E

Units of Observation: Assessing Nutrient Adequacy Using Household and Population Data

Typically, the unit of observation implicitly assumed in dietary assessment is the individual. That is, the analysis assumes that information is available on the usual intake of individuals. For either the probability approach or Estimated Average Requirement (EAR) cut-point method, data on individual intakes are compared with information on the distribution of individual requirements to estimate the prevalence of inadequacy in a group of individuals.

HOUSEHOLD-LEVEL ASSESSMENTS

In assessing the nutrient adequacy of household intakes, it is first necessary to construct a household requirement. It is important at this stage to be explicit about the intended application. One possibility is to evaluate the likely adequacy of intake for a specific household described in terms of the characteristics of each individual living in that household.

Energy

Using energy as an example, an estimate of the total energy need as a summation of the needs of the individuals in the household could be developed. In fact, the energy needs of particular individuals are not known, only the average of needs of similar individuals. By analogy the total need computed for the household from the Dietary Reference Intakes (DRIs) for individuals will have an associated variability. A joint 1985 report by the Food and Agriculture

Organization of the United Nations, World Health Organization, and United Nations University (FAO/WHO/UNU, 1985) on energy and protein requirements discussed the procedure for estimating the variance that should be attached to the household energy requirement estimate. In theory, a probability statement can be made about the likelihood of adequacy of the household energy intake. However, because of the expected correlation between energy intake and energy need, it will be difficult or impossible to interpret the probability unless the observed household intake falls well above or well below the distribution of needs of similar households. When this occurs there are serious limitations to the assessment of the estimated energy intake of a particular household and attempts to do so (with currently available methodology) are not recommended.

When the intended application is to assess the apparent adequacy of a population of households (e.g., in the examination of data from a household food use survey involving a large number of households), one can estimate the mean household energy requirement as a demographically weighted average—the summation of requirements for the typical household. In comparison with the description above, the variance of requirement would be increased to allow for the variation in household composition. A major distinction between assessing a particular household and assessing a population of households is that the population average household intake should be expected to approximate the population mean household energy requirement, thus the confidence associated with an assessment of the total group should be improved. Conversely, because of expected correlation between energy intakes and energy needs at the household level, it is not possible to generate an unbiased estimate of the prevalence of inadequate intakes. The issues are the same as those for assessment of populations of individuals.

Nutrients

Assessing the adequacy of intakes of other nutrients at the household level is also possible but the process is more complicated than for energy. Unlike for energy, where an aggregate household requirement can be generated, an aggregate household requirement cannot be used as an EAR for other nutrients because intake and requirement are not correlated for most nutrients. Even if household intake appears to meet the aggregate household need for the nutrient, the lack of correlation between intake and need suggests that there is no assurance that nutrient intakes will be distributed within the

household in a manner likely to satisfy the needs of the individual household members.

This problem has been identified since at least 1970 when a Food and Agriculture Organization/World Health Organization (FAO/WHO) report on requirements of iron demonstrated that simply computing the aggregate requirement of household members did not begin to address issues of estimating the amount of iron that needed to be supplied *at the household level* if adequacy of intake of the individual family members was to be expected. That is, when a diet providing the aggregate iron need is acquired and consumed by the household, it is likely that food (and iron) will be distributed in proportion to energy needs of the individuals. As a result, there will almost certainly be serious shortfalls in iron intake for women and very young children and surplus iron intakes for adult men and boys (FAO/WHO, 1970). Although the problem had been identified, practical approaches to resolution were much later in coming.

A possible solution to this problem—suggested but not developed in the 1970 report—is to estimate the required nutrient density of the household diet such that when that diet is shared in proportion to energy, there is high likelihood that the needs of all individuals would be met. By definition, such a diet provided in amounts to meet household energy needs would represent a nutritionally adequate household-level diet. The required household nutrient density is set with respect to the class of individuals with the highest nutrient density need. With the use of current FAO/WHO nutrient and energy requirement estimates and the exclusion of pregnant women from the consideration, it turns out that this is often pubescent boys and girls or women of childbearing age.

The calculation of required nutrient density is not as simple as computing the ratio of either the Estimated Average Requirement (EAR) or Recommended Dietary Allowance (RDA) for the nutrient to the average energy requirement. The calculations must take into account variability of the nutrient requirement, expected variability of the nutrient density in ingested diets, and assurance of adequacy for the targeted individual. The theoretical basis for such calculations was partially developed by the 1985 FAO/WHO/UNU committee and an operational approach was subsequently applied by Beaton. In an unpublished report to the Canadian International Development Agency in 1995, Beaton operationalized these concepts in developing guidelines for fortification of foods for refugees where the household was taken as the unit of observation (and of distribution). Because household-level calculations are most likely to be conducted in connection with planning rather than evalua-

tion, the technical aspect of the approach will be presented in a later report when planning is discussed.

With a reference nutrient density in hand, the proportion of households that meet two conditions can be calculated: an energy intake above the household level requirement and nutrient density above the reference. From this, as for assessment of groups of individuals, a prevalence of households with inadequate nutrient supplies and intakes may be computed. Note that the nutrient assessment can be meaningful only if household energy intake approximates the household energy need. This approach does not give an independent estimate of nutrient adequacy because if energy intake is inadequate for the total household, there can be no assurance that food (and nutrient intake) will be distributed in proportion to the energy needs of different classes of individuals—a core necessity of the nutrient density approach.

Although this approach can resolve some of the major issues when dealing with populations of households, it has severe limitations and is not recommended for assessment of observed intake of specific households.

A Caveat on Dietary Data Used for Household-Level Assessments

Although it is not within the purview of this report to address methodologies of food intake data collection, it is germane to warn about special issues to be considered in assessing the suitability of data or in developing adjustments. Information on household food consumption often comes from food *use* data, not from food *intake* data. Household food use refers to food and beverages used from household food purchases and supplies (stored foods, home production, etc.). Food use defined this way is not equivalent to food intake by individuals in the household. Food intake refers to foods actually eaten and is, in general, substantially less than food used by the household. Usage data must be adjusted (methods have been developed by the U.S. Department of Agriculture and others) to take into account food that is discarded and nutrient losses that may occur during storage, processing, and preparation (assuming that nutrient composition data relevant to foods as purchased rather than as consumed are used to compute energy and nutrient supply). Again the overriding principle is that both intakes and requirements must be expressed at the same level of aggregation and food preparation before valid comparisons can be made. Further, account must be taken of consumption of foods outside the household and whether

these are included in the estimate of food use at the household level. If they are not included, the reference requirement figures may need to be changed.

POPULATION-LEVEL ASSESSMENTS

At the population level the most common method for assessing nutrient adequacy is based on food disappearance data (food balance sheets) (Gibson, 1990). For this discussion, all reservations are admitted but set aside about the validity of per capita energy and nutrient supplies calculated from food disappearance data and the allowances that are made for food wastage down to the retail level as well as wastage in the household. The Food and Agriculture Organization (FAO) and many national governments have devoted much effort to improving these procedures. Because the data serve many important purposes in the examination of food trade trends and supplies, computation of apparent nutrient supplies is a secondary or tertiary use of data.

Customary food balance sheets provide information on a country's food supply available for consumption derived from calculations based on estimates of amounts of domestic food produced plus food imports and any change in food stocks since the previous reference period, and less food exports and food diverted to nonhuman sectors (e.g., animal feeds) or converted to other forms in processing (e.g., alcohol production or in North America the production of high fructose sweeteners). Losses that must be taken into account include losses in the field, storage and transportation, and processing (taking into account any by-products that reenter the human food supply) and losses and wastage at the retail and household levels (garbage). Losses at the retail and household level vary widely between populations and perhaps population subgroups. Once the supply of food available for consumption is calculated, it is often converted to a per capita basis by dividing it by estimates of population size, although for energy assessment it might be expressed as the aggregate total energy supply (the units for intake and requirement must be the same for assessment purposes).

Uses of food balance sheets include the analysis of trends in a population's food supply, formulating changes in agricultural policies, and monitoring changes over time in the types of foods consumed (FAO, 1998). An additional reported use, perhaps implicit in the foregoing material, is using food balance sheet data to assess overall adequacy of the food supply relative to a population's nutritional requirements.

Per Capita Energy Needs

Historically, the goal has been to assess the apparent adequacy of total energy supply for a population or group of populations. An approach to the estimation of population energy needs was described in detail by James and Schofield (1990). Energy needs of each physiological stratum of the population—taking into account either actual or desirable body size and physical activity—are multiplied by the number of individuals in that stratum and these needs are aggregated for the population. Under the condition of overall adequacy judged against this estimate of aggregate need (which could be expressed as the total or per capita energy need), the assumption must be that, on a chronic basis, energy intake is distributed across strata and individuals in proportion to energy needs. If per capita supply meets or exceeds the per capita requirement (including allowance for wastage), then a satisfactory situation *can and should* exist. However, where total supply appears to fall short of total need, it must be accepted that the distribution of intakes is likely to be inequitable. Without information about that distribution, inferences cannot be drawn about the likely prevalence of inadequate intakes within the population. Interpretation is limited to the unit of observation—the population as a whole or sometimes a specific population subgroup for which food use data are available.

Per Capita Needs for Other Nutrients

In theory, one could also assess per capita intake data for adequacy of other nutrients at the population level. The approach would have to involve a first step of generating a per capita requirement probably based on an intermediate nutrient density approach as discussed above for household intake data. It is not certain whether such an approach has ever been attempted. Approaches based on a per capita recommended intake (e.g., demographically weighted Recommended Dietary Allowances [RDAs]) will *not* work for the same reasons discussed for household-level intake data. That is, it is unreasonable to assume equitable (proportional to actual need) distribution of nutrients. Methodologies for population-level assessment of nutrient supply are in their infancy and any attempt at such assessment should be scrutinized with great care. In the past the most commonly used approach was the simple comparison of per capita supply with the RDA, with or without even demographic weighting. That is an inappropriate use of the RDAs, past or present (Beaton, 1999).

In theory, then, an assessment of nutrient supply can be made with the population as the unit of observation but it would require very careful thought in building an estimate of the appropriate reference population requirement.