may not be divided into separate components when amounts consumed (and amounts prepared, in the case of non-standard recipes) are estimated. Examples of mixed dishes for which this PSEM is well suited for use include thin, liquid soups, and sauces.

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that calibrated household utensils are the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and presentation mode of the food item.

When using calibrated household utensils to estimate amounts consumed, the respondent is shown the different-sized calibrated spoons, scoops, and/or ladles and is asked to identify the one that most closely corresponds to the utensil used. Once the respondent identifies the most appropriate spoon, scoop, and/or ladle, the enumerator asks the respondent to report the number of units of the spoon, scoop, or ladle that reflects the amount consumed. The enumerator then records the code of the spoon, scoop, or ladle selected and the number of units reported as consumed.

If none of the available spoons, scoops, and/or ladles correspond to the utensil used by the respondent, then a different PSEM should be used (e.g., proxy weight using rice or Kinetic Sand®).

Food items estimated using this PSEM are liquid and typically do not include inedible parts. Therefore, provided the PSEM has been assigned appropriately to the food items, as specified in the FRIL, there is no need to probe for potential inedible parts.

As is the case for all PSEMs, when using calibrated household utensils, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size

being estimated for the food item represents the amount consumed. When using direct calibrated household utensils as the PSEM, leftovers and additional servings are not estimated separately, but the respondent is reminded to consider them, both at the outset of portion size estimation for the food and afterward, as a means of confirmation.

Equipment, tools, and aids required

Calibrated household utensils: Commonly used spoons, scoops, and/or ladles that represent the typical types and sizes of utensils used in households for which the volume has been pre-determined by survey planners should be used for data collection and carried by enumerators. Spoons, scoops, and/or ladles available in the household cannot be used as a PSEM because they have not been calibrated (i.e., their volume is unknown).

Considerations and precautions for operationalization

A critical consideration when using calibrated household utensils is the choice of the spoons, scoops, and/or ladles to use for this method. The selected utensils should represent typical types and sizes of utensils locally available and should be widely used and readily recognized across the survey area. In some market areas where foods are sold in bulk and small amounts are purchased at a time, similar scoops, cups, and/or ladles may be used by vendors, and these can also be calibrated. The calibrated spoons, scoops, and/or ladles carried by the enumerator must be labeled with a size code (e.g., very small, small, medium, and large spoon; or spoon size S1, S2, S3, and S4). The use of measuring cups and spoons (i.e., utensils marked with divisions or units of measurement typically used to measure the volume of ingredients when following recipes) is not generally recommended because they are not commonly used in most LMICs and may not be filled to the brim.

A further consideration is the selection of specific food items for which this PSEM can be used. This selection should take place as part of preparatory work in advance of the survey and before enumerators are trained. The use of calibrated household utensils as a PSEM should be limited to liquid food items for which the assumption can be made that the utensils used are filled to the brim because the use of this PSEM assumes the measurement of the household utensil reported by the respondent is a level (not fractional or heaped) amount.

When using calibrated household utensils as a PSEM, allowing respondents to report multiple units is required for accurate portion size estimation, but the use of fractional unit reporting is strongly discouraged.

Figure 6. The Use of Calibrated Spoons, Scoops, and/or Ladles for Portion Size Estimation

Each utensil must be labeled with a permanent pen or adhesive sticker that can withstand field conditions and frequent washing.

Group II PSEMs

7. Graduated Portion-Size Food Photographs Depicting Multiple Portion Sizes for a Given Food Item

Description of the PSEM

When using graduated portion-size food photographs as a PSEM, the respondent is shown a photographic series of images representing a range of portion sizes of a real food item and asked to choose the one that most closely represents the amount of a given food item consumed. The enumerator records the code that corresponds to the selected food image.

The food item represented in the photographic series should be depicted in a single state, form, and mode of presentation that does not include inedible parts and is typically shown on a plate. Because graduated portion-size food photographs are typically not printed at full scale, they should include a reference object (e.g., cutlery, such as a spoon, fork, knife, or chopsticks; and/or a ruler) in each image in the photographic series to enable the respondent to appropriately relate the scale of the food images presented in the photograph. Food images in a photographic series are arranged successively from smallest to largest portion size; often six, or eight portion sizes are included in a photographic series. An even number of portion sizes should be used for all food items to prevent the tendency of the respondent to select the middle photograph (Nelson and Haraldsdóttir 1998b).

Types of food items for which this PSEM is well suited

In settings where well-developed and validated comprehensive food atlases are available, graduated portion-size food photographs can be used for a wide selection of food items. The selection of foods for which graduated portion-size food photographs should be developed and assigned as a PSEM requires careful consideration. Given the complexity of the development of food photographs, when resources are limited, *Intake* recommends developing only a relatively small number of graduated portion-size food photographs. Foods for which amounts consumed are well suited to be estimated using Group I PSEMs should not be prioritized for the development of graduated portion-size food photographs.

High-quality food photographs in which food items are depicted at an angle can show both the spread and the depth of the food item. As such, food photographs are well suited to estimate portion sizes of solid or semi-solid foods that are typically served in mounds, heaps, lumps, or chunks.

Graduated portion-size food photographs are especially well suited for food items that vary in portion size along a continuum from very small to very large, because this allows for depicting a range of visually discernible portion sizes in a photographic series for a given food item. Graduated portion-size food photographs can also be used for items that are irregular in shape or size and that are not available in commercially standardized amounts.

Graduated portion-size food photographs should only be developed for food items presented (and visualized) without inedible parts. When selecting the food items for which to develop food photographs, it is also important to consider if it is feasible to present the different intended portion sizes (established using existing dietary data) in the photographic series.

Graduated portion-size food photographs can be used for single foods or mixed dishes. However, graduated portion-size food photographs can only represent mixed dishes for which a standard recipe has been developed. The PSEM can be used for homogenous mixed dishes or for non-homogenous mixed dishes for which survey planners have decided it is appropriate to estimate the amount consumed of the entire mixed dish (i.e., the amount of nutrient-dense ingredients consumed are not estimated separately from other parts of the mixed dish.

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that a graduated portion-size food photograph is the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and presentation mode of the food item.

First, the photographic series that corresponds to the reported food item must be identified. This may be a photographic series for the exact food item reported or a similar one for which the food item consumed has been pre-determined to be an allowed substitution. Any substitutions allowed for a given food item depicted in a photographic series must be determined before data collection by survey planners and documented for the enumerator on the PSEM list. Once the correct photographic series has been identified by the enumerator and confirmed as such by the respondent, the respondent is asked to choose the portion size that most closely represents the amount of food item consumed.

As for all PSEMs, when collecting data on portion sizes for food items that could potentially include an inedible portion, it is essential for enumerators to always ask the respondent whether the portion size estimation for the food item includes an inedible portion. Since graduated portion-size food photograph should only be used to depict food items without inedible portions, the PSEM should only be used to estimate amounts of food items served without inedible portions, so that the respondent can accurately visualize the food item and report the amount consumed. If the presentation mode of the food item reported by the respondent (including whether or not there was an inedible portion included) is not consistent with the depiction of the food item in the graduated portion-size food photographs, a different PSEM should be used to estimate the amount of the food item consumed.

As is the case for all PSEMs, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food item represents the amount consumed. When using graduated portion-size food photographs, leftovers and additional servings are not estimated separately, but the respondent is reminded to consider them, both at the outset of portion size estimation for the food item and as a means of confirmation, after the portion size for the food item has been selected and reported by the respondent.

Once the respondent has confirmed the image corresponding to the portion size consumed, the enumerator records the code of the image selected from the photographic series. Depending on how survey planners decide to operationalize the use of graduated portion size food photographs, the respondent may be allowed to indicate a multiple and/or fractional unit of a portion-size depicted. Alternatively, the respondent may be allowed to indicate a portion size that is not depicted in the photographic series. If relevant, the enumerator records the number/fraction of the selected image or the code developed to represent the portion size not depicted.

Equipment, tools, and aids required

Graduated portion-size food photographs: Each enumerator should carry the same set of printed high-quality food photographs. Printed photographs are typically used even when using electronic data collection methods.

For ease of use during data collection:

i. The photographic series of the different portion sizes depicted for a given item should be printed in color on a single sheet of paper.

ii. All photographs should be laminated to protect them from deterioration as a result of frequent handling, dirt and dust, and potential water damage.

iii. The complete set of photographs should be bound in a single volume, atlas, or book bound with string and arranged in logical, easy-to-identify order (e.g., by food group).

Considerations and precautions for operationalization

High-quality, well-developed food photographs are not available for use in most LMICs. Given the complexity of the development of food photographs, when resources are limited, *Intake* recommends developing food photographs only when there is a high level of commitment and ample resources, including time, in advance of the planned survey. When resources are limited, a small selection of food photographs can be developed.

When graduated portion-size food photographs are developed, the selection of the portion sizes to depict in each image is an important consideration. The portion sizes depicted should ideally be derived from existing quantitative 24-hour dietary recall data to identify the minimum and maximum portions, if relevant per demographic group of focus for the survey (e.g., infants and young children consume in a different range of portion sizes than adults.) The available secondary data should be of high quality and be somewhat representative of the demographic groups to be included in the planned survey (e.g., infants and young children, adolescents, adult males, adult females). The minimum and maximum portion sizes depicted in the photographic series for a given food item are often defined as the 5th–10th and 90th–95th percentile of reported portion sizes for a given demographic group, respectively, derived from the reported distribution in previous dietary surveys (Nelson and Haraldsdóttir 1998b). Intermediate portion sizes are then set between the minimum and maximum portion sizes depicted; these portion sizes should increase in size along a continuum, i.e., the increment in portion size is always the same in grams. Detailed guidance on the development of graduated-portion size food photographs is available elsewhere.[24]

Whenever new graduated portion-size food photographs are developed for use in a dietary survey, before they are used for data collection, the food photographs should first be pre-tested and, ideally, validated to assess if the food photographs are feasible for potential survey respondents to use for portion size estimation and to assess if the food photographs perform well across the range of portion sizes usually consumed (e.g., a small quantity of peanuts or a large quantity of a staple such as rice), across diverse geographic areas (e.g., rural and urban), and across demographic groups with whom the photographs have been developed for use.

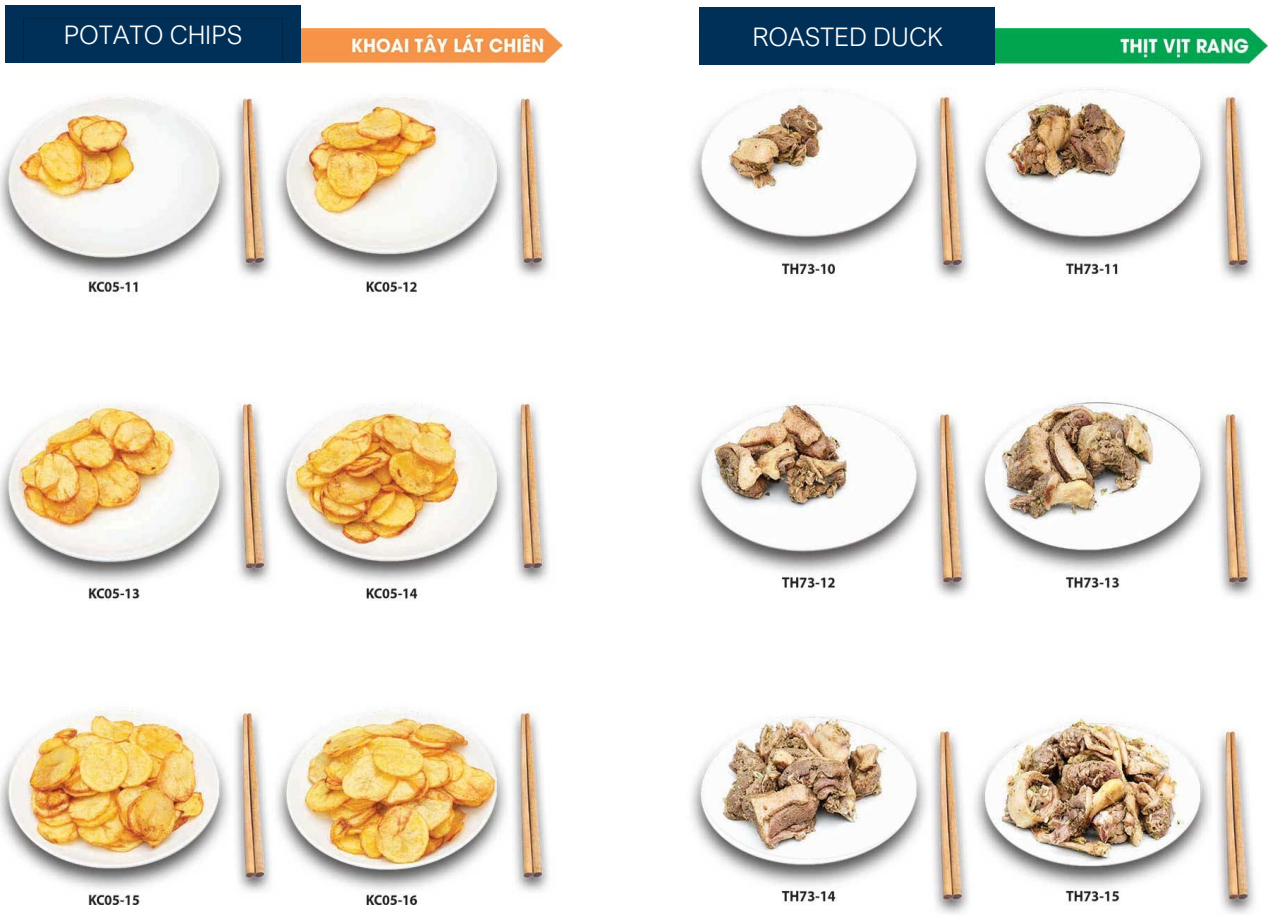
When using graduated portion-size food photographs as the PSEM for a given food item, it is possible to allow the respondent to report multiples and/or fractions of units depicted; or to report portion sizes not depicted.

If survey planners decide to allow the respondent to indicate a portion size that is not depicted, a new code must be developed and a gram weight established to represent each allowed portion size option that is not depicted. If survey planners decide to allow the use of fractions, then their use should be limited to halves, thirds, or fourths, as smaller fractions may be challenging to visualize and report and are unlikely to meaningfully affect the estimated portion size. The use of multiples and/or fractions should never be allowed in combination with portion sizes not depicted. A choice must be made to allow for either the use of fractional reporting or the reporting of portion sizes not depicted, or neither.

In some contexts, survey planners may wish to consider using the graduated portion-size food photographs of a given food item to estimate portion sizes of a set of similar food items that are not depicted (e.g., use a photograph of cooked spinach to assess the amount of cooked kale consumed). Allowing the use of substitutions with graduated portion-size food photographs as a PSEM requires careful consideration because of the added complexity that doing so entails for the 24-hour dietary recall interview and the complex downstream implications for data processing. When allowed, the number of permitted substitutions should be limited, and strict selection criteria must be set for the selection of the substitute food items. In addition, the PSEM list used to aid the enumerator during the 24-hour dietary recall interview must list each of the allowed substitutions.

[24] For detailed guidance on the development of food photographs, refer to Vossenaar M, Crispim SP, Lubowa A, Deitchler M, Moursi M, and Arimond M. 2020. *Guidance for the Development of Food Photographs for Portion Size Estimation in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries*. Washington, DC and Curitiba, Brazil: *Intake* – Center for Dietary Assessment/FHI Solutions and Department of Nutrition, Federal University of Paraná, Available at: Intake.org.

Figure 7. The Use of Graduated Portion-Size Food Photographs for Portion Size Estimation



Photographs reproduced with permission from Viet Nam National Institute of Nutrition (NIN). 2019. *Photo Book for Dietary Assessment.* Medical Publishing House. Hanoi: Medical Publishing House. The photographic series for potato chips (page 21) and for roasted duck (page 133) are both printed at 32% scale when printed on a full-size page.

8. Full-Size Food Photographs Depicting Multiple Unit Sizes of a Single Food in a Whole, Unprocessed State

Description of the PSEM

When using full-size food photographs as a PSEM, the respondent is shown a photographic series of different sizes of a single food, each at 100% scale, with the food typically shown in a whole, unprocessed state and in sizes in which the food naturally exists. The respondent is asked to select the food image that best represents the unit size served and, to report the number or fractions of the selected food size that was consumed. The enumerator records the selected size (i.e., the assigned code) and the number and/or fraction of the size of the food item that was consumed.

Full-size food photographs typically depict a series of entire foods that vary in size from smallest to largest but that are very similar in shape (e.g., entire avocados of different sizes). The sizes depicted for the food do not correspond to a range of possible portion sizes, but rather to different size gradations in which the specified food exists naturally.

Types of food items for which this method is well suited

The selection of foods for which full-size food photographs should be developed and assigned as a PSEM requires careful consideration. Given the complexity of the development of food photographs, when resources are limited, *Intake* recommends developing only a relatively small number of full-size food photographs. Foods for which amounts consumed are well suited to be estimated using Group I PSEMs should not be prioritized for the development of full-size food photographs.

This PSEM is limited to single foods consumed in a whole, unprocessed state. Full-size food photographs should not be developed for single foods that are more easily visualized when processed (e.g., a peeled and sliced apple) or for any type of mixed dish. They can, however, be used to estimate amounts of ingredients that are most easily visualized before they are processed and added to a mixed dish (e.g., before being peeled, cut, or sliced). For some foods, shapes and color vary between varieties and the food photographs are suitable only for a given variety.

Foods that can be prioritized for the development of full-size food photographs are foods that are very similar in shape even as they vary in size and can, therefore, be grouped into average standard sizes ranging, for example, from very-small through small, medium, large, and very large to extra-large. Furthermore, the food should typically be consumed or used in a few whole units that can be counted. The series of sizes depicted within a photographic series should fit on a single page at 100% scale.

Examples of foods well suited for this PSEM include many fruits (e.g., mangoes, avocados, guava, bananas, apples), vegetables often used as ingredients (e.g., onions, tomatoes, carrots, eggplant), and roots and tubers used as ingredients (e.g., beets, turnips, potatoes).

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that full-size food photographs are the most suitable PSEM to be used for the reported food by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and presentation mode of the food item.

Using full-size photographs as the PSEM for a food reported as consumed is only appropriate if the respondent reports consuming the food in the same unprocessed, natural state, form, and presentation as the food is depicted in the food image. The food images shown in the full-sized food photograph must represent the exact food consumed; substitutions are not typically permitted with the use of full-size food photograms.

If the unprocessed, whole, natural state, form, and presentation of the food includes inedible parts (e.g., mango with pit and peel), then the respondent should report the amount consumed of that food in that form and

presentation mode with inedible parts included. Alternatively, if the unprocessed natural state, form, and presentation mode of the food does not have any inedible parts, then this is how the food images should depict the food, and this is how the respondent should report the amount of that food that was consumed. When the state, form, and mode of presentation depicted in the photographic series is not consistent with the state, form, and presentation in which the respondent consumed the food, a different PSEM must be used for that food.

As is the case for all PSEMs, when using full-size food photographs, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food represents the amount consumed. When using full-size food photographs as a PSEM, leftovers and additional servings are not estimated separately, but the respondent is reminded to consider them, both at the outset of portion size estimation for the food and afterward, as a means of confirmation.

To use this PSEM during the 24-hour dietary recall interview, the respondent is shown a series of food photographs representing a range of sizes of a real food in the whole, unprocessed state in which the food naturally exists. The respondent is asked to select the image of the food that best represents the unit size of the food that was served. The respondent also reports the number and/or fractions of the image of the selected unit size to indicate the amount consumed. The enumerator records the selected food image (i.e., the assigned code) and the number and/or fractions of the selected food size that were consumed.

Equipment, tools, and aids required

Full-size food photographs: Each enumerator should carry the same set of printed high-quality food photographs. Printed photographs are typically used for portion size estimation even when using electronic data collection methods for the 24-hour dietary recall interview.

For ease of use during data collection:

- The photographic series of the different portion sizes depicted for a given item should be printed in color on a single sheet of paper.
- All photographs should be laminated to protect them from deterioration as a result of frequent handling, dirt and dust, and potential water damage.
- The complete set of photographs should be bound in a single volume, atlas, or book bound with string and arranged in logical, easy-to-identify order (e.g., by food group).

Considerations and precautions for operationalization

High-quality, well-developed food photographs are not available for use in most LMICs. Given the complexity of the development of food photographs, when resources are limited, *Intake* recommends developing food photographs only when there is a high level of commitment and ample resources, including time, in advance of the planned survey. The development of full-size food photographs is more feasible than the development of graduated portion-size food photographs because the procedures used to determine unit sizes depicted is not dependent on the use of existing, high-quality 24-hour dietary recall data. Therefore, when resources are limited, a small selection of full-size food photographs can be developed, but the selection of foods for which food photographs will be developed should be prioritized carefully.

When full-size food photographs are developed, the number and selection of the sizes to depict is an important consideration. *Intake* recommends depicting an even number of different-sized images of the food, to prevent the tendency of a respondent to select the middle-sized food image (Nelson and Haraldsdóttir 1998b). Often six or eight sizes of the food are included in a series, although the number is limited by how many full-size images fit on a single sheet of paper.

The recommended procedure to use for determining the number of different sizes to depict and the size of each one to photograph is outlined below.

1. Collect a sample of 20-30 units of the food (e.g., avocado) to be depicted in the food photograph. The sample of different units of the food should be collected by purchasing the food from different vendors in the survey area. Across the sample collected, the units of the food purchased should vary in size.
2. Take a single weight measurement for each food sample (including all inedible parts of the food in the weight measurement[25]), and document the respective weight (to the nearest gram) (i.e., weigh each avocado purchased and record its weight, including the peel and pit). All weight measurements should be made with a dietary scale that meets *Intake* specifications[26] and has been tested for accuracy and precision.[27]
3. Organize the food samples, along with the corresponding weight measurement for each unit of the food, in a continuum from smallest to largest (i.e., physically arrange the avocados in size from smallest to largest, using the recorded weight measurement as the reference for size).
4. Identify six or more weights (and ideally, an even number of weights) along the continuum that are spaced in such a way that, to the extent possible, the difference in size between each of the weights is visually perceivable and fairly equally spaced (in terms of the gram difference in weight). The smallest (or next smallest) and the largest (or next largest) food in the sample (in terms of gram weight) should typically be included among the weights identified, with the goal of representing the likely range of sizes. If the weights for a sample of 25 avocados were: 100 g, 105 g, 120 g, 123 g, 140 g, 142 g, 146 g, 148 g, 150 g, 170 g, 175 g, 180 g, 188 g, 192 g, 196 g, 200 g, 202 g, 203 g, 205 g, 210 g, 220 g, 222 g, 225 g, 225 g, and 228 g, it might be reasonable to select the following six weights from this sample of avocados to represent the series of avocado sizes to depict in the photographic series: 105 g, 123 g, 150 g, 175 g, 200 g, and 225 g.

Detailed guidance on the development of full-size food photographs is available elsewhere.[28]

Whenever new full-size food photographs are developed for use in a dietary survey, before they are used for data collection, the food photographs should first be pre-tested and, ideally, validated to assess if the food photographs are feasible for potential survey respondents to use for portion size estimation, and to assess if the food photographs perform well across the range of portion sizes usually consumed (e.g., a small quantity of peanuts or a large quantity of a staple such as rice), across diverse geographic areas (e.g., rural and urban), and across demographic groups with whom the photographs have been developed for use.

The use of full-size food photographs as a PSEM requires the use of multiples and fractions of the selected units for accurate portion size estimation. Reporting fractions can present cognitive difficulties for both the respondents and the enumerators, thus increasing the risk of error, especially in lower-literacy environments. Survey planners should always consider the survey context carefully to determine whether fractional unit reporting is feasible. When the use of fractions is not deemed feasible, then full-size food photographs should not be used as a PSEM. When deemed feasible, then their use should be limited to halves, thirds, or fourths, as smaller fractions may be challenging to visualize and report and are unlikely to meaningfully affect the estimated portion size. For example, a respondent may be allowed to report $^1/_2$ of the size of the food represented in photograph B5, but not $^1/_5$.

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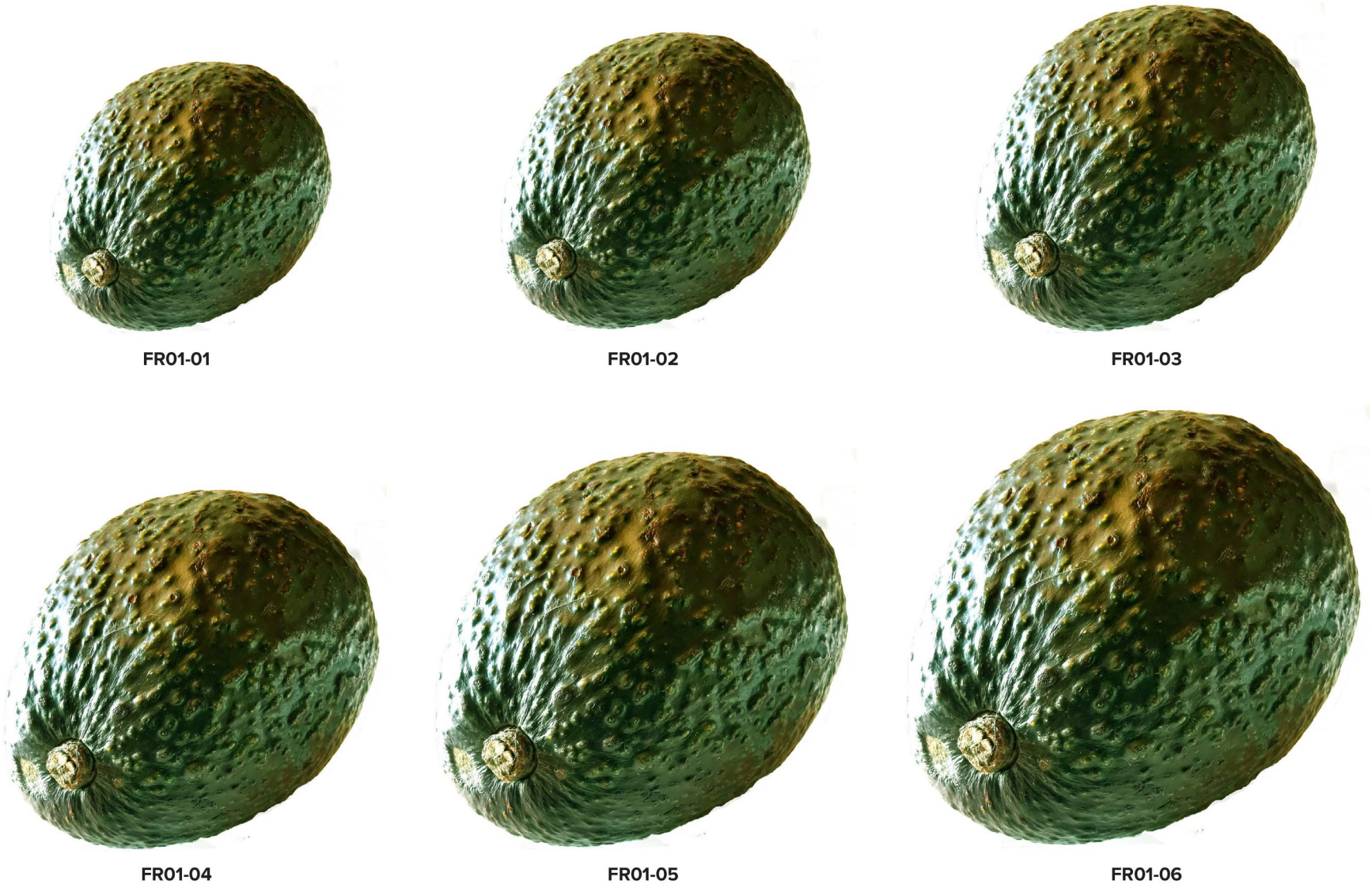
[25] As such, during data processing, an "edible portion factor" is needed to derive the edible portion of the food item.

[26] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[27] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[28] For detailed guidance on the development of food photographs, refer to Vossenaar M, Crispim SP, Lubowa A, Deitchler M, Moursi M, and Arimond M. 2020. *Guidance for the Development of Food Photographs for Portion Size Estimation in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries*. Washington, DC and Curitiba, Brazil: *Intake* – Center for Dietary Assessment/FHI Solutions and Department of Nutrition, Federal University of Paraná, Available at Intake.org.

Figure 8. The Use of Full-size Food Photographs for Portion Size Estimation



These food photographs are at 100% scale when printed on a full-size page.

9. 2D Shapes Depicting Multiple Unit Sizes for a Given Food Item

Description of the PSEM

When using 2D shapes as a PSEM, the respondent is shown a series of 2D shapes, such as drawings, printouts, or cardboard cut-outs, in a range of sizes to aid the respondent in visualizing the portion size of the food item reported to have been consumed. The 2D shapes do not look like the food item they are meant to represent, but they have a similar shape (i.e., 2D contour). Common shapes such as circles, triangles, or rectangles are made in different sizes and are meant to represent different sizes in which a food item is typically served, presented at 100% scale. Typically, different sizes of a given 2D shape are created for a single food item to represent different unit sizes (e.g., six or eight sizes per 2D shape).

During the 24-hour dietary recall interview, the respondent is asked to select the 2D shape that best represents the unit size of the food item served and, to indicate the number and/or fractions consumed of the selected 2D shape. The enumerator records the 2D shape selected that represents the unit size of the food item served and the number and/or fractions of units consumed (e.g., 2½ shape A).

Types of food items for which this PSEM is well suited

2D shapes are appropriate to use as a PSEM for food items that come in different sizes, are flat, without variation in thickness, and are typically consumed in a small number of whole units that can be counted. 2D shapes are typically developed for food items that do not include any inedible portions. Not many food items fit these criteria.

If 2D shapes are used as a PSEM with mixed dishes, the use should be limited to mixed dishes for which a standard recipe has been developed. The PSEM can be used for homogenous mixed dishes or for non-homogenous mixed dishes for which survey planners have decided it is appropriate for amounts to be estimated as a whole (i.e., the amount of nutrient-dense ingredients consumed are not estimated separately from other parts of the mixed dish). Examples include flatbreads (e.g. roti, chapatti, naan bread) and tortillas.

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that 2D shapes are the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and presentation mode of the food item. The food shape must represent the exact food item reported; substitutions are not typically permitted with the use of 2D shapes.

The enumerator must identify the 2D shape that corresponds to the reported food item. Once a suitable 2D shape series has been identified by the enumerator and confirmed as such by the respondent, the respondent is shown the different sizes and asked to choose the one that most closely represents the unit size and shape of the food item served. The enumerator records the 2D shape selected that represents the food item served and the number and/or fractions of units consumed (e.g., 2½ shape A).

Similar to all other PSEMs, the enumerator must always seek to ensure that the portion size being estimated represents the amount consumed, accounting for any leftovers and additional servings during the same eating occasion. When using 2D shapes as the PSEM, leftovers and additional servings are not estimated separately, but the respondent is reminded to consider them, both at the outset of portion size estimation for the food item and as a means of confirmation, after the portion size for the food item is selected and reported by the respondent.

Equipment, tools, and aids required

2D shapes: Each enumerator should carry the same set of high-quality 2D shapes (e.g., circles, triangles, or rectangles) in different sizes. 2D shapes can be drawings, printouts, or cardboard cut-outs. All 2D shapes used within a given survey should be identical (i.e., each enumerator carries exact replicas). These are needed even when using electronic data collection methods for the 24-hour dietary recall interview.

For ease of use during data collection:

i. Care should be taken to protect all 2D shapes from deterioration as a result of frequent handling, dirt and dust, and potential water damage (e.g., paper printouts should be laminated).

ii. All paper 2D shapes should be bound in a single volume, atlas, or book bound with string and arranged in logical, easy-to-identify order (e.g., by food group).

Considerations and precautions for operationalization

A critical consideration when using 2D shapes is the selection of specific food items for which this PSEM should be used. This must be done in advance of data collection. Considerations for the selection of food items include:

- Confirming the uniformity of the thickness of the food item.
- Confirming that the food does not have any inedible parts.
- Confirming that the number of units typically consumed is sufficiently low so that the respondent can easily count and report the number of units (e.g., fewer than 10 units).

When 2D shapes are developed, the number of sizes of 2D shapes to develop for each shape is an important consideration. *Intake* recommends depicting an even number of sizes of a given 2D shape to prevent the tendency of a respondent to select the middle-sized 2D shape. Ideally, at least six different sizes are available for each 2D shape.

The recommended procedure to use for determining the number of different sizes of 2D shapes to depict and the size of each one to depict is outlined below:

1. For the identified food item (e.g., corn tortilla), determine the 2D contour of how the food item is typically served and consumed (e.g., a triangle).
2. Collect a sample of 20-30 units of the identified food item (e.g., corn tortilla). The sample of the food item should be collected by purchasing the food item from different vendors in the survey area. Across the sample collected, the units of the food purchased should vary in size but should be shaped with a consistent 2D contour.[29]
3. Take a single weight measurement for each food item sample and document the respective weight (to the nearest gram) (i.e., weigh each corn tortilla purchased and record its weight). All weight measurements should be made with a dietary scale that meets *Intake* specifications[30] and has been tested for accuracy and precision.[31]

[29] For all vendors that make a given food item with similar shape and thickness and for which the 2D shape is being developed.

[30] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

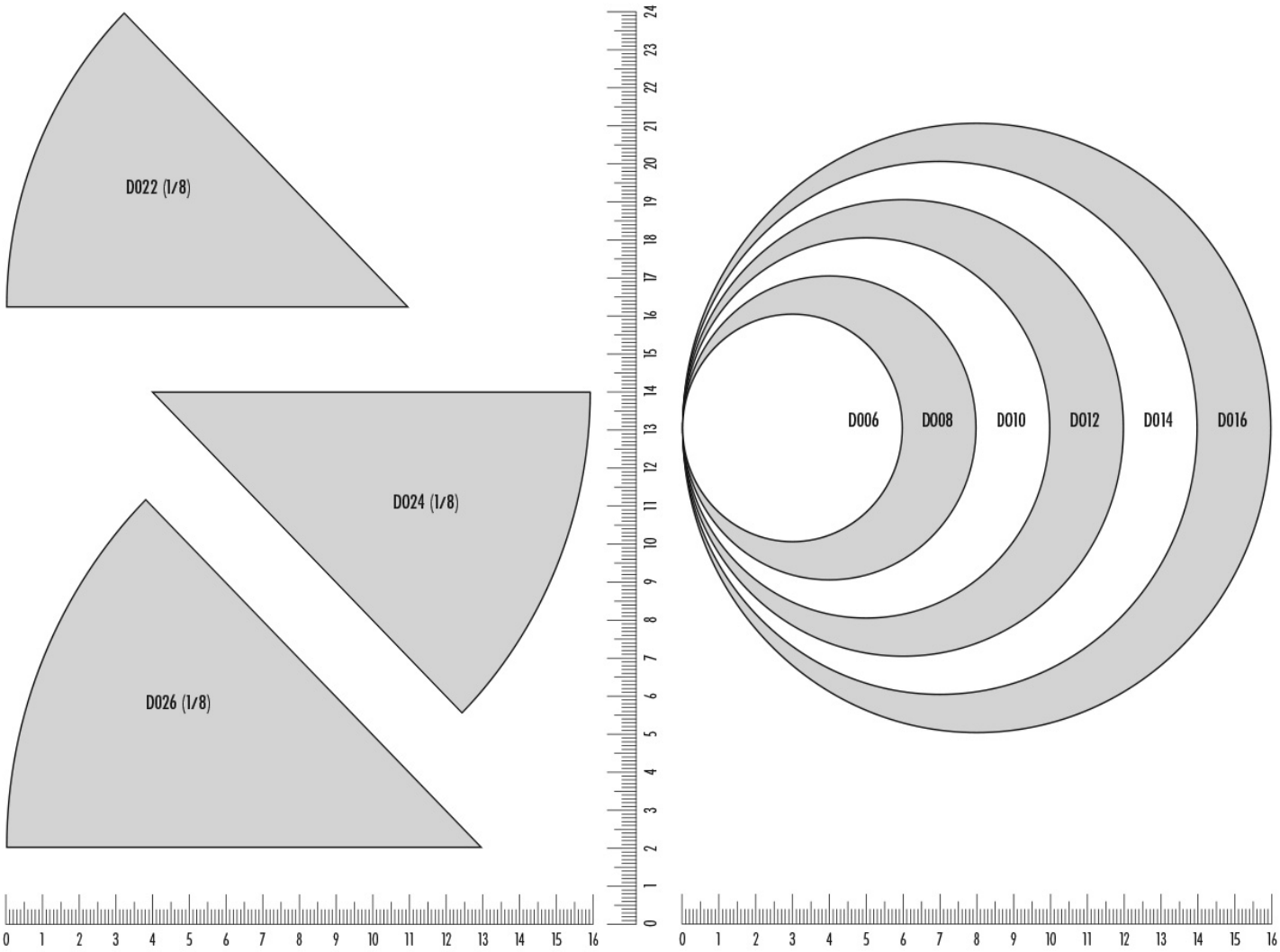
[31] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

4. Organize the food samples, along with the corresponding weight measurement for each unit of the food, in a continuum from smallest to largest (i.e., physically arrange the corn tortillas in size from smallest to largest, using the recorded weight measurement as the reference for size).
5. Identify six or more, weights along the continuum that are spaced in such a way that the difference in size between each of the weights is visually perceivable and fairly equally spaced (in terms of the gram difference in weight). The smallest (or next smallest) and the largest (or next largest) food items in the sample (in terms of gram weight) should typically be included among the weights identified. If the weights for a sample of 20 corn tortillas were: 15 g, 15 g, 16 g, 18 g, 18 g, 20 g, 20 g, 21 g, 21 g, 23 g, 24 g, 26 g, 28 g, 30 g, 30 g, 30 g, 33 g, 32 g, 34 g, and 36 g, it might be reasonable to select the following four weights to guide the size of the 2D contour: 15 g, 21 g, 26g, 28 g, 30 g and 34 g).

When new 2D food shapes are developed for a survey, the 2D shapes should first be pre-tested and, ideally, validated to assess if the 2D shapes are feasible for potential survey respondents to use for portion size estimation, and to assess if the 2D shapes perform well across the range of portion sizes usually consumed, across diverse geographic areas (e.g., rural and urban), and across the demographic groups to be included in the survey.

The use of 2D shapes requires allowing for the use of multiples and fractions of the selected 2D shape for accurate portion size estimation. Reporting fractions can present cognitive difficulties for both the respondents and the enumerators, thus increasing the risk of error, especially in lower-literacy environments. Survey planners should always consider the survey context carefully to determine whether fractional unit reporting is feasible. If deemed feasible, the use of fractions should be limited to halves, thirds, or fourths, as smaller fractions may be challenging to visualize and report and are unlikely to meaningfully affect the estimated portion size. For example, a respondent may report $^1/_2$ of shape C, but not $^1/_5$ of shape C. If fractional reporting is not deemed feasible for the survey context, then the use of 2D shapes as PSEM should not be considered for use in the survey.

Figure 9. The Use of 2D Shapes for Portion Size Estimation



Images reproduced with permission from Camenzind-Frey E and Zuberbuehler CA. 2014. *menuCH – SWISS PICTURE BOOK.* Bern: Federal Office for Public Health (FOPH) and Federal Food Safety and Veterinary Office (FSVO). 2nd revised edition.

10. 3D Food Models Depicting Multiple Unit Sizes for a Given Food Item

Description of the PSEM

When using 3D food models as a PSEM, the respondent is shown 3D food models made from wood, plastic, papier mâché, foam rubber, or other durable material to provide a realistic way for respondents to visualize and report the amount of a food item consumed. The 3D models should be made to look very similar to the food item they are meant to represent and are therefore always made at 100% scale (i.e., full-size). Typically, different-sized models are created for a single food item to represent different unit sizes.

During the 24-hour dietary recall interview, the respondent is asked to select the 3D food model that best represents the unit size of the food item served and to report the number and/or fractions consumed of the selected 3D model. The enumerator records the 3D food model selected that represents the food item consumed and the number and/or factions of the units consumed (e.g., 2½ food model A).

Types of food items for which this PSEM is well suited

3D food models can be assigned as a PSEM to estimate the amount consumed of a wide array of food items. This PSEM is well suited for food items with definite shapes and graduated sizes that are commonly eaten directly from the hand and for which units can easily be counted (e.g., whole fruits and vegetables).

Although 3D food models are well suited to estimate amounts consumed of a wide array of food items, in practice their use is limited because they are cumbersome for the enumerator to carry in the field. Also, the development of 3D food models is resource-intensive and requires considerable technical expertise, both for determining the unit sizes to depict and producing the model. 3D food models should therefore only be considered for the estimation of amounts of food items that are widely consumed. Examples include commonly consumed fruits and vegetables (e.g., bananas, avocados, mangoes, zucchini, eggplant, sweet potato).

If 3D food models are used as a PSEM with mixed dishes, the use should be limited to mixed dishes for which a standard recipe has been developed. The PSEM can be used for homogenous mixed dishes, or for non-homogenous mixed dishes for which survey planners have decided it is appropriate for amounts to be estimated as a whole (i.e., the amount of nutrient-dense ingredients consumed are not estimated separately from other parts of the mixed dish).

Use of the PSEM during the 24-hour dietary recall interview

To use this PSEM, the enumerator must first confirm that 3D food models are the most suitable PSEM to be used for the reported food item by asking the respondent a series of questions (i.e., interview probes) that help the enumerator to confirm the match of the food item in the PSEM list, according to the reported state, form, and presentation mode of the food item. The food model must represent the exact food item reported; substitutions are not typically permitted with the use of 3D food models.

The enumerator must identify the model series that corresponds to the reported food item. Once a suitable 3D food model series has been identified by the enumerator and confirmed as such by the respondent, the respondent is shown a series of models representing a series of increasing unit sizes and asked to choose the one that most closely represents the unit size of the food item served. The enumerator records the code of the 3D food model selected, and the number and/or fractions of units consumed (e.g., 2 food model C).

As for all PSEMs, when collecting data on portion size for food items that could potentially include an inedible portion, it is essential for enumerators to always ask the respondent whether the portion size estimation for the food item includes an inedible portion. Knowing whether a food item could potentially include an inedible portion is facilitated by the use of a PSEM list that includes all relevant variations of a food item and specifies if each one includes an inedible portion. 3D food models that depict a food item with an inedible portion should only be used to estimate amounts of food items that were reported as served in that presentation mode, so that the respondent can accurately visualize the food item with the inedible portion included. Similarly, 3D food models that depict a

food item without an inedible portion should only be used to estimate amounts of food items that were reported as served in that presentation mode, so that the respondent can accurately visualize the food item with the inedible portion excluded. If the presentation mode of the food item reported by the respondent (including whether or not there was an inedible portion included) is not consistent with how the food is depicted by the 3D food model, a different PSEM should be used to estimate the amount of the food item consumed.

As is the case for all PSEMs, the enumerator must always determine if there were leftovers and/or additional servings during the same eating occasion to ensure that the portion size being estimated for the food item represents the amount consumed. When using 3D food models, leftovers and additional servings are not estimated separately, but the respondent is reminded to consider them, both at the outset of portion size estimation for the food item and afterward, as a means of confirmation.

Equipment, tools, and aids required

3D food models: Each enumerator should carry the same set of high-quality 3D food models that depict a variety sizes and/or shapes at 100% scale (i.e., full-size) for a limited selection of specific food items. These are needed even when using electronic data collection methods.

- All 3D food models used within a given survey should be identical (i.e., exact replicas).
- Models can be made from wood, plastic, papier mâché, foam rubber, or other durable material. Models should look realistic and so should be made at full scale and using appropriate colors.
- For ease of use during data collection, models should not be too heavy and must be sturdy enough to endure frequent handling and potential exposure to dirt, dust, and water.

Considerations and precautions for operationalization

The development of 3D food models requires considerable technical expertise. Even when a limited selection of 3D food models is developed, the process can be time- and resource-intensive. As such, 3D food models should not be developed for food items for which there is an acceptable Group I PSEM.

When 3D food models are developed, the number of sizes of each model to develop for each food item is an important consideration. *Intake* recommends depicting an even number of sizes of a given 3D food model to prevent the tendency of a respondent to select the middle-sized 3D food model. Ideally, at least six different sizes are available for each 3D food model.

The recommended procedure to use for determining the number of different sizes of 3D food models to depict and the size of each one to depict is outlined below:

1. Collect a sample of 20-30 units of the identified food item (e.g., banana). The sample of the food item should be collected by purchasing the food item from different vendors in the survey area. Across the sample collected, the units of the food purchased should vary in size.
2. Take a single weight measurement for each food item sample and document the respective weight (to the nearest gram) (i.e., weigh each banana purchased and record its weight). All weight measurements should be made with a dietary scale that meets *Intake* specifications[32] and has been tested for accuracy and precision.[33]

[32] For guidance on dietary scale specifications, refer to Vossenaar M, Hotz C, Lubowa A, Ferguson E, and Deitchler M. 2020. *Recommended Specifications for Dietary Scales for Use in Quantitative 24-Hour Dietary Recall Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

[33] For guidance on procedures for testing dietary scales, refer to Vossenaar M, Deitchler M, Hotz C, Lubowa A, and Ferguson E. 2020. *Routines and Procedures to Test the Accuracy and Precision of Digital Dietary Scales Used in Quantitative 24- Hour Dietary Recall Surveys.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions, Available at Intake.org.

3. Organize the food samples, along with the corresponding weight measurement for each unit of the food, in a continuum from smallest to largest (i.e., physically arrange the banana in size from smallest to largest, using the recorded weight measurement as the reference for size).
4. Identify six or more weights along the continuum that are spaced in such a way that the difference in size between each of the weights is visually perceivable and fairly equally spaced (in terms of the gram difference in weight). The smallest (or next smallest) and largest (or next largest) food items in the sample (in terms of gram weight) should typically be included among the weights identified. If the weights for a sample of 20 bananas were: 70g, 73g, 75g, 95g, 100g, 102g, 105g, 120g, 121g, 122g, 130g, 142g, 145g, 148g, and 150g, it might be reasonable to select the following six weights to guide the size of the 3D food model: 75 g, 95 g, 105 g 120 g, 130 g, and 145 g.

When new 3D food models are developed for a survey, the 3D models should first be pre-tested and, ideally, validated to assess if the 3D models are feasible for potential survey respondents to use for portion size estimation, and to assess if the 3D models perform well across the range of portion sizes usually consumed, across diverse geographic areas (e.g., rural and urban), and across demographic groups to be included in the survey.

The use of 3D food models requires the use of multiples and fractions of the selected 3D food model for accurate portion size estimation. Reporting fractions can present cognitive difficulties for both the respondents and the enumerators, thus increasing the risk of error, especially in lower-literacy environments. Survey planners should always consider the survey context carefully to determine whether fractional unit reporting is feasible. If deemed feasible, the use of fractions should be limited to halves, thirds, or fourths, as smaller fractions may be challenging to visualize and report and are unlikely to meaningfully affect the estimated portion size. For example, a respondent may report $^1/_2$ of 3D model A, but not $^1/_5$ of 3D model A. If fractional reporting is not deemed feasible for the survey context, then the use of 3D food models as PSEM should not be considered for use in the survey.

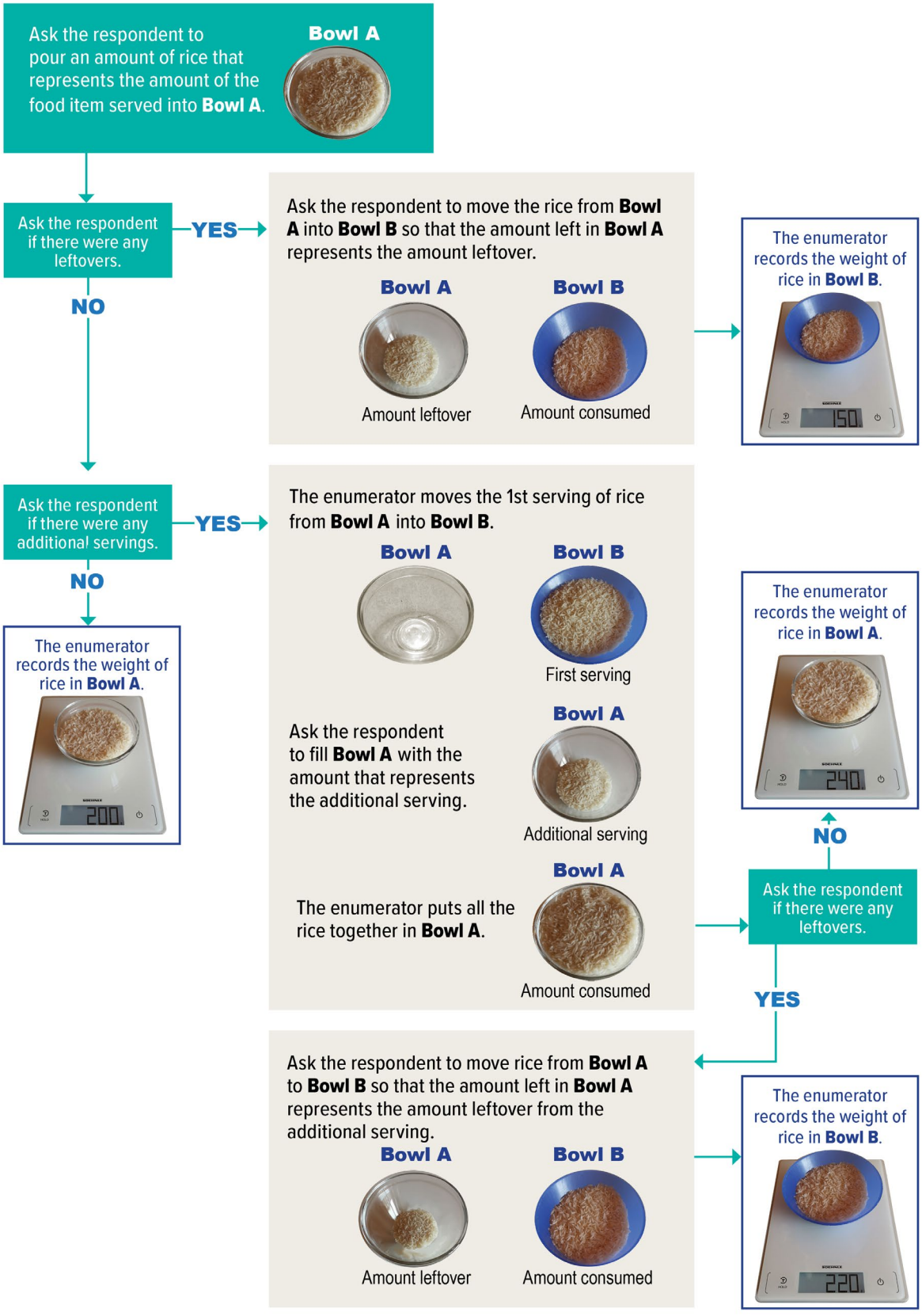
Figure 10. The Use of 3D Food Models for Portion Size Estimation

Source: Fruits and Vegetables 3D Model, Available at https://open3dmodel.com/3d-models/3d-model-food-fruits-vegetables_182877.html

Annex 2. Iterative Approach to Account for Leftovers and Additional Servings When Using Direct Weight or a Proxy Material

When using direct weight or a proxy material as the PSEM, the amount served and the amount leftover can be visually represented by the respondent with the food replica or proxy material. This process is illustrated in Figure 11 below with the use of a proxy material that is free-flowing, i.e., raw rice. In this example, the enumerator asks the respondent to bring out the exact type of bowl from which the food item was consumed (Bowl A). Using the same bowl as had been used for consuming the food item provides the respondent with the most realistic opportunity to visually recollect the portion size consumed. Bowl B should be provided by the enumerator and does not need to be similar to Bowl A. This bowl is used as an aid to carry out the iterative approach used to derive the amount consumed.

Figure 11. Flow-Chart to Illustrate the Iterative Approach to Account for Leftovers and Additional Servings When Using Raw Rice for Portion Size Estimation



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