

The prevalence of undernourishment indicator

What is the prevalence of undernourishment indicator?

The **prevalence of undernourishment (PoU)** indicator is a long-established measure, maintained by the FAO Statistics Division. The indicator was first presented in 1963, with the *Third World Food Survey* and then progressively refined.³⁹

The methodology for estimating the PoU is based on the comparison of a probability distribution of *habitual* daily *dietary energy consumption*, $f(x)$, and a threshold level, called the *minimum dietary energy requirement* (MDER). Both are based on the notion of an *average individual* in the reference population.⁴⁰ Formally, the PoU is estimated as follows:

$$PoU \equiv \int_{x < MDER} f(x) dx \quad (1)$$

In other words, the PoU is the probability that, after randomly selecting one individual from the population, (s)he is found to be consuming an amount of dietary energy that is insufficient to cover his or her requirement for an active and healthy life. This probability is taken as an estimate of the likely proportion of people that are undernourished in the population. An estimate of the **number of undernourished (NoU)** is then produced by multiplying the estimated PoU by the population size. The PoU and NoU have been adopted as indicators used to monitor progress towards the targets set by the Millennium Development Goals (in particular, the hunger target of MDG 1) and at the World Food Summit, respectively.

It is worth emphasizing that the probability distribution used to draw inference on the *habitual* levels of dietary energy consumption in a population, $f(x)$, refers to a typical level of daily energy consumption *during a year*. As such, $f(x)$ does not reflect possible implications of insufficient food consumption levels that may prevail over shorter periods of time. If, and only if, the *average* food consumption over such a period is below requirement, the indicator would signal a condition of undernourishment.

Moreover, given that both the probability distribution $f(x)$ and the threshold level in (1) are associated with the representative individual of the population – that is, a statistical construct corresponding to an individual of average age, sex, stature and physical activity level – *they do not represent, respectively, the empirical distribution of per capita food in the population and a threshold level that is meaningful for any actual individual in the population.*

Three frequent critiques

In recent years the FAO methodology has been exposed to three major critiques:

1. The indicator is based on a narrow definition of “hunger”, covering only chronic conditions of inadequate dietary energy

intake. Other aspects of food inadequacy, for example micronutrient deficiencies, are not captured.

2. The PoU indicator systematically underestimates undernourishment, as it assumes a minimum level of physical activity, typical of a sedentary lifestyle. Hence the indicator neglects the fact that many poor people are engaged in demanding physical activities.
3. The methodology is complex and based on allegedly weak macro data, whereas household surveys alone allow for a direct and more accurate measurement of undernourishment.

The first concern is indeed justified. The PoU indicator is designed to capture a clearly – and narrowly – defined concept of undernourishment, namely a state of dietary energy deprivation lasting over a year. This report is addressing this limitation by presenting and discussing measures of different dimensions of food security, through the FAO suite of food security indicators. The suite comprises numerous indicators that reflect aspects associated with the elements of a broader concept of food insecurity and hunger.

The second criticism is unfounded as the object of the criticism is actually a virtue of the methodology that is not always and not easily appreciated. As already mentioned, the FAO methodology is based on a probabilistic approach and a representative individual. Ideally, the adequacy of dietary energy intake, and thus the condition of being undernourished, would be assessed at the individual level, by comparing *individual* energy requirements with *individual* energy intake. This would allow the prevalence of undernourishment to be estimated by counting the number of people who are classified as undernourished. Such a “headcount” approach, however, is not feasible for two reasons. First, individual energy requirements are practically unobservable with standard data collection methods.⁴¹ Second, individual food consumption cannot be measured precisely because of disparities in intra-household food allocation, the variability of individual energy requirements, and the day-to-day variability of food consumption that can arise for reasons that are independent from food insecurity (including different workloads or lifestyles, or cultural and religious habits).

Given that it is practically impossible to proceed with a headcount approach, the solution adopted by FAO has been to apply the PoU, which is an *estimator that refers to the population as a whole*, summarized by the statistical device of a “representative” individual. Obviously, when considering the population as a whole, it must be recognized that, as body weight, metabolic efficiency and physical activity levels will vary in the represented population, there is a *range* of values for energy requirements that are compatible with healthy status. It follows that only values below the minimum of such a range can be associated with undernourishment, in a probabilistic sense. Hence, for the PoU to indicate that a randomly selected individual in a population is undernourished, the appropriate threshold must be set at the lower end of the range of normal energy requirements.

The third criticism ignores the high costs of implementing surveys capable of properly estimating undernourishment for the vast majority of the countries monitored by FAO. At a minimum,

these surveys should capture food consumption at the individual level and should contain sufficient information to assess *habitual* consumption levels, as well as information on the anthropometric characteristics and activity levels of each surveyed individual that would enable the relevant individual energy requirement *threshold* to be estimated. These data requirements suggest that specific surveys, different from and more expensive than existing household surveys, would need to be designed for this purpose. By contrast, the FAO PoU methodology allows the integration of information from household surveys with macro data sources, such as food balances, censuses and demographic surveys.

Computing the PoU in practice

Estimating equation (1) requires an analytic expression for $f(x)$, and the identification of the MDER threshold.

The functional form for the probability distribution $f(x)$ is chosen from a parametric family. Its characterization is obtained by estimating parameters for the *mean*, the *coefficient of variation (CV)* and the *coefficient of skewness*. Improving estimates of these parameters based on available data from various sources is a continuing endeavour of the FAO Statistics Division.

■ The choice of a model for the distribution

Starting with the estimates produced for the *Sixth World Food Survey* in 1996, the distribution was assumed to be lognormal. This model is very convenient from the analytic point of view, but has limited flexibility, especially in capturing the skewness of the distribution.

During the revision of the methodology conducted in 2011 and 2012, attention was drawn to the fact that raising the mean while keeping the CV constant under the lognormal distribution would result in non-negligible probability of unreasonably high levels of energy consumption. Rather, it seems more plausible that an increase in mean food consumption would make the distribution less skewed, as the relative increase in consumption among those who already consume above the average is likely to be smaller than for those consuming below the average.

The search for a more flexible model led to the adoption of the skew-normal and skew-lognormal families of distributions introduced by Azzalini,⁴² with the results published in *The State of Food Insecurity in the World 2012*.

■ Estimating mean food consumption

To estimate per capita dietary energy consumption in a country, FAO has traditionally relied on its own food balance sheets, which are available for more than 180 countries. This choice was mainly due to a lack of suitable surveys conducted on a regular basis in most countries. Through data on production, trade and utilization of food commodities, the total amount of dietary energy available for human consumption in a country for a one-year period is derived using food composition data, allowing computation of per capita dietary energy supply (DES).

During the revision conducted in 2011 and 2012, it was noted that losses of otherwise available food might occur *after the food has been produced and made available for consumption*, most notably during distribution at the retail level.⁴³ A first step toward addressing this problem was taken in 2012, by introducing a parameter that captures food losses during distribution at the retail level. Region-specific values of average calorie losses have been estimated based on data provided in a recent FAO study of food losses,⁴⁴ ranging from 2 percent of the quantity distributed for dry grains, up to 10 percent for perishable products such as fresh fruit and vegetables.⁴⁵

■ Estimating the coefficients of variation and skewness

Data from representative national household surveys are the only reliable source for directly estimating the other parameters of food consumption distributions.⁴⁶

Different types of household survey, including income, expenditure and living standard measurement surveys, collect information on food acquisition (commonly referred to as “consumption” by economists). Their features and the quality of the information collected have implications for the estimates of habitual dietary energy consumption. In this connection, two main issues are noteworthy.

First, while undernourishment is considered an individual condition, data on food consumption are usually available only at the household level. Hence, individual food consumption can only be approximated by dividing available food by the number of household members.

Second, in most cases surveys collect data in terms of quantities of food acquired over a reference period. From these quantities, one needs to infer the levels of individual energy intake. The conversion of food quantities into dietary energy and making the distinction between acquisition and consumption often require large approximations. As these result in overestimation of the level of individual dietary energy intake in some cases and underestimation in others,⁴⁷ the simple sample variance of food consumption would not be a proper estimator of the variance of habitual food consumption in the population, which is needed to estimate of the CV of food consumption of *the representative individual*.

To control for such excessive variation in the data, in the past per capita caloric consumption figures were tabulated by household income class and the variation in average caloric consumption *between* income classes was calculated.⁴⁸ The resulting CV – labelled as “due to income” ($CV|y$) – excludes variability in habitual food consumption that is uncorrelated to household income. The “total” CV of habitual food consumption for the representative individual was then obtained using the following equation:

$$CV(x) = \sqrt{(CV|y)^2 + (CV|r)^2}$$

where $CV|r$ reflects variation caused by factors that induce variability in food consumption and are not correlated to income.⁴⁹ With the 2011–12 revision of the methodology, a more advanced method for estimating the CV and skewness in food

consumption has been implemented. This is based on regression analysis that decomposes the total variation of food consumption into two components: one that reflects the variability of habitual food consumption and another that, due to the variability of observed consumption around its mean, is unrelated to the concept of food insecurity that informs the PoU estimator. Research is continuing within the FAO Statistics Division on how to decompose most effectively the total variation present in food consumption data from available surveys.

■ Estimating the MDER threshold

To calculate the minimum dietary energy requirement (MDER) threshold, FAO employs normative energy requirement standards based on the result of the joint FAO/WHO/UNU expert consultation that produced the most up-to-date reference for human energy requirements.⁵⁰ These standards are obtained by calculating the needs for basic metabolism (i.e. the energy expended by the human body in a state of rest) and multiplying the latter by a factor greater than one, to take into account the

physical activity associated with a normal and active life (referred to as the PAL [physical activity level] index).

As individual metabolic efficiency and physical activity levels are variable within groups of the same age and sex, energy requirements can only be expressed as ranges for such groups. To derive the MDER threshold, the minimum of each range for adults and adolescents is specified on the basis of the distribution of ideal body weights and the midpoint of the values of the PAL index associated with sedentary lifestyle (1.55). The lowest body weight for a given height that is compatible with good health is estimated on the basis of the fifth percentile of the distribution of body mass indices in healthy populations.⁵¹ Once the minimum requirement for each sex-age group has been established, the population-level MDER threshold is obtained as a weighted average, considering the relative frequency of individuals in each group as weights.

That the threshold is determined with reference to light physical activity (as normally associated with a sedentary lifestyle) does not negate the fact that the population also includes persons engaged in moderate and intense physical activity. It is just one

BOX A2.1

Early projections misjudged number of undernourished in 2009–10

In the early months of 2008, the FAO Food Price Index had reached a new and pronounced high. This food price crisis, coupled with what appeared to be a worldwide economic crisis, led to concerns that the number of food-insecure people in the world would increase substantially. FAO was put under considerable pressure to provide early estimates of what the likely impacts on undernourishment might be, before the actual data needed to inform the PoU estimate were available. In response to such pressure, new ad hoc methods to gauge the likely increase in the number of undernourished people were devised. In the 2008 edition of *The State of Food Insecurity in the World*,¹ FAO predicted an increase of 75 million undernourished people in 2008 (almost 9 percent of the last available figure), bringing the total to 913 million. These estimates assumed a rather pessimistic evolution of global food supply. The following year, a further increase of about 11 percent of the number of undernourished was foreseen. This was based on the prediction of a model developed by the United States Department of Agriculture and a bleak global macroeconomic outlook – shared by all major international organizations – that predicted reduced export growth and capital inflows in developing countries, assuming that the financial crisis would lower the availability of foreign direct investment, remittances and, possibly, official development assistance.

The 20 percent increase over the 848 million undernourished people estimated for 2003–05 meant that the number of hungry people in 2009 could have exceeded the one billion mark.

As actual data on food availability and utilization for 2007–09 became available, it also became evident that the worst-case predictions that had informed the 2009 and 2010 editions of *The State of Food Insecurity in the World*,² had not materialized. Estimates produced with the traditional methodology in 2010 put the figure for the number of undernourished for 2005–07 back to 847.5 million; this figure did not change by much the following year, when an estimate of 850 million was produced for the 2006–08 period, well below the 913 million estimate for 2008 issued two years earlier. It also started to become evident that both the food price spike of 2007–08 and the ensuing economic crisis had not been as dire as previously assumed, at least in much of the developing world. Moreover, the pass-through of international prices for primary food products to final consumer prices was much more muted than previously feared. Analysis of food price transmission from the international market to domestic markets shows that many, though not all, developing countries managed to shelter their consumers from the international food price hikes. And finally, many developing countries recovered quickly from the impacts of the global recession or were not much affected by the financial crisis that had engulfed many developed countries.

¹ FAO. 2008. *The State of Food Insecurity in the World 2008: High food prices and food insecurity – threats and opportunities*. Rome.

² FAO. 2009. *The State of Food Insecurity in the World 2009: Economic crises – impacts and lessons learned*. Rome; FAO and WFP. 2010. *The State of Food Insecurity in the World 2010: Addressing food insecurity in protracted crises*. Rome.

way to avoid overestimating food inadequacy when only food consumption levels are observed that cannot be individually matched to the varying requirements.

A frequent misconception when assessing food inadequacy based on observed food consumption data is to refer to the midpoint in the overall range of requirements (that is, with reference to a PAL of 1.85) as the threshold to identify inadequate energy consumption within the population. Unfortunately, such reasoning would lead to gross bias. To appreciate why, notice that even in groups composed of only well-nourished people, roughly half of these will have intake levels below mean requirements, as there will be people engaged in low physical activity. Using the mean requirement as a threshold would certainly produce an overestimate, as all adequately nourished individuals with less than average requirements would be misclassified as undernourished.⁵²

The value of the MDER threshold for all monitored countries is updated by FAO every two years, based on regular revisions of the population assessments of the UN Population Division as well as data on population heights from various sources, most notably the *Monitoring and Evaluation to Assess and Use Results of the Demographic and Health Surveys* (MEASURE DHS) project coordinated by USAID (<http://www.measuredhs.com>). When data on population heights are not available, reference is made either to data on heights from countries where similar ethnicities prevails, or to models that use partial information to estimate heights for various sex and age classes.

What the PoU measures (and what it does not)

The terms “undernourishment” and “hunger” implicitly refer to situations of a *continued inability to obtain enough food*. Often, the FAO undernourishment figures have been interpreted as if they provided an indication on the broader concept of food insecurity. This is certainly misleading. Four points are worth highlighting in this context.

First of all, while there may be various ways to measure quantities of food, the FAO method is defined with respect to dietary *energy*. It is very likely that a diet that provides insufficient

energy also does not guarantee sufficient protein and micronutrient intake. The reverse, however, is not true, as there may be micronutrient deficiencies associated with energy-abundant diets. This means that the PoU estimates will not reflect the full extent of *malnutrition*, which is still an important dimension of food insecurity, as explained in the discussion on the suite of food security indicators presented in this report.

A related point concerns the fact that the term “undernourishment” as used in naming the indicator, being based on food “consumption” data, refers to *access to food*, rather than to its *utilization*. This has sometimes been an additional source of confusion.⁵³

Moreover, it should be emphasized that the degree of inadequacy measured by the PoU is relative to the *habitual consumption level*. The PoU refers to the likely proportion of individuals in a population in such a condition *over the period covered by the assessment*. As data used to estimate average consumption are recorded with reference to one year, the indicator can only be interpreted as capturing the extent of *chronic* food deprivation. It does not reflect the effects of temporary food shortages or of short-lived crises, unless such crises have long-lasting effects on peoples’ ability to access food. This also means that it does not capture, for example, the economic and social costs associated with food procurement, which may have a strong impact on the quality of life of people who are striving to maintain adequate dietary energy intake, even if they do not become undernourished.

Finally, as extensively explained in this annex, the PoU indicator only provides a measure of the likely prevalence of food deprivation *for the entire population, and not separately for different population groups*. The national figures published in this report cannot easily be disaggregated to provide a picture of the state of undernourishment for particular geographic areas or for socio-economic groups within a country.

An important consequence of all this is that, for a more complete description of the state of food insecurity, the PoU indicator should be complemented by other indicators. A broader suite of food security indicators, capturing the various facets of food insecurity in a country and within its population, would also allow decision-makers to design and implement more targeted policy measures. The second section of this report presents an initial attempt at defining such a suite.