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SURVEY GUIDANCE DOCUMENT

Planning and Design Considerations for Quantitative 24-Hour Recall Dietary Surveys in Low- and Middle-Income Countries

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JANUARY 2020

Recommended Citation

Deitchler M, Arimond M, Carriquiry A, Hotz C and Tooze JA. 2020. *Planning and Design Considerations for Quantitative 24-Hour Recall Dietary Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions.

Acknowledgments

We gratefully acknowledge the careful work of Marieke Vossenaar, who reviewed and provided input into the final draft version of this document.

About *Intake*

Intake is a Center for Dietary Assessment that aims to strengthen policies and programs to improve nutritional status by increasing the availability, quality, comparability, and use of reliable dietary data and metrics in low- and middle-income countries (LMICs). We hope that the availability of valid, concise, effective diet-related metrics, along with *Intake* technical assistance for the planning, design, collection, analysis, and use of dietary data, can play an important role in helping actors in LMICs to develop evidence-based nutrition and agriculture policies and programs to ensure high-quality diets for all.

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List of Abbreviations

DRI	dietary reference intakes
EAR	estimated average requirement
FAO	Food and Agriculture Organization of the United Nations
FCDB	food composition database
FFQ	food frequency questionnaire
FRIL	food, recipe, and ingredient listing
GIFT	Global Individual Food Consumption Data Tool
INFOODS	International Network of Food Data Systems
IOM	U.S. Institute of Medicine
ISU	Iowa State University
mg	milligram(s)
LMIC	low- and middle-income country
ME	margin of error
NHANES	National Health and Nutrition Examination Survey
PC-SIDE	PC Software for Intake Distribution Estimation
PSEM	portion size estimation method
RME	relative margin of error
SSB	sugar-sweetened beverage
U.S.	United States
WHO	World Health Organization

Executive Summary

National governments require information on dietary intakes to inform a wide range of policy and programmatic decisions, all aimed at improving health and well-being. This document aims to present a series of issues and choices that must be considered during the planning and design of a quantitative 24-hour recall dietary intake survey at large-scale.

When planning the design for a dietary survey, the financial and human resources available to support the survey activities must be carefully considered, as each survey design decision will have resource implications. The single largest driver of survey cost is likely to be the geographic level (e.g., national, regional, provincial) at which the survey data must be reported. Therefore, survey planners should explicitly map where “data-dependent” decisions will be taken on food and nutrition policies and programs. What decisions hinge on which specific results, and at what administrative level are these decisions taken? At what geographic level(s) of disaggregation are data absolutely required?

In cases where there is large variation in dietary practices across the country, some level of geographic disaggregation might be necessary to ensure meaningful results. Similarly, if significant differences in the diets of populations living in urban and rural areas are expected, then urban/rural stratification of the sample would be recommended.

A second key driver of survey cost is the number of demographic groups to be sampled for the survey. The number of demographic groups will multiply both the time and the cost required to conduct the survey. Target demographic groups for the survey should therefore be selected carefully based on public health priorities and feasibility.

Once major design decisions have been taken, scenarios for sampling and sample size can be considered. Sample designs for dietary surveys are usually either household-based or target group-based. In this document, we briefly describe these sampling approaches, and key considerations related to each with respect to respondent burden, sample size calculation, and resource requirements. Sample size determination for dietary surveys is complex; to help guide decisions on sample size requirements, we provide estimates for margins of error (MEs) for a set of dietary outcomes for a range of sample sizes.

There are several methodological choices unique to a 24-hour recall dietary survey that must be made, including the number of repeat 24-hour recalls to collect, and whether and how to carry out a “pre-training” with respondents. We provide a description of these methodological choices.

When to collect data for a dietary survey also requires careful consideration. Dietary intakes vary across time — across seasons and days of the week and according to cultural and religious practices. We present options for addressing the issue of seasonality and outline standard best practices for collecting dietary data across days of the week and for accounting for cultural and/or religious feasting and fasting rituals.

Next, again because they are unique to dietary surveys, we describe a set of inputs and databases that should ideally be prepared in advance of the survey. This entails substantial pre-survey work that must be planned and budgeted. The databases include a food, recipe, and ingredient listing (FRIL); a food composition database (FCDB) for the survey; and a “standard recipe” database. When data on nutrient supplement intake are collected as part of a dietary survey, and the data collected are intended to be used in the estimation of nutrient intake, in many contexts, a database for nutrient supplements (by brand, type, nutrient composition, etc.) also needs to be developed in advance of the survey.

Portion size estimation is also a major challenge in all quantitative dietary surveys. Portion size estimation methods (PSEMs) must be selected and assigned to each item included in the FRIL in advance of data collection. Ideally, the selected PSEMs are also pre-tested for feasibility before data collection. When novel PSEMs will be used for the survey, these methods should not only be pre-tested but, when possible, the methods should be

validated against weighed records in the survey context. A PSEM conversion factor database for the survey also needs to be compiled, ideally before data collection begins. This database is needed to convert the portion size of a food or beverage estimated as consumed by a respondent into a gram unit weight, and to take account of any relevant edible portion factor.

Finally, to provide some context for estimating the cost for a dietary survey, we provide relevant background information and discuss how different survey design decisions may impact the cost of data collection.

1 Why Undertake a Dietary Survey

National governments use dietary intake data for multiple purposes, including for:

1. Assessing food and nutrient intake —To assess and describe current intakes of energy, macronutrients (fats, proteins, carbohydrates), micronutrients (vitamins and minerals), food groups, and foods[1] (including intakes of fortified or fortifiable food vehicles)
2. Assessing prevalence of inadequacy —To characterize gaps between current intakes and adequate intakes relative to World Health Organization (WHO)/Food and Agricultural Organization of the United Nations (FAO) or other international or national nutrient intake recommendations
3. Assessing adherence to guidance and/or to healthy dietary patterns —To characterize gaps between current intakes/dietary patterns and global and national dietary guidance, and to characterize diets using diet quality indicators
4. Assessing prevalence of consumption —To assess prevalence of consumption of specific nutrient-dense or nutrient-poor foods/food groups[2]
5. Providing baselines, assessing trends —To describe and monitor changes over time for all of the above (intakes, inadequacy, adherence to guidance, and prevalence of consumption), including after national policy and programmatic interventions
6. Informing policies and programs —To inform development of new policies and programs to improve nutrient intakes, dietary patterns, and/or nutritional status
7. Developing consumer guidance —To inform development of consumer guidance (e.g., the development of food-based dietary guidelines) and/or educational campaigns and social/behavior change communications materials

For each of these uses, Table A1-1 (Appendix 1) provides one or two specific examples.

Before undertaking a dietary survey, survey planners should identify current priority questions and the proposed uses of the dietary data, as different uses have implications for survey design and sample size.

[1] For simplicity in language, in this document, we use the term “foods” to refer to both foods and beverages.

[2] Note that non-consumers (i.e., “never-consumers”) cannot be identified with the use of a single short-term 24-hour dietary recall instrument. Even when replicate 24-hour recalls are collected per respondent, more than two are generally needed, even with the use of a food frequency questionnaire (FFQ) with a 1-year (or 2-year) recall period as a covariate to inform consumption over a longer time period. However, depending on the purpose of the analysis, the percent of consumers of a food or food group on a given day could be reported using one day of the 24-hour dietary recall data collected for respondents. In this case, the data should be reported and interpreted as the percent who consumed the food (or food group) in the 24-hour reference period. These data would not reflect and should not be interpreted as the percent of usual consumers of the food (or food group).

2 Survey Design Options and Implications for Sample Size

This section provides an overview of survey design decisions, approaches to sampling, and of sample sizes required to estimate dietary outcomes at various levels of precision. Because of the complexities of survey and sample design and sample size determination for dietary surveys, we advise involving a statistician with an appropriate background in dietary surveys as early as possible in the survey planning process.

2.1 Design Options

2.1.1 Geographic Strata

Because of major implications for survey design and cost, survey planners must make important decisions related to geographic scope and, specifically, on the required level of disaggregation for survey results. Will national-level estimates suffice? Or is it necessary to obtain regional- or provincial-level estimates, or estimates for other geographic strata (e.g., urban/rural)?

To inform these important decisions, survey planners should explicitly map where “data-dependent” decisions will be taken on food and nutrition policies and programs. In other words, what decisions hinge on which specific results, and at what administrative level are these decisions taken? At what geographic level(s) of disaggregation are data absolutely required?

In cases where there is large variation in dietary practices across the country, some level of geographic disaggregation might be necessary to ensure meaningful results. Similarly, if significant differences in the diets of populations living in urban and rural areas are expected, then urban/rural stratification of the sample would be recommended.

2.1.2 Demographic Groups to Be Targeted

Survey planners should also discuss priority demographic groups for the survey, as each age/sex group will multiply the sample size. Inclusion of numerous age/sex groups may also increase respondent burden, depending on the sampling approach for the survey (for example, when a caregiver responds for many children in a household-based sampling approach). A larger sample size, both in general and within households, may result in declining data quality.

To the extent possible, when designing a dietary survey, it is advisable to define the demographic groups to be sampled for the survey according to the sex, age-bands, and physiologic descriptors (such as pregnancy and lactation status) that are associated with different nutrient requirements. This is because analysis of dietary data typically involves comparing a respondent’s intake data against the dietary reference information (for example, an estimated average requirement [EAR] value for a nutrient) associated with his/her sex, age, and physiologic status. Defining the demographic groups to be targeted for the survey so that they are aligned (as nearly as possible) with the demographic criteria associated with different nutrient requirements is one strategy to help control the extent of error that is introduced at the time of analysis, as well as to allow the data to be more easily interpreted.

When resource limitations or other considerations prevent such alignment, and a defined demographic group for a survey includes individuals with different reference intakes, a compromise approach is to scale the intakes of some of the persons in the group so that a single requirement can be assumed for everyone. For example, the EAR in the U.S. Institute of Medicine (IOM) Dietary Reference Intakes (DRI) (IOM, 2000) for vitamin C for boys aged 14–18 years is 63 mg/d and for girls aged 14–18 is 56 mg/d. If a demographic group for a survey was defined as all persons 14–18 years, the boys' intakes could be scaled by a factor equal to 56/63, so that intakes for both boys and girls 14-18 years could be compared to the EAR of 56 mg/d.

There are several additional factors that should be considered when defining the demographic groups of focus for a dietary survey that pertain specifically to infants and children. One key guideline is that children who are likely to be breastfeeding and children who are likely not to be breastfeeding should be defined as different demographic groups for the purpose of a dietary survey,[3] if both sets of children are of interest to include in the survey. This is because dietary surveys cannot accurately collect data on the amount of breast milk consumed or the nutrient content of that breast milk; in other words, the full diet of breastfed children cannot be quantified through a dietary survey. The statistics that can be reported for breastfed children are therefore different than those that can be reported for children who are not breastfed, and for those statistics that can be reported for both breastfed and non-breastfed children, the interpretation of the data is different. This issue, and others related to dietary data collection among older children, are discussed in more detail in Box 1.

Further, survey planners should consider whether it is desirable to assess the intake of small population sub-groups, such as pregnant or lactating women or under-represented ethnic minorities. If respondents for the survey were selected in the same proportion in which they are represented in the population, the resulting sample would include few persons of small sub-populations. If the intake of small population sub-groups is of interest, to control sample size it is often a good idea to oversample these selected sub-populations (e.g., pregnant or lactating women).

[3] This is often proxied by defining the demographic groups as children 6–23 months (likely to be breastfeeding) and children 24–59 months (likely not to be breastfeeding). The appropriate age range to define for "likely to be breastfeeding" and "likely not to be breastfeeding" should be adapted to the specific context in which the survey will be carried out.

Box 1. Special Considerations for Collecting Quantitative 24-Hour Recall Dietary Data for Infants, Children, and Adolescents

Survey planners should be aware of several issues specific to assessing dietary intakes of infants and children.

Infants and Young Children

For infants and young children who stay at home, the survey respondent is usually the mother but may include another caregiver responsible for feeding the child. When mothers work outside the home and where caregiving is split during different times of the day, multiple respondents are likely to be required.

For infant and young children whose diet includes more than a minimal amount of breast milk, the usual set of dietary outcomes, e.g., usual mean nutrient intake and prevalence of nutrient inadequacy, cannot be estimated. This is because, outside of small research studies, it is generally not possible to estimate the quantity of breast milk or the nutrient composition of the breast milk that a child has consumed. Assumptions can be made about these factors, but this adds a very significant amount of error and unreliability to any estimates of nutrient intake or inadequacy. This limitation should be carefully considered before a decision is taken to invest in the added expense and logistic complications of collecting quantitative 24-hour recall dietary data on children currently breastfed.

There may be other dietary outcomes of interest for this demographic group, including:

- Infant and young child feeding indicators
- Nutrient density of the complementary diet
- Consumption amounts of specific foods to inform potential fortification programs
- Contributions of specific foods to nutrient intakes from the complementary diet to inform feasible food-based dietary guidelines
- Adherence to food-based dietary guidelines for infants and young children

Specific objectives and dietary outcomes of interest should be identified and agreed to during the survey planning process, as this will help determine if a quantitative 24-hour recall dietary method is required for data collection or if a simpler approach could suffice.

Respondent burden is also a concern. Ideally, no respondent would be asked to provide dietary recall data for more than one child, as doing so may have a negative impact on response rate and data quality. For this reason, survey planners may wish to consider collecting dietary data on at most one demographic group of young children (e.g., only children 2–5 years old, rather than both children 6–23 months old and children 2–5 years old). This issue is most relevant to consider if a household-based sampling approach will be used for the survey. The issue is less of a concern if a target group-based sampling approach is used for the survey.

Preschool and School-Aged Children Attending School

Preschool and school-aged children up to the age of approximately 10–12 years may not be able to reliably report their own dietary intake. Additionally, their caregivers are not with them at school and therefore also cannot reliably report all of their children's intake. Data collection at the school (e.g., for recipes of school meals) may be needed to supplement data collection in the home, and the quantity consumed (particularly at school) would likely be reported with more error than for other demographic groups. Research in high-income settings suggests that children aged 12 years and older may be able to report their own consumption, but, as with younger children, recipe data collection in the schools and/or vendors near the schools may be required.

Adolescents

Adolescents may be away from home for short or long periods of time for many reasons, including school, employment, and temporary fostering. This introduces additional challenges and complications in locating the selected respondents. Adolescents may nevertheless be defined as a priority demographic group for a survey, but challenges with data collection and a potentially higher non-response rate than for other demographic groups should be discussed—and budgeted for—during the survey planning process.

2.1.3 Approaches to Sampling

There are two main approaches to sampling that can be used for a population-based dietary survey, a household-based sampling approach, or a target group-based sampling approach. The key distinction between a household-based sampling approach and a target group-based sampling approach is that in a household-based sampling approach the survey team lists (enumerates) housing units in the enumeration areas (i.e., clusters) selected for sampling, but individuals within households are not enumerated in advance. In a target group-based sampling approach, the survey team carries out a full census in the enumeration areas selected for sampling prior to drawing the sample, and multiple samples (i.e., one sample for each demographic group defined for the survey) are drawn per enumeration area if the survey will collect data for more than one demographic group.

In a household-based sampling approach, sampled households may or may not include individuals in the target demographic group(s) of focus for the survey; this has implications for sample size calculation. When using a household-based sampling approach, the sample size of respondents needs to be translated into a household sample size to account for the number of households that would need to be visited to obtain the desired sample size of respondents.[4] When using a target group-based sampling approach, the sample size of respondents that has been calculated for each demographic group of focus for the survey does not need to be translated into a household sample size. This is because, in the case of a target group-based sampling approach, the sample for each demographic group of focus for the survey is selected directly from a sampling frame of eligible individuals (not households) who are members of that target demographic group.

When possible, *Intake* recommends adopting a target group-based sampling approach for quantitative 24-hour recall dietary surveys carried out in low- and middle-income countries (LMICs), particularly if the survey will collect dietary data on multiple demographic groups. Using a target group-based sampling approach will likely help reduce respondent burden and the time spent at each household, which may, in turn, have implications for obtaining better data quality. Because the demographic groups of interest for the survey are sampled directly from a target group-based sampling frame within each enumeration area, it is also more likely that the desired sample size for each demographic group will be more closely attained than would be the case with a household-based sampling approach.

2.1.4 Survey Domains

Survey professionals refer to survey domains. A survey domain is a sub-population for which separate estimates of population quantities are desired. An example of a survey domain is an urban or rural population for a given demographic group targeted for the survey. Domains can be design domains or analytical domains. Design domains are determined a priori and are an integral component of the design of the survey. If the survey is to produce estimates at the domain level, then the sample size in each domain must be sufficient to ensure the desired level of precision for each indicator in each domain. For example, a design domain may be the rural population of women of reproductive age in a geographic region of the country. Analytical domains, on the other hand, are not considered when selecting a sample size, so it is often difficult to determine ahead of time the precision that will be achieved for those secondary domains. An example of an analytical domain is the sub-population of women of reproductive age who completed secondary education who live in a rural area in a specific region of the country.

2.1.5 Stratification and Clustering

Most national surveys have complex, multi-stage designs. The actual design is often a compromise between cost, feasibility, and precision, and almost always includes stratification and clustering within domains. No country

[4] To make this calculation also requires making a decision on whether all eligible respondents per target demographic group will be selected for sampling within a household or if only one eligible respondent will be randomly selected for sampling, as the appropriate demographic statistics to apply to translate the respondent sample size into a household sample size depends on whether all eligible respondents or a random selection of eligible respondents per target demographic group will be sampled within a selected household.

keeps an enumeration of all persons (or households) in the population and their addresses. However, in most countries, a list of small administrative areas called enumeration areas is typically available. The idea then is to randomly select enumeration areas to sample and to then produce a list (or sample frame) of households (for a household-based sampling approach) or individuals within each demographic group to be targeted (for a target group-based sampling approach) within each of the enumeration areas selected for sampling. These sampling frames are then used for selection of the households (for a household-based sampling approach) or individuals (for a target group-based sampling approach) to sample in the enumeration area. The size of enumeration areas can vary, so the probability of selection of a household or an individual in different enumeration areas can vary as well.

One important reason to carry out cluster sampling is cost and convenience. This comes at a price in loss of precision because individuals or households within a cluster tend to be correlated. This loss of information is quantified in what is called the "design effect" (see Section 2.4.1), which compares the size of the variance of estimated quantities when observations are correlated relative to the size of the variance when observations are independent.

2.2 Information Required to Carry Out the Sampling

To implement a sampling approach for a population-based survey, it is important to have up-to-date information, or recent projections based on earlier census data, on the demographic characteristics of the population and, when possible, also on the socioeconomic characteristics of the population. The exact information that would be needed to carry out the sampling for a given survey would vary according to the specifics of the sample design. Advice from a statistician should be sought as early as possible in the survey design process to ensure all necessary information is available, or can be collected, and will be used appropriately for the sample selection process. This information is needed not only to select a probability-based random sample, but also so that appropriate weighting can be applied to the data at the time of analysis.

2.3 Representability and Weighting

By construction, samples that result from complex survey designs are not representative at the national or other desired levels unless the analysis is weighted to reflect different probabilities of selection. Therefore, estimates such as usual dietary intake means, the prevalence of nutrient inadequacy, and others will be biased, sometimes severely so, if the sample is analyzed unweighted.

In any survey in which respondents are selected with a probability different from the frequency with which they appear in the population, it is critically important to construct sample weights and to then use the weights in all subsequent analyses.

In their simplest form, weights are inversely proportional to the probability of selection associated with each sample person. For example, to sample four times more adult women than adult men in a population where the ratio of adult women to adult men is 1:1, each adult male in the sample would get a weight of 1 and each adult female would get a weight of 0.25. These survey weights can be computed for each phase of the survey if, at any of those levels, sampling is not proportional to population frequencies.

More typically, weights are used not only to account for the over- or under-sampling of certain population sub-groups, but also to correct for missing data and other factors that contribute to making the sample less similar to the population from which it was drawn.

For example, suppose that in a certain area there are 50% women and 50% men, but the sample has 60% females and only 40% males. The weight in this case would be computed as 0.5 ÷ 0.6 = 0.83 for females and 0.5 ÷ 0.4 = 1.25 for males. In other words, each female in the sample represents 0.83 women in the population, and each male in the sample represents 1.25 men in the population. These weights are called "post-stratification weights."

In most situations, it is desirable for the sample to be balanced with respect to more than one characteristic. For example, it is often important that the sample provides approximately correct proportions by sex, age group, and socioeconomic group. When post-stratification weights are constructed to balance more than one factor, it becomes necessary to use iterative approaches to calculate them. A commonly used algorithm is called "raking," and software packages that implement raking are available.

Note that to construct post-stratification weights, the frequencies of each characteristic of interest in the population from which the sample is drawn must be known, at the lowest level of geography at which the data will be reported.

The final weight is obtained by multiplying the sampling weight by the post-stratification weight.

2.4 Sample Size Calculations

When planning a survey, it is important to ensure an adequate sample size to guarantee the desired precision of estimates of the statistics. Statistics that are often of interest to report from a quantitative 24-hour recall dietary survey include the mean usual intake of a nutrient; the percentage of persons in a population group with inadequate intakes; and the quantiles (or percentiles) of distribution of usual intakes of nutrients, food groups, and foods. The sample size that is required to achieve a given precision depends on several factors, including the design of the survey and the anticipated non-response rate.

For most standard survey designs and for statistics such as means and percentages (or proportions), it is possible to estimate the sample size to meet the selected precision with a given confidence analytically, using mathematical expressions.[5] If the statistic of interest is a quantile, however, it is not possible to estimate the required sample size to meet a specified precision using a formula. This is because quantiles are nonlinear functions of the observations. For this type of statistic, the only available approach is numerical or via simulations.

For dietary surveys, there is an additional challenge, namely, that the quantity of interest, the usual intake of a nutrient, food group, or food, is not observed. Instead, it is typical to observe one daily intake for each respondent, and a second daily intake for a random subset of respondents (refer to Section 3.1). The standard formulas for estimating sample size for means and percentages assume that the quantity of interest (usual intakes, in this case) are observed and therefore do not account for the additional error introduced by the fact that only a noisy measurement of usual intake can be obtained. As a consequence, the sample sizes obtained by standard formulas tend to be optimistic for dietary outcomes, in the sense that the realized precision achieved, once statistics from predicted usual intakes are estimated, will always be lower than the nominal value.

Appendix 2A provides details of a simulation approach we have used for sample size estimation for a quantitative 24-hour recall dietary survey and includes a series of figures illustrating how the error around an estimate (i.e., the precision) changes based on the approach used to calculate sample size. Results across a range of possible sample sizes and for different dietary outcomes are provided, assuming a nutrient with a moderately skewed intake distribution. Results for a nutrient with a severely skewed distribution are provided in Appendix 2B.

Here, we summarize the results from the simulations for a nutrient with a moderately skewed intake distribution to provide relevant sample size guidance. The simulation results for a nutrient with a severely skewed intake distribution provide a worst-case scenario that is unlikely to be observed in most survey data.

As expected, the simulation results show that the sample sizes obtained by a standard sample size formula tend to be optimistic for dietary data because of the error introduced by the fact that only a noisy measurement of usual intake can be observed. For example, assuming a simple random sample of 200 respondents is collected, with a second day of dietary recall collected among a random sample of 20% of those respondents, the simulation results show that, for estimating a percentage that is equal to 50.0%, this statistic would have a ME of approximately ±9 percentage points, whereas the standard formula for sample size estimation for a percentage

[5] Refer, for example, to Lohr (2010).

equal to 50.0% indicates a ME of approximately ±7 percentage points for that same sample size. For both sample size estimation approaches, the highest ME is expected at a percentage equal to 50.0%. For percentages that are higher or lower than 50.0%, the respective ME would be lower for each approach.

As mentioned above, for estimating quantiles of intake, it is not possible to use a standard sample size formula. The simulation results in Appendix 2A suggest that with a simple random sample of 200 respondents, where 80% of respondents have one day of dietary recall data and a random sample of 20% of respondents have two days of dietary recall data, most quantiles can be estimated with reasonable precision, even after accounting for the additional uncertainty that arises because true usual intakes are not observed.

Because different nutrients have different ranges of intakes (and different units associated with them), to generalize sample size precision results for estimation of quantiles, it is most straightforward to report the level of precision as relative margin of error (RME). (The RME is the half-width of the confidence interval divided by the estimated value of the statistic.[6]) For quantiles that are not in the extreme tail of the distribution, the simulation results show that the RME is approximately 5%, and for quantiles in the tail of the distribution (i.e., 10th and 90th), the RME is between 8% and 12%. If the true 10th quantile is 50 units, then an 8% RME translates into a 95% confidence interval equal to (46, 54). If for the same quantile value of 50 units the RME is 12%, then the 95% confidence interval would be (44, 56).

Based on these results, *Intake* recommends a minimum simple random sample of 200 respondents per survey domain. But this sample size of 200 respondents needs to be further adjusted upward to account for the effects of the survey design (design effect) and expected non-response. If a design effect of 2 and a non-response rate of 20% are assumed, a minimum sample size of 500 respondents should be collected per survey domain, with at least one repeat dietary recall collected on a random subset of respondents. (Refer to Section 3.1 for guidance on the sample size required for the repeat dietary recalls.)

To improve precision in reporting of estimates (means, percentages, and quantiles), or to account for the potential for a very severely skewed distribution of intake for a nutrient, the sample size should be increased beyond this minimum simple random sample of 200 respondents per survey domain. In addition, it is important to note that the above sample size calculations assume a nutrient of focus for analysis that is ubiquitously consumed. To obtain the same MEs and RMEs estimated by the simulations in Appendix 2A and 2B for episodically consumed foods, food groups, and nutrients, a different set of considerations and a higher sample size (particularly for the sub-sample on which repeated 24-hour recall data are collected) would apply.[7] Finally, where a household-based sampling approach is used, the sample size of respondents calculated (after adjustment for the expected design effect and non-response rate) needs to be translated into the number of households to sample to try to obtain the sample size of respondents desired (see Section 2.1.3 and footnote 4).

[6] For example, the RME for an estimate of 20.0 units with a 95% confidence interval of (14.0, 26.0) is 30%: [6 units divided by 20.0 units] x 100. The half-width of the 95% confidence interval is 6 units (i.e., [26-14] / 2).

[7] Refer to Tooze (2020), available at Intake.org, for a discussion of considerations in relation to estimating usual intakes for episodically consumed foods, food groups, and/or nutrients.

2.4.1 Design Effect

When using a multi-stage approach to select the sample for a survey (i.e., when a simple random sample approach is not used), a design effect must be incorporated into the sample size calculation. Stratification tends to increase the efficiency of the design and results in design effects that are less than 1. Clustering, on the other hand, has the effect of decreasing efficiency and results in design effects that exceed 1. This is because respondents who reside in the same geographic area (e.g., enumeration area, or survey cluster) are more likely to be similar to one another than respondents who are dispersed across different clusters (as would likely be the case with a simple random sample approach to sampling). This intracluster correlation needs to be accounted for in the sample size calculation for a complex, multi-stage probability survey design.

Some national dietary intake surveys (for example, the U.S. National Health and Nutrition Examination survey [NHANES]) have used a design effect of 1.5 (Johnson et al., 2014) for sample size calculation based on previous survey data. Other national surveys, including some in Africa, have assumed a design effect of 2, without data from previous studies. To be conservative, *Intake* recommends assuming a design effect of 2, when data are not available from other dietary surveys in the country. A design effect of 2 means that twice the number of respondents in the proposed survey are needed to achieve the same precision that would have been obtained with a simple random sample.

2.4.2 Planning for Non-response

Sample size calculations also need to account for the expected response rate. Despite best attempts, it is almost never possible to collect data on 100% of the sample selected for the survey, but replacing respondents who do not respond is not recommended. Unless this is done carefully, it is possible that the resulting sample will no longer be representative.

A standard approach to address non-response is to include a factor for non-response in the sample size calculation. Response rates in dietary surveys that do not include biomarkers have been very high in some recent national surveys in Africa (e.g., 98%–99% in Uganda [Harvey et al., 2010] and Ethiopia [Mengistu et al., 2017]). However, a national survey in South Africa that included biomarkers but not dietary data collection reported a response rate of 77% (Shisana et al., 2014). A recent smaller survey in southern Nigeria that included both dietary and biomarker data collection achieved an 89% response rate (De Moura et al., 2015). Considering these non-response results, *Intake* recommends using a non-response rate of 20% for dietary surveys in LMICs, when earlier survey data is not available on which to base the expected non-response rate.

3 Methodological Choices That Affect Cost and Logistics

When using the quantitative 24-hour recall method to collect dietary data, there are several methodological choices that affect cost and logistics, including decisions related to the total number of repeat recalls to be collected in the survey, the number of repeat recalls to collect per respondent, whether to supplement the 24-hour dietary recall with a food frequency questionnaire (FFQ), and whether and how to “pre-train” respondents.

3.1 Number of Repeat Recalls

Unlike some other types of nutrition surveys, quantitative 24-hour recall dietary surveys require multiple visits to collect data from the same respondent.[8] This affects cost and survey logistics and adds complications when survey teams implementing other (non-dietary) modules have different visit schedules. Multiple visits to the same respondent are required to obtain data for at least a sub-sample of respondents on the foods and beverages consumed for multiple (at least two), non-consecutive 24-hour recall periods (typically, with each recall per respondent separated by 3-10 days). Repeat recalls on a random sub-sample of individuals are required to estimate usual dietary intakes at the population level and the prevalence of inadequacy for nutrient intakes (IOM, 2000).

Collecting replicate 24-hour dietary recalls is considered a standard best practice. The general rule of thumb is that at least 50 respondents (unadjusted for design effect and non-response) need to report consuming the nutrient, food group, or food of interest in at least two 24-hour dietary recalls across non-consecutive days to be able to use a statistical method to estimate usual intake.[9] If a complex, multi-stage survey design is used for data collection, to meet this minimum sample size of 50 respondents (before adjustment for a design effect and non-response), it may therefore be necessary to collect data on a total of 125 individuals (if allowing for a design effect of 2 and a non-response rate of 20%).

Normally, in a target group-based sampling approach, the random subset of respondents for which a second day of dietary recall is collected is selected from the sample frame of individuals per demographic group targeted who completed the first dietary recall. This same approach can also be used when a household-based sampling approach was used to select the sample for the first day of dietary recall.

Increasing the total number of repeat recalls collected in the sample beyond the minimum required increases the reliability and precision of estimates, particularly when estimating dietary outcomes (such as quantiles) that involve data in the upper and lower tails of the sample distribution. Increasing the total number of repeat recalls can also be especially helpful when it is of interest to estimate dietary outcomes related to foods, food groups, and/or nutrients consumed infrequently or by a small portion of the population.

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[8] The multiple visits referred to here for dietary surveys are in addition to the multiple household visits that should be included in a survey protocol to reduce the survey non-response rate and potential bias in the data collected.

[9] The probability of having at least two recalls with consumption reported for a given nutrient, food group, or food of interest can be calculated from the following binomial formula (assuming independence of recalls), where n is the number of recalls per person, c is the number of recalls per person with consumption, and p is the probability of consumption on any recall (U.S. EPA [2016]; Kirkpatrick et al. [2017]):

$$\Pr(c \geq 2) = \sum_{c=2}^{n} \binom{n}{c} p^c (1-p)^{n-c}$$

The total number of repeat recalls can be increased in one of three ways:

- By increasing the number of randomly selected respondents from whom two repeat recalls are collected
- By collecting more than two repeat recalls for a random subset of the population
- By both increasing the number of randomly selected respondents from whom repeat recalls are collected and increasing the number of repeat recalls collected per individual to three (or more)

If the second option is selected, it is important to note that, even if the number of replicate observations obtained for each individual is increased, it is still important to include the minimum number of respondents in the replicate sub-sample.

3.2 Food Frequency Questionnaires

A FFQ is sometimes implemented during the same household visit as the 24-hour dietary recall. Whether or not this is needed or advisable depends on survey objectives. The 24-hour dietary recall, when repeat recalls are collected on a random subset of respondents, can provide estimates for a wide range of outcomes related to nutrient intake, including estimation of usual energy, macronutrient and micronutrient intakes, and prevalence of nutrient inadequacy, among others.

If survey objectives include characterizing the usual intake distributions of foods, food groups, or nutrients that are not consumed daily by the vast majority of the population, then the number of repeat recalls may need to be increased beyond the minimum number required to estimate usual intakes for ubiquitously consumed foods, food groups, and nutrients. Supplementing the 24-hour recall with a targeted FFQ may also improve estimation of usual intakes for rarely consumed foods and food groups.

However, FFQs must be developed appropriate to the survey context and should be tested and validated for the population where they will be used, which adds very substantial cost and time.[10] In addition, the analytic procedures for integrating the food frequency data in the estimation of the dietary outcomes of interest is complex and may require the assistance of a statistician familiar with modeling dietary data for this purpose. Because of the added cost, time, and complexity associated with the use of FFQs to estimate dietary outcomes related to foods and food groups that are consumed infrequently by the target population, *Intake* recommends carefully considering the option of increasing the number of repeat recalls in lieu of using a FFQ.[11]

3.3 Pre-training of Survey Respondents

In addition to the multiple recalls (on a random subset of the sample) that are required to allow for estimation of usual intakes and prevalence of nutrient inadequacy, a pre-data collection meeting with the respondent may be needed. Special methods have been developed for quantitative 24-hour recall dietary surveys implemented in low- and middle-income settings, where there may be low literacy or where individuals may eat from a common pot. In Africa, the most widely used or adapted methodology (Gibson and Ferguson, 2008) for these settings involves meeting with individuals selected for sampling several days prior to the first data collection visit to carry out a pre-training of survey respondents. This pre-training can either be carried out through a one-on-one meeting at the respondent's home or by organizing a meeting of a small group of respondents (e.g., no more than 30) who reside in close geographic proximity (e.g., in the same survey cluster).

The exact scope of the pre-training can be tailored to the survey context. At a minimum, however, *Intake* recommends that the following elements be addressed in the pre-training:

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[10] Discussion of the development, validation, and use of FFQs is beyond the scope of this document. Readers are referred to the U.S. National Cancer Institute's Dietary Assessment Primer and specifically the following two webpages: "Food Frequency Questionnaire at a Glance" at https://dietassessmentprimer.cancer.gov/profiles/questionnaire/ and "Validation" at https://dietassessmentprimer.cancer.gov/profiles/questionnaire/validation.html [Both accessed 9th January 2019].

[11] For further discussion of considerations in relation to the collection and analysis of episodically consumed foods, food groups, and nutrients, we recommend survey planners consult Tooze (2020), available at Intake.org,

- Sensitization about all elements of the survey, including why the individual was selected to participate in the survey
- A description of the dietary component of the survey, including the types of questions that will be asked (e.g., that the respondent will be asked to recall all foods and beverages consumed, and the amounts consumed, over the 24-hour recall period)
- The importance of the respondent not changing what or how much s/he eats for the purpose of the survey

The pre-training meeting also provides a good opportunity to begin the process of explaining the consent process for the survey to provide respondents time to carefully consider the opportunity to participate in the survey, before being requested to sign the consent form at the time of data collection. In addition, the pre-training meeting provides an opportunity to schedule the data collection visit with the respondents. This may reduce the number of visits to the household required to find the respondent at home and allows the respondent to know in advance the day and night that will be included in the recall period, which may help aid the memory process.

Optionally, the pre-training meeting may also introduce respondents to use of a pictorial chart showing a selection of foods and/or beverages that may be consumed in the survey context. When a pictorial chart is used, the chart is left with the respondent, who is advised to mark when a given food or beverage is consumed, to aid in the recall process at the time of the data collection visit. When there are multiple respondents selected for the survey in a given household, a chart for each respondent should be provided. The use of the pictorial chart can add time to the pre-training meeting, as it is essential that the respondents understand its purpose as a memory aid and that the chart is not meant to be a guide to the foods/beverages that should be consumed during the recall period. The development of a good pictorial chart requires time and resources, both to identify the right set of example foods to include and to test to ensure that the depictions are clearly recognizable to individuals who are similar to the targeted survey respondents. Although every effort should be made to advise respondents to eat as usual, the practice of using a pictorial chart may still affect behavior.

In contexts where eating off a common plate is a typical practice, the pre-training meeting can also provide an opportunity to provide individual plates and/or bowls and cups to respondents, so that they can eat off a separate plate/bowl and use a separate cup for beverages on the day and night that will be the focus of the recall. This practice may help respondents better estimate the amount of food and beverages consumed but could also have an unintended effect of influencing behavior. For this reason, this component of the pre-training meeting is also optional, and its appropriate use may be highly context-dependent. When the decision is taken to distribute plates and/or bowls and cups to respondents, the practice should be applied to all targeted survey respondents, not just those who report eating from shared plates as a customary practice. As with the use of a pictorial chart, to our knowledge, there is no empirical data to report on the impact of providing plates and/or bowls and cups to respondents in shared-plate and/or -bowl eating context.

4 Pre-survey Inputs Unique to Dietary Surveys

Dietary surveys require advance preparation of several essential resources. These include:

1. A food, recipe, and ingredient listing (FRIL): A comprehensive list of foods, mixed dishes, and ingredients—and their relevant descriptive details—that are likely to be encountered during the 24-hour dietary recall in all geographic areas where the survey will be implemented and for all demographic groups that will be targeted in the survey.
2. A food composition database (FCDB) for the survey: A database providing the energy content and nutrient composition for each item included in the FRIL.
3. A standard recipe database: A set of standard recipes[12]—with details on ingredients and their average proportions—for commonly consumed mixed dishes that have been identified to be prepared similarly across a geographic area of focus for the survey.
4. A portion size estimation method (PSEM) list: For each item listed in the FRIL and standard recipe database, a single 'preferred' PSEM—and if needed, a single 'alternative' PSEM—should be assigned for use during the collection of the 24-hour dietary recall data, to help the respondent estimate the quantity of each item consumed.
5. A PSEM conversion factor database: A database to provide the conversion factors needed to translate the quantity of each item reported as consumed into grams, given the assigned PSEM for that item and the corresponding edible portion factor for the item.
6. A probe list: A job aid that should be used by enumerators during data collection to facilitate high-quality dietary data collection that includes the necessary level of specificity and detail about the items reported as consumed by the respondent. The probe list provides the relevant probes (follow-up questions) the enumerator should ask for each item the respondent reports as having consumed so that each item reported as consumed can be correctly linked to the corresponding item in the FCDB and assigned the appropriate energy and nutrient composition values.
7. A nutrient supplement database: A comprehensive listing of nutrient supplements available in the survey area, listed by brand, type, dosage, and composition for each nutrient supplement-type (e.g., calcium supplements, iron-folic acid supplements) for which it is of interest to estimate nutrient intake from supplement use for a given demographic group of focus for the survey.

The time and resources for development of these pre-survey inputs and databases are often underestimated.

4.1 The Food, Recipe, and Ingredient Listing

A comprehensive FRIL is an essential first step of pre-survey work because it will be used to inform the details of several crucial dietary assessment inputs and tools to be used during data collection and analysis (e.g., probe list for food details to collect during the 24-hour recall, selection of appropriate PSEMs, selection of the mixed dishes for standard recipe data collection, and completion of the FCDB for the survey). The food and ingredient items included in the FRIL must be well described with the relevant descriptors for that item listed (e.g., variety/color/state; maturity; part of food item; mechanical processing; other processing; cooking method; any additions [e.g., salt, sugar]; any brand, fortification and enrichment details; and the presentation mode or the way in which the food or ingredient is served and consumed). For each food, mixed dish, and ingredient included in

[12] A "standard recipe" is an "average" recipe that aims to reflect the way that a given mixed dish is usually prepared by respondents in the survey areas. A standard recipe can be used for a given mixed dish that is known to be prepared similarly across a survey (in terms of the ingredients used, the ingredient proportions, and the preparation methods).

the FRIL, the various forms in which that item is consumed should be listed on a separate line. For example, if a food can be consumed raw, baked, or boiled, then each of these forms of the food should be listed on a separate line in the FRIL. Incomplete listings are one of the main reasons for problems during survey implementation, errors during data processing, and delays between data collection and availability of results. Previously, methods for developing food and recipe lists have not been well described. *Intake* is currently developing a series of documents to outline different approaches and to provide associated guidance for developing a FRIL for a dietary survey.[13]

4.2 The Food Composition Database

Discussion of the current status and the plans and timing for completion of the FCDB for the survey should be among the first survey planning activities. The FCDB for the survey is what assigns the relevant energy, macronutrient, and micronutrient values and other food composition data (e.g., trans fat, non-intrinsic sugars, sugars) to each item that is listed in the FRIL. Where a food item is listed in various forms (for example, as raw, baked, boiled), the food composition values associated with each form of that food item would be different, because of the differences in nutrient loss due to the method used to prepare the food.

Detailed guidance on development of a FCDB is available from the International Network of Food Data Systems (INFOODS).[14] Because of the complexities involved in compiling high-quality food composition data, experts familiar with best practices recommended by INFOODS should ideally be engaged in the process to compile the FCDB for the survey. In addition, international initiatives, such as the FAO/WHO Global Individual Food consumption data Tool (GIFT) platform, are currently encouraging use of a harmonized food coding system, called "FoodEx2."[15] Survey planners may wish to consider this system of food coding in the FCDB developed for the survey, as it will facilitate cross-survey analyses and cross-country comparison of results.

4.2.1 Data on Fortified and Biofortified Foods

Survey planners should also assess and discuss the availability of data on nutrient content of fortified foods and the completeness of the FCDB for the survey with respect to fortified foods, including mass fortification (e.g., salt, sugar, oil, flours) and market-driven, voluntary fortification of commercial products (e.g., infant cereals, bouillon cubes). Most countries, including high-income countries, do not have complete data on the nutrient content of all commercially fortified products because new products are constantly added to the marketplace. Regarding fortified products, data collection tools should be aligned with the FCDB for the survey; that is, they should be designed to distinguish intake of fortified products only if nutrient content data are available for the products.

Where biofortified crop varieties are being disseminated and promoted, there may be interest in capturing data on coverage or consumption. It is advisable to consult with organizations disseminating and promoting these crops regarding the feasibility of capturing this in the context of dietary recalls; feasibility may depend on current consumer awareness and on the visibility of "traits" (such as the color of orange-fleshed sweet potatoes or orange maize). Moreover, in survey contexts where the biofortified crops of interest are not ubiquitously consumed among the target population, survey and sample size design considerations related to episodically consumed foods would apply (see Section 3.1). And, as above, nutrient content data must be available and integrated into the FCDB for the survey.

4.2.2 Food Groups and Processing Level of Foods

In addition to nutrient data, the FCDB for a dietary survey often incorporates information on food groups, either through the coding scheme or though including additional variables. If survey objectives include estimating food

[13] See Intake.org for access to the full set of *Intake* resources currently available online.

[14] Standards, guidelines, and other resources are available at http://www.fao.org/infoods/infoods/standards-guidelines/en/ [Accessed 9th January 2019].

[15] For details, see the GIFT website at http://www.fao.org/gift-individual-food-consumption/en/. For details of the FoodEx2 coding system, see European Food Safety Authority (2015).

group intake and dietary patterns, for example, in relation to food-based dietary guidelines, it is useful to include codes or variables in the FCDB for the survey to allow prompt analysis by food group. Similarly, there is rising interest in understanding the prevalence of consumption of processed foods, and particularly of "ultra-processed foods."[16] As for food groups, if analysis by processing level is desired, precoding of the FCDB with each item classified according to level of processing will speed analysis.

4.3 Standard Recipe Database

Most quantitative 24-hour recall dietary surveys employ a mix of "standard" recipes for mixed dishes and direct data collection from respondents on recipes prepared in the home (i.e., "non-standard" recipes). The balance between the two will depend on the level of nutritionally important variability in recipes as prepared in homes and on the capacity and training level of available enumerators because a very high level of skill is required for household-level recipe data collection. The time and cost associated with collecting household-level recipe data should also be considered in relation to the time and cost required for standard recipe data collection. Standard recipes are also needed for foods prepared outside the home (by vendors or in restaurants).

When there are major regional variations in diet patterns and food preparation, the standard recipe database may need to be developed for multiple regions, accordingly. In countries with longstanding repeated or continuous dietary survey programs, standard recipes continue to be added. In a first national survey, compilation of a standard recipe database can be a major effort.

However, there are usually available data sources to accelerate the process. For example, academic and other research institutions in the country may have available standard recipe data from dietary studies carried out in the survey area. Any such recipe data collected should be screened for quality based on adherence to recommended data collection procedures. Standard recipes should represent recipes as usually prepared by the population to be surveyed, and not idealized or nutritionally optimized versions, such as might be included in certain consumer education materials.

Methods for recipe data collection are summarized in Gibson and Ferguson (2008). More recently, *Intake* has begun to consolidate procedures, guidance, and tools for recipe data collection.[17]

4.4 Portion Size Estimation Method List

Standard methods for dietary data collection in low- and middle-income settings must include a set of carefully selected PSEMs, such as:

- Direct weighing of salted foods carried by the enumerator team, or direct weighing of actual foods[18], if the same food consumed the previous day is still in the household
- "Proxy weighing"[19] of free-flowing materials (e.g., dry rice, dry beans, water[20]) and/or materials that can be shaped (e.g., playdough, modeling clay)

[16] The classification scheme for level of food processing is new and evolving, and national-level results are available for only a few countries. For a recent example from Canada, see Moubarac et al. (2017).

[17] Once finalized, all related tools and guidance material will be available at Intake.org.

[18] Direct weighing of actual foods should only be used when survey conditions are such that it is ethical, culturally appropriate, and practical for fresh food to be supplied by the household for the purpose of the PSEM.

[19] "Proxy weighing" means the respondent shows the quantity consumed by using the proxy material provided by the interviewer. This amount is weighed and later converted to grams of recalled food consumed using conversion factors based on density. For example, dried beans can be heaped on a plate to show the quantity of a thick stew consumed the previous day. The beans are weighed and the weight of the stew is estimated based on the known density (weight/volume) of the beans and the known density of the stew recipe.

[20] The use of water as a proxy free-flowing material for collecting the estimated quantity of a food consumed by a respondent should only be considered for use in survey contexts, when survey conditions are such that it is ethical, culturally appropriate, and practical to request that water be supplied by the household (i.e., where water is readily available in the survey context and not regarded as a scarce or valuable resource by households).

- Standard unit size (e.g., 1 slice of pre-cut, processed bread)
- Calibrated utensils commonly used by household in the survey context (e.g., spoons, scoops and ladles)
- 2D food shapes and 3D food models
- Food photographs when validated photographs are available for the specific context
- Market prices

In national surveys in many high- and middle-income countries, photo atlases have been developed and validated[21] and are used by respondents to help estimate quantities consumed. Where photo atlases are used, a complex set of factors must be considered with respect to the food depicted in the photos, the portion sizes reflected, and the allowed "use" of the photos in the survey context (e.g., if the photos are allowed to be used as an aid for reporting of portion sizes for "food substitutes" and if respondents are allowed to report fractions or multiples of the portion sizes depicted in the photos). Tests of photo atlases in low-income and low-literacy settings have shown mixed results,[22] and resources (time and money) for local testing and validation are often lacking.

To simplify enumerator training and for survey logistics, it is highly advisable to select a minimum set of PSEMs for data collection. For example, many experienced survey teams have moved from using a large number of diverse estimation methods and tools to focus on using direct weighing and/or proxy weighing using dry rice, dry beans or playdough for as many foods as possible. In addition, it is often advisable to select a single 'preferred' PSEM—and if needed, a single 'alternative' PSEM—to use for each item in the FRIL.

4.5 Portion Size Estimation Method Conversion Factor Database

Once selected, for each PSEM selected (other than direct weighing), a database needs to be developed to allow conversion to grams. This database will need to include a unique PSEM conversion factor for each food and ingredient included in the FRIL and standard recipe database, and, when relevant, an edible portion factor[23] to account for any part of a food not consumed (peels, pits, bones, etc.). Some conversion factors can be derived from existing data sources, but primary data collection is likely to be required for some conversion factors, if no existing data are available. Guidance on developing a PSEM conversion factor database for a dietary survey is forthcoming from *Intake*.[24]

4.6 Probe List

Once the FRIL is completed, survey planners will need to prepare a probe list to be used by enumerators as a job aid during data collection. The probe list should provide the relevant details about the items listed in the FRIL and standard recipe database in a format (usually by food grouping) that helps the enumerator to know what probing questions should be asked of the respondent when an item is reported as consumed. The probe list typically includes questions relating to the following details of the item consumed: 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 (e.g., boiled, roasted, shallow-fried, deep-fried); additions (e.g., salted, added sugar); and brand, fortification and enrichment (for commercial products).

[21] For an example of a validation protocol, see European Food Safety Authority (EFSA) (n.d.).

[22] For examples from African settings, see Amougou et al. (2016); Bouchoucha et al (2016); Huybregts et al. (2008); Korkalo et al. (2013); and Venter et al. (2001).

[23] The edible portion factor is defined as the proportion of a food that is usually eaten expressed as a ratio of the entire food, i.e., edible portion ÷ (edible + inedible portions). The edible portion factor is a value ≤1. The edible portion factor is equal to 1 when the entire food is edible.

[24] Once finalized, this guidance will be available at Intake.org.

4.7 Nutrient Supplement Database

Survey planners should also decide early in the survey planning process if the survey will collect data on nutrient supplement intake and use this information in the estimation of nutrient intakes. Collecting data on nutrient supplement intake in most LMIC settings is challenging and requires advance planning. This is because, in many countries, a wide variety of commercially marketed supplements are available, but databases on the nutrient content of supplements are lacking. Quality control may also be lacking, such that the true nutrient content of supplements is not reflected on package labels. Further, unless the supplement is still in the home, recall of supplement composition can be difficult. In addition, to use data on nutrient supplement intake to inform the estimates of nutrient intake from the survey, the standard analysis methods for treatment of these data require that data be collected on the number and frequency of consumption of the nutrient supplement over a 30-day reference period.

Where the decision is taken to collect data on nutrient supplements and to use this information in the estimation of nutrient intakes, the development of a nutrient supplement database for the survey will likely be needed, which, depending on the context, could be a significant effort.

If a decision is taken to not estimate nutrient intake from supplements, it may still be useful to collect data on the coverage of nutrient supplements more generally, focusing only on the specific nutrient supplements provided by the healthcare system. Measuring coverage, which is of value to programs, should be considered as a separate issue from quantitative measurement of nutrient intake from supplements.

5 Pre-survey Fieldwork, Training, and Piloting

Dietary surveys require careful pre-testing and piloting. The need for pre-testing and piloting is not unique to dietary surveys, but because of the complexity of collecting 24-hour recall dietary data[25] these steps are essential.

Pre-testing can occur at several stages, including pre-testing by senior survey staff after the first draft of questionnaires are developed, to allow for refinements to survey methods (e.g., PSEMs) and tools (e.g., probe list) before training. Additional pre-testing can be built into practical exercises during supervisor and enumerator training. Formal piloting of surveys involves full implementation of all survey activities and modules with all survey field staff, and is particularly important in complex multi-topic and multi-team surveys.

Field teams who will be collecting and supervising the collection of dietary data should receive substantial training and have ample opportunity for collecting practice 24-hour recall dietary data in the field before beginning actual data collection for the survey. Given the complexity of collecting dietary data, *Intake* recommends that survey field teams receive a minimum of three weeks training in dietary data collection. This 3-week time allocation allows time for teams to practice dietary data collection, but does not include a formal survey pilot or final field test before beginning data collection.

Ideally, surveys are piloted in each survey language. Ample time between the pilot and the main survey is required to allow for any needed corrections to the survey instrument and enumerator guidance materials. This is particularly the case when the survey employs direct data entry on tablets or similar devices, given that the software being used might need to be adapted.[26] Pilot studies nearly always result in refinements to methods and "scripts," so an additional final field test should be done after training the field team and immediately before the survey begins. This final field test is usually considered as the last element in the training of the field team.

[25] Standard best practices for 24-hour recalls include a "multiple-pass" approach that requires translation of a somewhat lengthy script and set of probes, which are not required for many other types of survey questions.

[26] Additional pre-survey activities may be required that are specific to selected software.

6 Timing of the Survey

6.1 Seasonality

Seasonal differences in food availability can affect dietary intake patterns, dietary quality, and energy and nutrient intakes. All dietary surveys need to consider seasonality issues, as the results obtained at one time of the year may not be representative of dietary intakes at other times of the year. *Intake* recommends consultation with local experts in the agriculture sector to map out the timing and food availability patterns in the survey population in each geographical area or agro-ecological zone to be sampled.

Seasonality can be addressed by extending the period of data collection over multiple seasons or by repeating data collection in different seasons, both of which have obvious cost implications. If the survey extends across seasons, scheduling should ensure that dietary intake data for all strata or sub-groups (geographic, demographic, etc.) are equally represented in each season; this will avoid erroneous conclusions that dietary intakes differ between two groups when differences are actually due to seasonal dietary changes.

When these approaches are not feasible, the timing of the survey in relation to seasonal food availability should be carefully considered. We recommend that the survey be carried out at times that avoid the extremes of seasonal food availability (unless survey objectives dictate otherwise). This may be done by conducting a survey through the season that is of the longest duration and hence somewhat more representative of usual intakes over the year or in a period that represents an intermediate situation with regard to seasonal food availability. For example, a late post-harvest period may be intermediate to a “lean” season of the lowest food availability and the harvest or early post-harvest period when food availability and variety are greatest.

6.2 Extended Holidays or Periods of Religious Observation

Events that affect dietary patterns in the population should also be considered when scheduling surveys. Unless a survey is designed to represent intakes across all or most of a year, inclusion of these periods may produce results that are not representative of intakes through the majority of the year. Examples include extended fasting periods, such as Ramadan or Lent, or feasting periods, such as Eid, Christmas, or Easter holidays. For surveys that are conducted over a relatively short period of time (measured in weeks or a few months), *Intake* recommends avoiding these periods in populations where these practices are prominent (i.e., when a large proportion of community members have unusual eating patterns due to fasting or feasting).

6.3 Weekdays and Weekends

The survey should be scheduled to include data collection across all days of the week, with weekdays and weekends proportionately represented, to ensure that any changes in dietary patterns across the week are accounted for. For example, both market days and nonmarket days should be reflected in the survey. Similarly, “routine” fasting, such as a weekly fast day, should also be reflected in the survey.

7 Rough Estimates of Costs, and Options and Trade-offs for Minimizing Them

Data collection costs for quantitative 24-hour recall dietary surveys were estimated at approximately US$250 per household, based on six African and two South Asian surveys fielded from 2007 to 2011 (Fiedler et al., 2013). These surveys all used a household-based sampling approach, not a sampling approach that was target group-based. Survey costs would likely increase for a target group-based sampling approach.

In all eight surveys for which data collection costs were reported, dietary recall data were collected for an infant/young child and his/her care provider. Of these eight surveys, the highest estimated cost per household was US$533, for a 2011 survey conducted in Nigeria. Only one of the eight surveys (Kenya) was a national survey; for this survey, per-household costs were about US$300.

These cost estimates are driven by many context-specific factors, including the scope, geography, and dispersion of the surveyed area; the specific sample design of each survey, and the structure of the field teams. As a result, the estimates should be considered as context-specific approximations of data collection costs, specific to the sample design and time period of the survey.[27]

To estimate the cost of data collection for a quantitative 24-hour recall dietary survey in a specific country context, a budgeting exercise that accounts for decisions around survey design, country-specific geographic factors, and local costs must be carried out.

The main drivers of total data collection cost will be the geographic level for which the survey data must be reported (e.g., national, regional, or provincial); the number of demographic groups targeted; the desired level of precision; and the total number of repeat 24-hour recalls to be collected.

The sampling approach used for the survey is another factor that may influence the cost of data collection. In most contexts, data collection for a target group-based sampling approach will be more expensive than data collection for a household-based sampling approach, assuming all other survey design-related factors (such as sample size) are the same.

Decisions on what dietary outcomes are of interest could also be a driver of cost, because it is cheaper (requires a smaller sample) to estimate a mean intake than, for example, to estimate the percentage of a demographic group with inadequate intakes, or to estimate intakes among low or high consumers, such as the bottom or top deciles, with the same level of precision.

Similarly, the nutrients, food groups, and foods of interest for estimating usual intake can also be an important driver of survey cost, because, as described earlier, the estimation of usual intakes for episodically consumed foods, food groups, and nutrients requires a higher sample size of repeat 24-hour dietary recalls to be collected and/or a greater number (i.e., more than two) of 24-hour recalls per individual to be collected than for ubiquitously consumed foods, food groups, and nutrients.

Survey planners need to make difficult trade-offs between precision of estimates and the level at which data will be reported. Collecting data to be reported at the national level, with stratification by rural/urban areas, would allow for more precision and possibly representation of more demographic groups at a lower cost than collecting

[27] Note that, from the data presented in Fiedler et al. (2013), we were unable to determine whether the sample sizes cited were the sample size planned for each survey or the sample size achieved for each survey. Therefore, the per-household costs cited here could be the cost per household in the sample size planned for the survey or the cost per household eventually surveyed and included in the final sample of survey data. It was also not clear from the data presented in Fiedler et al. (2013) if the estimated costs of data collection per household accounted for carrying out a pre-training with respondents or collecting repeat recalls on a random sub-sample of respondents.

data to provide estimates with the same level of precision at lower administrative geographic levels, such as at the provincial or regional level.

Other options include a phased approach, where the first planned survey could be viewed as a province- or regional-level survey, potentially to be scaled up to the national level in future years. In this scenario, one or several priority provinces or regions would be selected for the first survey. This approach also eliminates or decreases the complexities of coordinating and ensuring consistency across numerous provinces or regions, and ideally results in a well-documented model and very high-quality data in the selected province(s) or region(s). But this phased approach would not deliver national-level estimates following the initial survey, and therefore would not be appropriate when national-level estimates are the priority need. However, it could be considered if province- or regional-level estimates are required, and budget or logistical constraints preclude a high-quality survey in all desired provinces or regions in one round.

These difficult decisions and trade-offs should be discussed as early as possible in the survey planning process, since the geographic scope and sample size will drive all other early planning, such as identifying the right number of implementing partners and the right number and location of collaborating institutions, and determining the necessary scope, locations, and cost for the pre-survey work to be carried out.

Appendix 1. Uses of Dietary Data

Table A1-1. Examples of Uses of Dietary Data[a]

Type of use	Example
Assessing intake	**Ethiopia:** A nationally representative survey identified gaps between intakes and desired intakes and desired nutrient densities from complementary foods for pastoralist infants and young children (Harvey et al., 2010). **United States:** The continuous National Health and Nutrition Examination Survey showed inadequate intake of fruits and excessive intakes of solid fats and added sugar, and identified sweetened beverages as providing nearly half the added sugar in the U.S. diet (Reedy, 2013).
Assessing prevalence of inadequacy	**Mexico:** The most recent nationally representative survey indicated prevalence of inadequate vitamin and mineral intakes by age, location, and socioeconomic status (Pedroza-Tobías et al., 2016; Sánchez-Pimienta et al., 2016).
Assessing adherence to guidance	**Netherlands:** Results from a nationally representative survey were used to assess adherence to World Health Organization Guidelines on consumption of free sugars (Sluik et al., 2016). **Brazil:** Results from a nationally representative survey were used to assess adherence to the World Cancer Research Fund's recommendation on intake of red and processed meat (de Carvalho et al., 2016).
Assessing prevalence of consumption	**Philippines:** Results from nationally representative surveys were used to assess the prevalence of consumption of foods/food groups and to compare them between urban and rural areas and different geographic areas (Food and Nutrition Research Institute-Department of Science and Technology, 2015). (Additional results reported at: fnri.dost.gov.ph/index.php/137-more-pinoy-eat-less-fnri-survey [Accessed 9th January 2019].)
Providing baseline/ assessing trends	**Philippines:** Repeated nationally representative surveys are used to assess trends in nutrient and food intakes and in inadequacy (Sluik et al., 2016). **United States:** The continuous National Health and Nutrition Examination Survey is used to monitor trends in consumption of foods, beverages, and ingredients, and to monitor differential trends by socioeconomic, geographic, and racial groups (see, for example, Dunford and Popkin (2017); Engle-Stone et al. (2012).
Informing policies/ programs	**Cameroon:** To inform fortification policy and programs, a nationally representative survey established the proportion of women and children consuming potentially fortifiable foods (oil, wheat flour, sugar, bouillon cube) and the frequency and amount consumed (Powell et al., 2016). **Mexico:** To contribute to a national policy dialogue, data on sugar-sweetened beverage (SSB) consumption from a nationally representative survey were used to estimate long-term impacts of a SSB tax on diabetes and cardiovascular diseases (Sánchez-Pimienta et al., 2016).
Developing consumer guidance	**Benin:** Data from a purposive selection of urban and rural areas were used to identify commonly consumed foods and quantities consumed. The survey data informed development of food-based dietary guidelines with the objective of ensuring that the resulting guidelines were realistic and acceptable (Lévesque et al., 2015). **United States:** U.S. government researchers presented dietary intake results from the continuous National Health and Nutrition Examination Survey to the expert committee and public/stakeholders early in the process of the revision of the U.S. Dietary Guidelines (Reedy, 2013; Moshfegh, 2013).

[a] Nationally representative surveys are usually conducted with multiple objectives, often including most or all uses listed in this table. The examples are not exhaustive but are meant to allow readers to access examples in the English-language published literature and from publicly available reports and presentations in English.

Appendix 2A. Simulation Exercise to Estimate the Precision with Which Dietary Statistics Can Be Estimated for a Range of Sample Sizes—Moderately Skewed Intakes[28]

Methodology for Estimation of Sample Sizes

The distributions of usual intakes of most nutrients are skewed, with a long tail to the right (IOM, 2000). The degree of skewness depends on the nutrient. Those nutrients that are pervasive in the food supply (macronutrients, mostly) tend to exhibit almost symmetric intake distributions. Micronutrients that appear in few foods have very skewed distributions. Most micronutrients exhibit moderately skewed distributions, although the presence of outliers is the norm.

To estimate the precision with which dietary statistics can be estimated for different sample sizes for a moderately skewed intake distribution, we first simulated usual intakes of nutrients with moderately skewed distributions. Examples of such nutrients include calcium, iron, potassium, vitamin C, and folate.

To estimate the precision with which dietary statistics can be estimated for different sample sizes for a severely skewed intake distribution, we also simulated usual intakes of nutrients with severely skewed distributions. Examples of nutrients with severely skewed distributions include vitamin B12, vitamin A, and zinc. These nutrients would be expected to require a higher sample size than those nutrients with a moderately skewed distribution to obtain the same level of precision for most statistics (other than percentages).

In way of summary, here we describe the methods for simulating the moderately skewed distributions. Results from the simulations for severely skewed distributions are provided in Appendix 2B.

Simulating Usual Intakes

We generated one half million (i.e., 500,000) moderately skewed usual intakes y_i from the following distribution:

$$y_i \sim 20\,\chi_5^2 + N(200, 10^2)$$

The top panel of Figure 2A-1 shows a histogram of the generated values.

Simulating Daily Intakes from Moderately Skewed Usual Intakes

Daily intakes were simulated as follows. To generate a single sample of size *n* (for *n* = 100, 200, …, 600), we first randomly selected *n* usual intakes from the simulated distribution of usual intakes. For each of the *n* individuals, we generated a daily intake as:

$$Y_{i1} = y_i + e_{i1}$$

where Y_{i1} denotes the first daily intake for person *i*, y_i is the usual intake for person *i*, and e_{i1} is the deviation from usual intake for the person on day 1. The e_{i1} are normally distributed variables with mean equal to 200 and standard deviation equal to 65.

[28] The simulation work in Appendix 2A and 2B was designed, carried-out, and written up by Alicia Carriquiry. The recommended citation to use for the work presented in Appendix 2A and 2B is: Carriquiry A. 2020. "Simulation exercise to estimate the precision with which dietary statistics can be estimated for a range of sample sizes. Appendix 2A and 2B." in Deitchler M, Arimond A, Carriquiry A, Hotz C, Tooze JA. *Planning and Design Considerations for Quantitative 24-Hour Recall Dietary Surveys in Low- and Middle-Income Countries.* Washington, DC: *Intake* – Center for Dietary Assessment/FHI Solutions.

We then randomly selected 20% from the n individuals and generated a second daily intake for them in the same way, so that:

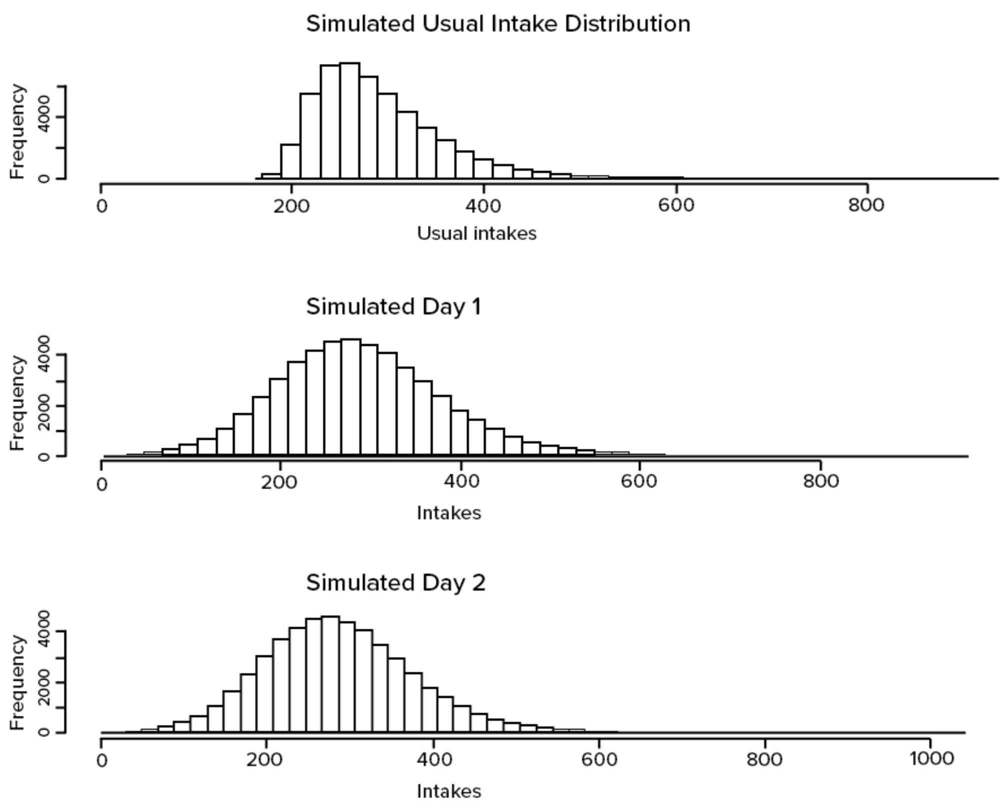
$$Y_{i2} = y_i + e_{i2},$$

where the e_{i2} are again normally distributed variables with mean equal to 200 and standard deviation equal to 65. This resulted in a sample of size n individuals; we observed a single daily intake for 80% of them, and two daily intakes for the other 20%.

For each value of n, we repeated the process above 100 times. That is, we constructed 100 random samples of size 100, 200, …,600 individuals, for a total of 600 samples.

The two bottom panels in Figure 2A-1 show the distribution of simulated daily intakes for days 1 and 2 for one of the 100 samples that were generated when n = 400.

Figure 2A-1. Simulated Usual Intakes and Two Daily Intakes for a Moderately Skewed Nutrient



The Precision of an Estimated Percentage as a Function of Sample Size for Moderately Skewed Intakes

The precision of an estimate can be defined in many ways. Here, we use the margin of error (ME) of the estimate as an indicator of precision. For a 95% confidence level, the ME of an estimated percentage is equal to:

$$ME = 1.96\sqrt{\frac{p(100 - p)}{n}}$$

where p is the percentage to be estimated. The ME calculated from the above formula is equal to the half-width of the 95% confidence interval for a percentage. The expression inside the square root is maximized for any n when p = 50.0%*.* Therefore, the ME is largest for estimated percentages that are close to 50.0%.

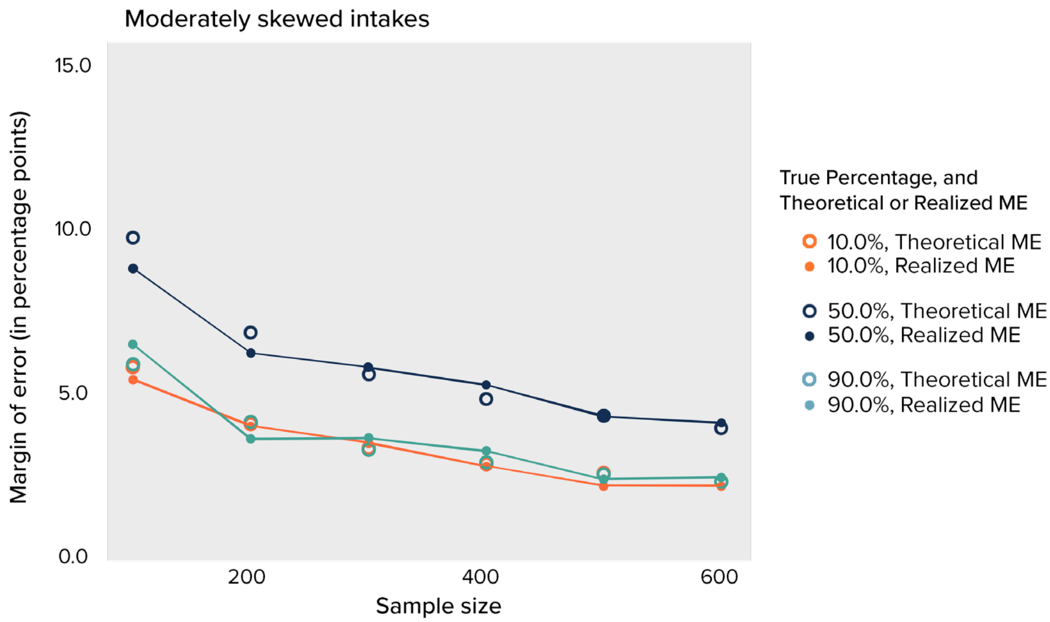
We focused on the precision of estimates of three different percentages, *p = 10.0%, p = 50.0%* and *p = 90.0%*, using three different approaches:

- Approach 1. Theoretical precision, using the standard formulas for computing sample size.
- Approach 2. Realized precision using simulated usual intakes, where we used the 100 samples of usual intakes from the simulated population and in each sample computed the 10th, 50th, and 90th quantiles. Results are obtained by averaging the quantiles across the 100 replicated samples.
- Approach 3. Realized precision using estimated usual intakes. Here, we first estimated the usual intake distribution using the daily intakes that were generated for each individual, using PC-SIDE (Iowa State University [ISU], 2003).[29] Whereas Approach 2 above calculated the distribution of usual intakes by averaging the usual intakes from 100 different samples, in Approach 3, usual intake is estimated with PC-SIDE, using one daily intake for 80% of the sample and two daily intakes for 20% of the sample. From those, we then obtained the 10th, 50th, and 90th quantiles of the estimated distributions of usual intakes. As before, we averaged those quantiles over the 100 replicated samples.

Close agreement would be expected between the theoretical precision (Approach 1) and the precision that results from using simulated usual intakes (Approach 2) when computing percentages. Lower precision (higher ME) than the theoretical precision (Approach 1) would be expected when instead the daily intakes are used to estimate usual intakes (Approach 3) and then percentages are computed. Figure 2 shows the theoretical ME (open circles) for estimates of true percentages equal to 10.0%, 50.0%, and 90.0% (Approach 1) and the realized ME (solid circles) obtained as the average of 100 estimated MEs computed from the sampled usual intakes, as a function of sample size (Approach 2).

[29] PC-SIDE (PC Software for Intake Distribution Estimation) is a software application developed by researchers in the Department of Statistics at ISU to implement the ISU Method for analysis of dietary data (Nusser et al. [1995]; Nusser et al. [1996]) to estimate the distributions of usual intake of nutrients.

Figure 2A-2. Theoretical MEs and Realized MEs Obtained When Usual Intakes Are Available



Theoretical MEs (open circles) (Approach 1) and realized MEs (solid circles) (Approach 2). Sample size is shown on the x axis. The dark blue curve corresponds to the ME for an estimate of a true percentage equal to 50.0%. The orange and teal curves correspond to the ME for an estimate of a true percentage equal to 10.0% and 90.0%, respectively.

In Figure 2A-2, the theoretical ME (Approach 1) and the realized ME (Approach 2) agree closely, as expected. In practice, however, usual intakes are not observed. What is the loss in precision when we instead estimate usual intakes from a small number (i.e., 2) of daily intakes obtained from a randomly selected 20% subset of respondents (Approach 3)?

Figure 2A-3 shows the theoretical ME for the estimates of true percentages equal to 10.0%, 50.0%, and 90.0% (Approach 1) and the average realized ME when usual intakes are estimated from two daily intakes obtained from a randomly selected 20% subset of observations (Approach 3). As expected, the realized MEs for Approach 3 are larger than the theoretical ones (Approach 1) because the theoretical MEs do not account for the additional error incurred when estimating usual intakes.

Figure 2A-3. Theoretical MEs and Realized MEs Obtained When Usual Intakes Are Estimated from Daily Intakes

Theoretical MEs (open circles) (Approach 1) and realized MEs (solid circles) (Approach 3). Sample size is shown on the x axis. The dark blue curve corresponds to the ME for an estimate of a true percentage equal to 50.0%. The orange and teal curves correspond to the ME for an estimate of a true percentage equal to 10.0% and 90.0%, respectively.

Figure 2A-3 highlights the following:

- The difference between the theoretical ME (Approach 1) and the realized ME (Approach 3) increases noticeably (compared to Figure 2) when usual intakes are unobserved.
- This difference decreases as sample size increases. For example, when *n*=100 for a simple random sample with a random subset of 20% of respondents with a second day of dietary recall, to estimate a percentage with a true value close to 50.0%, the difference between the theoretical ME (Approach 1) and the realized ME (Approach 3) is about 4 percentage points in absolute terms. With a simple random sample of size 200 with a random subset of 20% of participants with a second day of dietary recall, estimation of a percentage with true value close to 50.0% will result in an average realized ME of about 9 percentage points (Approach 3), about 2 percentage points higher than what the standard calculations for sample size (Lohr, 2010) would anticipate (Approach 1). When *n* = 600, the difference reduces to about 1 percentage point.

Precision of Quantiles as a Function of Sample Size for Moderately Skewed Intakes

As stated earlier, there are no analytical expressions for estimating the sample size that would be needed to achieve a desired precision when estimating quantiles. Therefore, in this section, simulations are exclusively relied on.

One other characteristic of quantiles is that their actual value depends on the range of intake values of a given nutrient. For example, the quantiles of the usual intake of vitamin B12 are below 5 mg in most population sub-groups, while the quantiles of folate might take on values in the 200–500 dietary folate equivalent range. The simulated distribution of moderately skewed intakes in Figure 2A-1 might correspond to what might be observed for folate in adults or for calcium in children. Because the ME of quantiles depends on the value of the quantile, the focus here is on the relative margin of error (RME), defined as the ME (or half-width of the confidence interval) divided by the value of the quantile, so as to eliminate dependence on the quantile value itself.

Here, the "true" quantile values are those computed from the simulated population of 500,000 usual intakes. Five quantiles are shown in Table 2A-1.

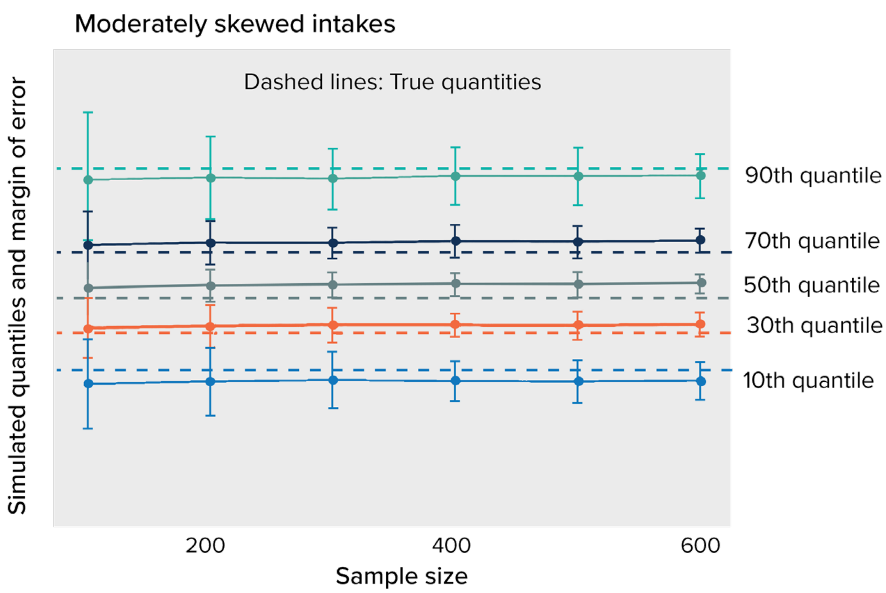
Table 2A-1. "True" Quantile Values Computed from the 500,000 Simulated Usual Intakes

Quantile	231.03	259.92	287.4	322.04	385.63
% Below	10.0	30.0	50.0	70.0	90.0

Figure 2A-4 shows the true quantiles, along with the estimated quantiles and associated MEs, when using daily intakes and PC-SIDE (ISU, 2003) to estimate the usual intake distribution (Approach 3). Since PC-SIDE produces unbiased estimates of the quantiles of usual intakes, the estimates themselves are largely unaffected by sample size. Estimated quantiles are shown in solid lines. The true quantiles are shown in dotted lines. The figure shows that PC-SIDE estimated quantiles from the estimated usual intake distributions are mostly unbiased, with a small deviation from true quantile values.

What does depend on the sample size is the precision with which those quantiles are estimated. The error bars in the figure correspond to the ± ME for each estimated quantile at each sample size. As expected, precision increases with sample size and, consequently, the error bars get narrower. Figure 2A-4 also shows that for all sample sizes, error bars get wider as the quantiles move toward the tails of the distribution. Note that for all sample sizes, the precision with which the median can be estimated is always better than the precision with which the 10th and the 90th quantiles can be estimated.

Figure 2A-4. True Quantiles, Estimated Quantiles from PC-SIDE, and 95% Error Bars for Five Quantiles



So that these results can be generalized to quantiles of other nutrients, with different ranges of intakes, Figure 2A-5 shows the RME of the estimated quantiles for each sample size.

Figure 2A-5. Relative Margin of Error for Five Estimated Quantiles from PC-SIDE

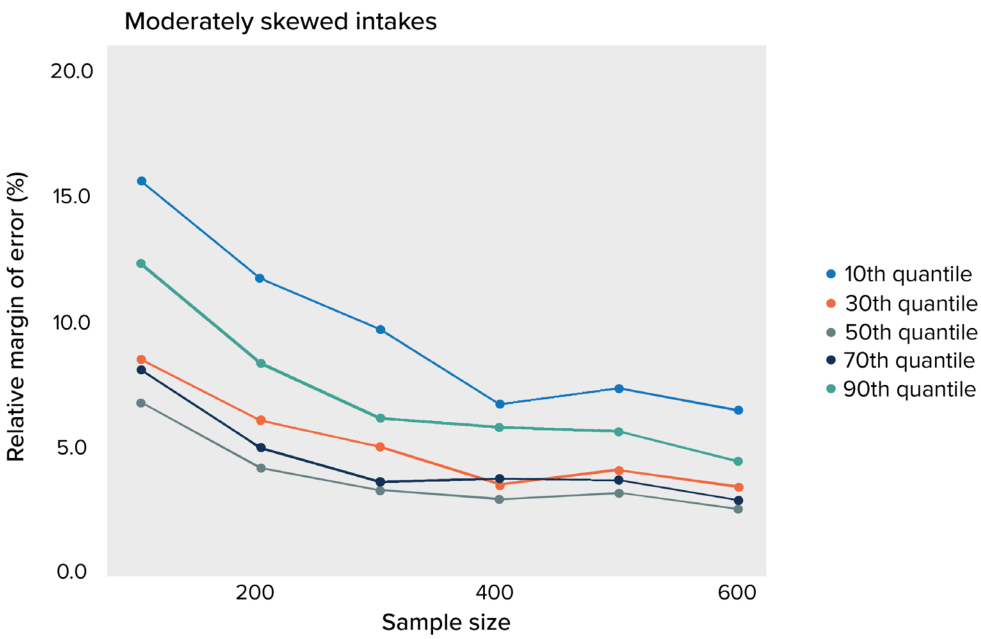


Figure 2A-5 suggests that with a simple random sample of 200 respondents, where 80% of respondents have one day of dietary recall data and 20% of respondents have two days of dietary recall data, most quantiles can be estimated with reasonable precision, even after accounting for the additional uncertainty that arises, because true usual intakes are not observed (Approach 3). For quantiles that are not in the very tail of the distribution, the RME is approximately 5%, and for quantiles in the tails (10th and 90th), the RME is between 12% and 8%, still reasonable. If the true 10th quantile is 50 units, then an 8% RME means that the estimate will be within ± 4 units, with 95% confidence. If, for the same quantile, the RME is 12%, the estimate will be within ± 6 units, with 95% confidence.

Appendix 2B. Simulation Exercise to Estimate the Precision with Which Dietary Statistics Can Be Estimated for a Range of Sample Sizes—Severely Skewed Intakes

This Appendix provides the results associated with the simulations to generate severely skewed distributions. As noted earlier, nutrients with a strongly skewed distribution include vitamin B12, vitamin A, and zinc. The results in Figures 2B-1 thru 2B-5 below complement Figures 2A-1 thru 2A-5 in Appendix 2A. Whereas Figures 2A-1 thru 2A-5 in Appendix 2A show the simulation results for a moderately skewed distribution, Figures 2B-1 thru 2B-5 in this Appendix show these same simulation results, but for a severely skewed distribution. Apart from the degree of skewness of the simulated population of usual intakes, the methods used to generate the results shown here are the same as those described in Appendix 2A.

As expected, the simulation results indicate that the precision with which percentages can be estimated is not negatively affected by the skewness of the distribution of the nutrient. As shown in Figure 2B-3, with a simple random sample size of 200, where 80% of respondents have one day of dietary recall data and 20% of respondents have two days of dietary recall data, the estimated ME for a true percentage of 50.0% is approximately 9 percentage points. A 9 percentage point ME was also estimated for a moderately skewed distribution, for a simple random sample (and a random subset of repeat recalls) of the same size (refer to Appendix 2A).

Also as expected, the simulation results indicate that nutrients with a severely skewed distribution would require a higher sample size than those nutrients with a moderately skewed distribution to obtain the same level of precision for quantiles. For example, Figure 2B-5 shows that with a simple random sample of 200 respondents, where 80% of respondents have one day of dietary recall data and 20% of respondents have two days of dietary recall data, after accounting for the uncertainty that arises because true usual intakes are not observed, the RME is approximately 35% for the 50th quantile, and between 26% and 84% for quantiles in the tails (i.e., 10th and 90th). If the true 10th quantile is 50 units, then an 84% RME means that the estimate will be within ±42 units with 95% confidence. If, for the same quantile, the RME is 26%, the estimate will be within ±13 units with 95% confidence. This is as opposed to the 8%–12% RME that was observed for the 90th and 10th quantiles for a moderately (as opposed to severely) skewed distribution (refer to Appendix 2A). It is important to keep in mind, however, that it is rare to observe a distribution of intakes with such an extreme degree of skewness, so the results presented in this appendix represent an unlikely worst-case scenario.

Figure 2B-1. Simulated Usual Intakes and Two Daily Intakes for a Severely Skewed Nutrient

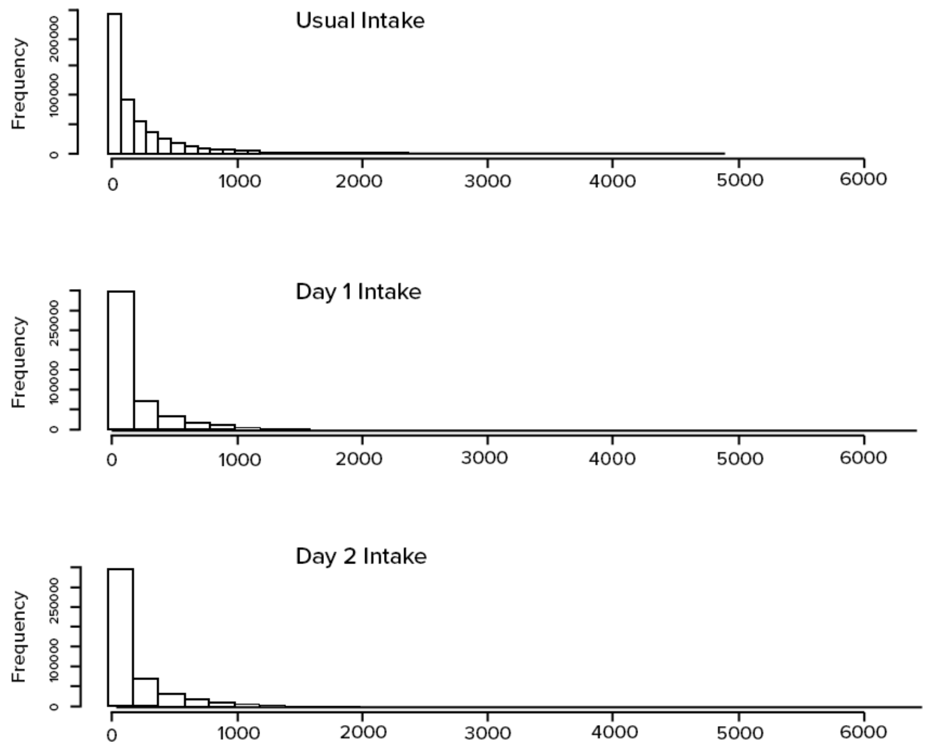


Figure 2B-2. Theoretical MEs and Realized MEs Obtained When Usual Intakes Are Available

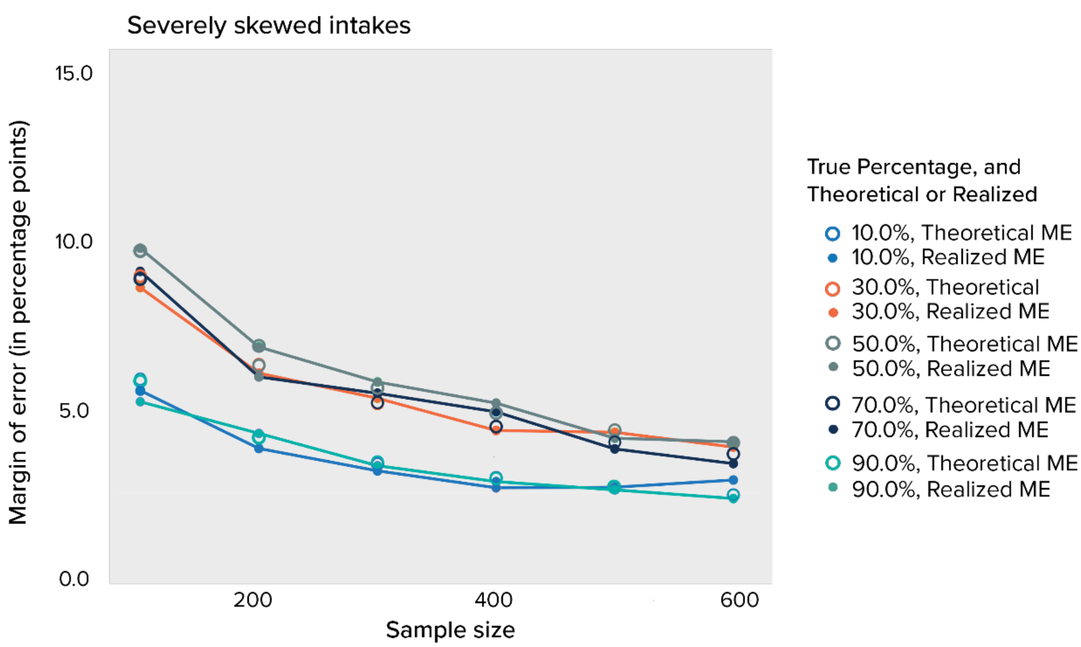


Figure 2B-3. Theoretical MEs and Realized MEs Obtained When Usual Intakes Are Estimated from Daily Intakes

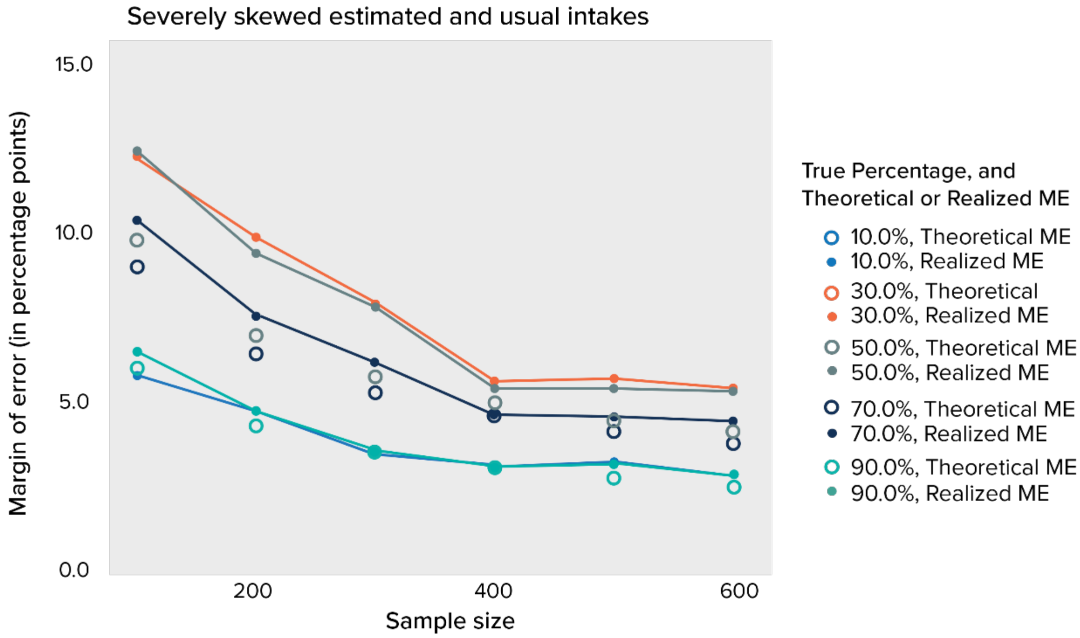


Figure 2B-4. True Quantiles, Estimated Quantiles from PC-SIDE, and 95% Error Bars for Five Quantiles

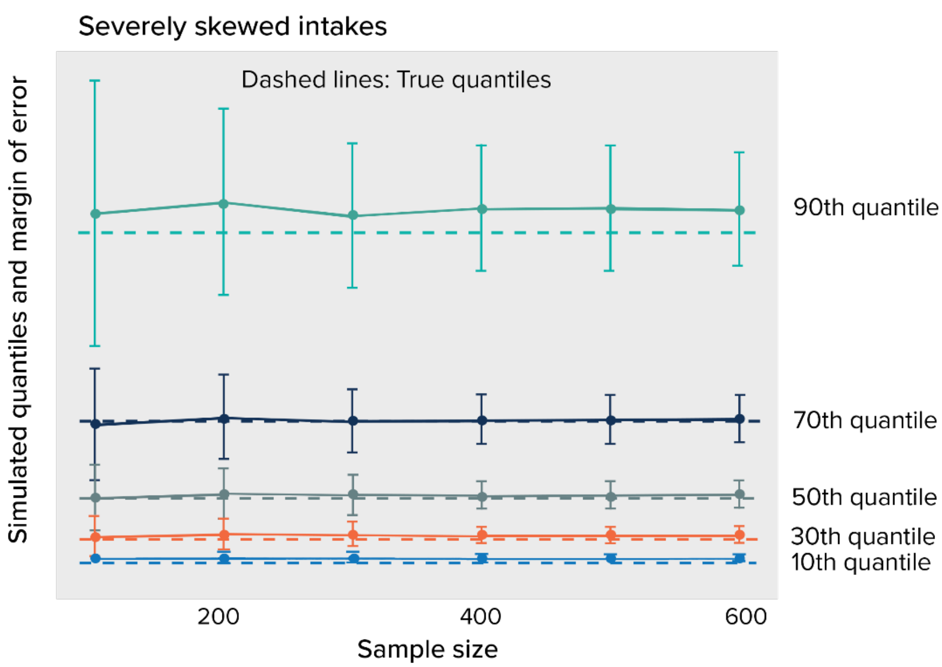
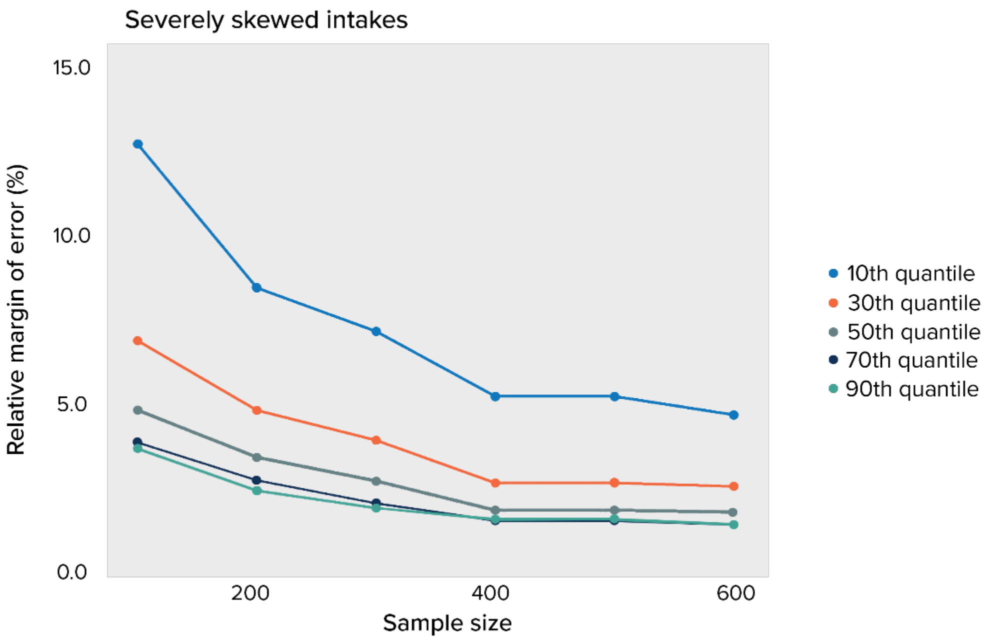


Figure 2B-5. Relative Margin of Error for Five Estimated Quantiles from PC-SIDE



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