Annex 2

Updating and overhauling the FAO methodology for assessing food insecurity – a summary of changes and their impacts

Introduction

During the past five years, the increased volatility of food prices and the availability of new sources of data on food access have emphasized the need for a revision of the FAO methodology[91] to improve the estimation of undernourishment. In 2010, the Committee on World Food Security (CFS) called for a review of the hunger measure, and an Expert Round Table was held in September 2011 to discuss the merits and drawbacks of the existing methodology.[92]

The Round Table confirmed that the FAO methodology is fundamentally valid in its statistical principles, and that no viable alternative has been made available thus far to globally assess the extent of chronic food deprivation. However, the experts gathered in Rome also found that the methodology could be improved in several ways, especially by making fuller use of the increased number of available household expenditure and living standard measurement surveys, which could provide more information on food access distribution in the population.[93]

The experts also emphasized that the state of food insecurity in any country cannot be comprehensively assessed by reference only to the prevalence of undernourishment defined in terms of dietary energy. It was unanimously felt that a broader core set of food security indicators is needed to capture other dimensions of food insecurity beyond that of food energy deprivation. The economic consequences of maintaining adequate energy intake in the face of higher food prices, as well as the nutritional implications of diets that are sufficient in terms of calories but deficient in fundamental micronutrients ("hidden hunger"), have been identified as two aspects not captured by the prevalence of undernourishment indicator that merit proper attention.

In response to the above conclusions and to the explicit request by CFS, the evidence presented in this year's edition of *The State of Food Insecurity in the World* has been strengthened in two major ways. First, the entire series of undernourishment figures have been updated back to 1990, reflecting improvements in both the data and the methodology used. Second, an initial core set of indicators has been identified to convey information on various facets of food insecurity.

Both efforts should be seen as the starting point for a continued endeavour to improve the monitoring of food security. While both the methodology and the conceptual framework for food insecurity assessment have been significantly amended this year to reflect the improved data and information, further revisions are expected in the near future, as more reliable data on food waste and more surveys to assess the distribution of food access become available. Also, although several additional indicators that can provide useful information on food security have been identified, coverage in terms of countries and years for many of these is still far from complete.

This technical annex includes a description of the various data innovations and methodological improvements included in the 2012 edition of this report, compared to the traditional methods adopted previously. It provides an assessment of the marginal impact of each innovation on the estimated numbers and prevalence rates, to help explain the considerable differences between this year's and last year's assessments. The traditional methods used to estimate the prevalence of undernourishment are described in detail in an extended technical note available online at www.fao.org/publications/sofi/en/.

The FAO methodology in brief

Since its establishment, FAO has been charged with responsibility for monitoring the world food situation to enable the international community to appropriately direct actions aimed at promoting universal achievement of the right to adequate food. FAO's food security monitoring work involves, *inter alia*, estimation of the prevalence of undernourishment indicator, published annually in *The State of Food Insecurity in the World*.

The terms "undernourishment" and "hunger" have been interpreted as referring to a continued inability to obtain enough food, that is, a quantity of food energy sufficient to conduct a healthy and active life. Two issues have to be addressed in reaching a viable operational definition of undernourishment.

First, considering the complexity of human nutrition, and both quantitative and qualitative dimensions of food, the expression "enough food" needs to be qualified. The FAO method has been based on the measurement of dietary energy intake, with "enough" defined with reference to a normative dietary energy requirement benchmark established by nutritionists. Accordingly, a human being is considered to be undernourished if the level of his or her habitual dietary energy intake is below the minimum level nutritionists deem appropriate. As such, "undernourishment" has been defined as an extreme form of food insecurity, arising when food energy availability is inadequate to cover even minimum needs for a sedentary lifestyle.

Second, there is the question of the appropriate time span to assess undernourishment. For how long should an individual be deprived of the minimum energy intake before he or she is considered "undernourished"? If our interest is in highlighting deep, chronic undernourishment, the reference period should be long enough for the consequences of low food intake to be detrimental to health. Although there is no doubt that temporary food shortage may be stressful, the FAO indicator is based on a full year, with the average consumption of food over the period referred to as the habitual level.

Hence, the FAO indicator is designed to capture a clearly – and narrowly – defined concept of undernourishment, namely a state of energy deprivation lasting over a year. As such, the FAO indicator is not meant to capture short-lived effects of temporary crises. Furthermore, it does not capture inadequate intake of other essential nutrients; nor does it capture the effects of other sacrifices that individuals or households may make to maintain their consumption of dietary energy.

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For a more complete description of the state of food (in) security, the prevalence of undernourishment indicator has to be supplemented with a broader set of indicators to monitor various dimensions of food security.

Summary of changes and impacts

Substantial data innovations embedded in the undernourishment estimates

The new estimates presented in this year's report are the result of considerable efforts to update and improve the database used. Updates have been obtained for data on food supplies, population and the intranational food access distribution as recorded by household expenditure and living standard measurement surveys. Table A2.1 reports the estimates published in The *State of Food Insecurity in the World 2011*, along with estimates produced by applying each of the revisions in sequence, with some indication of their effects at the margin, from 1990–92 to 2009 (the latest year for which an assessment was conducted using the previous methodology in 2011).

Population size

Updated information on population size and structure has been obtained from the latest revision of world population estimates.[94] This includes substantial revisions of population estimates for some countries with a large number of undernourished people, such as Bangladesh and China. China's population estimate for the 1990s has been revised upwards by as much as 25 million people, with a resulting increase of both the prevalence and the absolute number of undernourished earlier, while Bangladesh's population has been revised downwards by about 11 percent (or 17 million people). The impact on undernourishment is thus different over the entire period. If the new population data were to be applied to the other data used for the estimates presented in 2011, there would have been an increase of 2.8 percent in the number of undernourished for the base period of 1990–92, and a reduction of 1.4 percent in 2009.

Human stature and energy requirements

A second revision relating to population data has involved the average physical stature of people by sex and age. New data has been obtained from the Demographic and Health Surveys programme of the United States Agency for International Development (USAID) and from household surveys that report anthropometric statistics. On the basis of the revised heights, the reference minimum dietary energy requirement (MDER) for each country has been re-estimated. In some cases, this has led to significant changes in MDERs and, therefore, for the prevalence of undernourishment, especially for countries for which data on heights were previously absent and therefore assumed to be equal to those of other countries with similar ethnicities. As the revision has generally resulted in a reduction of estimated average heights, compared with those previously assumed (implying a reduction of dietary energy requirements), the overall impact attributable to this revision would be a reduction in the estimated number of undernourished over the entire period, ranging from –2.4 percent in 1990–92 to –3.1 percent in 2009.

Food supply

The next change considered relates to the total availability of calories. The FAO Statistics Division has recently published new estimates of dietary energy supply for all countries in 2009, with revisions of the entire series. Differences with respect to past estimates can be found over the entire series, but have only been

TABLE A2.1
Impact of individual data and methodology revisions on FAO estimates of undernourishment

	Number of undernourished in the developing regions (millions)							
	1990-92	1995-97	2000-02	2005-07	2009	2010	2011	2012
As reported in 2011	**833**	**774**	**821**	**839**	**866**			
+ Population change	+24	+12	+11	-5	-12			
	(+2.8%)	(+1.5%)	(+1.4%)	(-0.6%)	(-1.4%)			
+ Heights change	-21	-25	-27	-23	-27			
	(-2.4%)	(-3.2%)	(-3.3%)	(-2.8%)	(-3.1%)			
+ Dietary energy supply (DES) change	+12	+10	-2	-31	-66			
	(+1.5%)	(+1.4%)	(-0.2%)	(-3.8%)	(-8.0%)			
+ Food losses	+111	+114	+124	+125	+125	877	874	870
	(+13.2%)	(+14.8%)	(+15.5%)	(+16.1%)	(+16.4%)			
+ Methodology changes	+23	+24	-22	-35	-33			
	(+2.3%)	(+2.7%)	(-2.4%)	(-3.9%)	(-3.8%)	(-2.9%)	(-2.7%)	(-2.2%)
New assessment	**980**	**909**	**905**	**870**	**853**	**852**	**852**	**852**
Overall changes	**+17.7%**	**+17.5%**	**+10.2%**	**+3.6%**	**-1.5%**			

Notes: Marginal changes due to each revision are shown in parentheses. Figures reported in 2011 refer to those published in *The State of Food Insecurity in the World 2011*.
Source: FAO.

substantial for the most recent periods. Use of the updated values of dietary energy supply would result in, everything else unchanged, an increase in the estimated number of undernourished in the initial periods (+1.5 percent in 1990–92, and +1.4 percent in 1995–97) and a reduction in the latest ones (0.2 percent in 2000–02, –3.8 percent in 2005–07, and –8 percent in 2009).

Food losses

The presence of food losses occurring at the retail distribution level has been identified in the past as a known source of bias in FAO estimates of undernourishment, which used the dietary energy supply obtained from the food balance sheets to estimate the mean distribution of food consumption.[95] Lack of reliable estimation of the extent of such losses, however, has prevented their consideration in past estimates. In this year's edition of *The State of Food Insecurity in the World*, a first step has been taken towards correcting the estimate of mean dietary energy consumption at household level, by introducing a parameter for food losses occurring during distribution at the retail level. Country-specific values of the average per capita loss of calories at various stages of the commodity chain have been estimated based on data provided in a recent FAO study of food losses, revealing that significant food losses may occur during retail distribution, that is, from the moment food is made available for human consumption at the wholesale level to the time it reaches the households.[96] Estimates vary by region and by food category, ranging from 2 percent for dry grains to 10 percent for fresh fruits and vegetables. Applied to the various components of the food balance sheets, these coefficients imply an overall reduction in terms of calories available for human consumption at the household level, thus increasing the estimated number of undernourished.

Of all the revisions, this is the one that causes the most dramatic change in the estimated prevalence of undernourishment in the world, with impacts ranging from +13.2 percent in 1990–92 to +16.4 percent in 2007–09. These estimates of food losses during distribution and storage are still tentative, based on rough regional aggregates published in the referenced FAO study, and are expected to be refined in the future as more precise country-specific estimates become available.

Improvements in estimation methods

The FAO Statistics Division recently conducted a thorough revision of its undernourishment methodology, elements of which have been presented and discussed in various fora, including a Round Table organized by the Committee on World Food Security in September 2011 and at the International Scientific Symposium on Food and Nutrition Security Information in Rome in January 2012. While the review confirmed the overall validity of the fundamental approach, it also revealed scope for improvement. The changes introduced with this edition of *The State of Food Insecurity in the World* concern:

- the functional form used for the distribution of dietary energy consumption in the population; and
- the way in which the parameters involved – namely the average, the coefficient of variation (CV) and the skewness of the distribution of habitual food consumption in the population – are estimated.

These changes strengthen both the methodological soundness and the empirical validity of the underlying inferential method.

The distributional model

Since it was first adopted in 1996, the lognormal specification for the distribution has not been changed, and updates have been limited to revisions of the mean dietary energy consumption (based on data published in the food balance sheets) and to occasional revisions of the CV, when data from more recent household consumption surveys were made available to FAO. In all other cases, the lack of adequate food consumption data from nationally representative surveys did not warrant changes in the CV, which was therefore kept constant. However, raising the mean, while keeping the assumption of lognormal distribution, has the consequence of also increasing the implied probability of high levels of consumption. This raises doubts about the appropriateness of the distribution used for recent years in many countries, where the distribution of food access may have become less skewed than implied by the lognormal model. For this reason, a more flexible model (the skew-normal introduced by A. Azzalini in 1985) has been deemed more appropriate to represent the distribution of habitual food consumption in the population. Compared with the previous version, the statistical model can now capture changes in the asymmetry of the distribution of food consumption; such changes could derive, for example, from targeted food supply schemes that only affect a specific part of a population and that could not have been captured by the approach used in the past.

Parameter estimates: mean dietary energy consumption

A known source of bias in the FAO estimates of undernourishment is the lack of reliable information on the extent of food losses. Criticisms have therefore been raised regarding the practice of assuming the mean of the distribution of calorie consumption in the population to be equal to the average dietary energy supply from food balance sheets. The estimates reported in this year's report reflect the results of an important step to correct this bias. The estimated mean of the distribution of caloric consumption is now lower than the dietary energy supply by a coefficient that reflects food losses incurred during distribution and at the retail level, and has been estimated using data provided in a recent FAO study for all regions in the world (see the discussion of food losses above).

Parameter estimates: coefficient of variation and skewness of food consumption distribution from household survey data

In the past, the CV of the distribution of dietary energy consumption in the population was the only parameter used to represent the inequality in the distribution of food consumption. The parameter was estimated differently for different countries, depending on the availability of data. A revision of these estimates has been long overdue. Thanks to collaboration with national statistical offices responsible for household survey data collection and dissemination, FAO has not only updated the estimates of coefficients of variation, but for the first time has estimated the skewness of the distribution of food consumption in the population.

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A total of 47 surveys have been processed, ranging from 1995 through 2010. As most of these surveys are income and expenditure surveys, they have not been designed to specifically capture the level of yearly habitual food consumption of individuals living in the surveyed households; rather, they provide data on total household acquisition of food during a short reference period (from one week to one month). In most cases, it has thus been necessary to re-process available household-level information to control for excessive variability due to seasonal variation in food expenditure and to the difference between reported food *acquisition* levels over a short period, and the needed average yearly food *consumption* levels. Other sources of variability in the food consumption data obtained from these surveys include the fact that food acquired may be given out to guests or people other than household members, and households may have been using previously stored food during the reference period or, conversely, purchasing food to build up stocks. All these problems call for careful procedures to control for data quality and to process the data available to estimate the CV and skewness of individual habitual consumption.

In the end, new parameters have been obtained for 37 countries; together, these account for almost 70 percent of the number of undernourished in the developing world. In the absence of usable new evidence for the remaining countries, the coefficients of variation (and implied skewness) have been kept unchanged from values used in the past.

Projections when data are missing

New data on food supply distribution across households and on human stature and energy requirements, obtained from surveys, are not available for all countries and all years covered. This created the need to devise sound methods to project the new information to years for which no survey data are available, for both food distribution and food requirements.

Projection of food distribution parameters

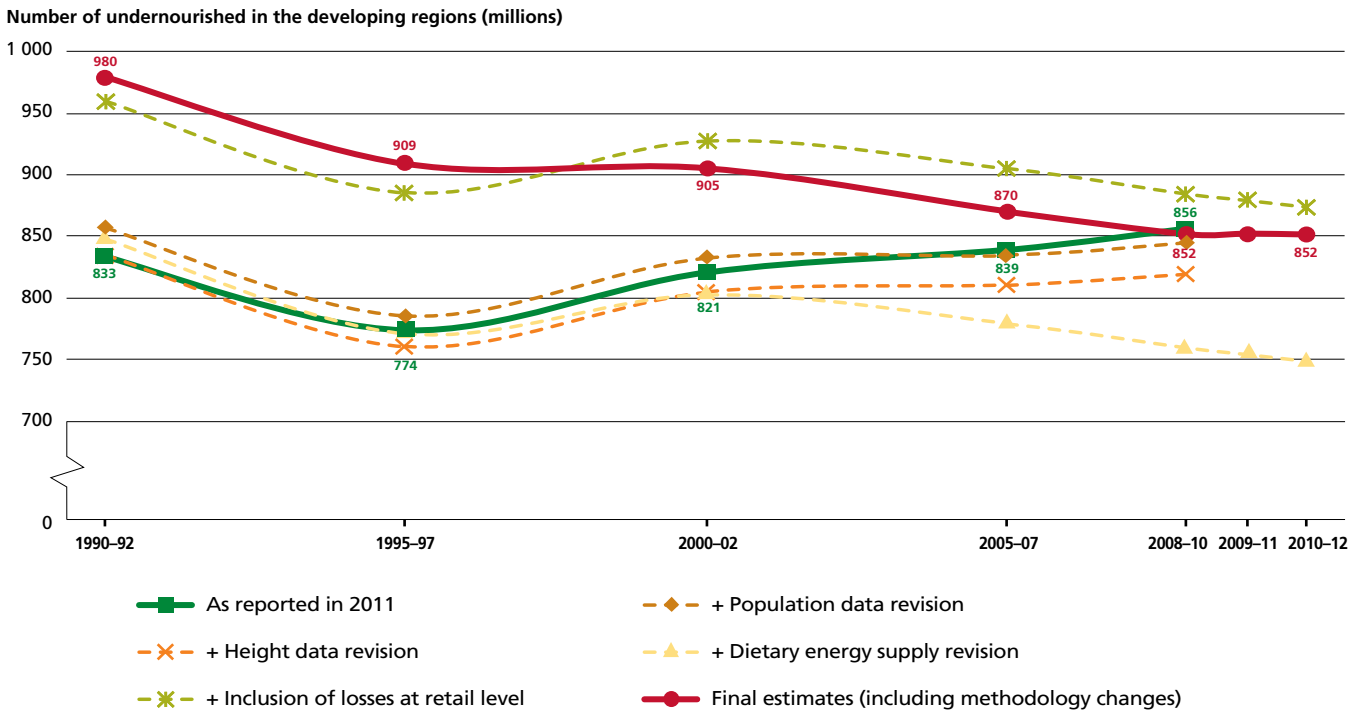
Until the 2011 edition of this report, coefficients of variation of habitual food consumption were kept fixed at the values estimated in 1996 in preparation for the World Food Survey.[97] Under the assumption of a lognormal distribution, these CV values also imply a fixed value for the coefficient of skewness.[98]

As noted, in this year's edition we have calculated the CV and the coefficient of skewness for per-person habitual food consumption in each country and for each year when a suitable survey was available. For years falling between two surveys, the missing information on CV and skewness has been estimated with a simple linear interpolation of the two parameters. The same linear interpolation has been applied to the five years preceding the first available survey, by using the old parameters as starting points.

For the years following the latest available survey, the CV and skewness estimated from the latest available survey have been retained. These parameters' values will be changed when new surveys become available.

FIGURE **A2.1**

Impact of individual data and methodology revisions on FAO estimates of undernourishment



Note: Figures reported in 2011 refer to those published in *The State of Food Insecurity in the World 2011*.
Source: FAO.

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Projections of stature and dietary energy requirements

The dietary requirement threshold for a country (the MDER) is calculated as an average across sex and age groups in the population. To estimate energy requirements for each sex and age category, we use the median height of people in that group, as revealed by surveys reporting anthropometric measures.[99] When more than one survey is available for a country, we project the heights from the oldest survey retrospectively, and project forward those from the most recent one. For years in between surveys, we linearly interpolate the median heights for each sex and age group.

Application of these changes in methodology, including the changes in the distributional model and the new parameters for variation and skewness, on top of all the other revisions already discussed, would have generated changes in the estimated number of undernourished in the developing world, ranging from an increase of 2.3 percent in 1990–92 and 2.7 percent in 1995–97, to reductions of 2.4, 3.9 and 3.8 percent, respectively, for 2000–02, 2005–07 and 2009.

The graphs in Figure A2.1 show the effects of the various changes described. The results of the comprehensive revision of data and methodology presented in this report are overall impacts on the estimated number of undernourished of +17.9 percent in 1990–92 and of –1.5 percent in 2009 compared with the assessment based on the data published in 2011 with no methodological changes.

TABLE A2.2
Food security indicators available online*

Type of indicator	Source	Coverage	Core	New
DETERMINANTS OF (INPUTS TO) FOOD INSECURITY				
Availability				
Average dietary supply adequacy	FAO	1990–2012	■	■
Food production index	FAO	1990–2012	■	
Share of energy supply derived from cereals, roots and tubers	FAO	1990–2012		
Average protein supply	FAO	1990–2012		
Average supply of protein of animal origin	FAO	1990–2012		
Physical access (conditions for physical access to food)				
Percentage of paved roads over total roads	International Road Federation	1990–2009		
Rail lines density	WB	1990–2010		
Road density	WB, Transport Division	1990–2009		
Economic access (affordability)				
Food price level index	FAO/WB	1990–2010	■	■
Utilization				
Access to improved water sources	WHO/UNICEF	1990–2010		
Access to improved sanitation facilities	WHO/UNICEF	1990–2010		
OUTCOMES				
Inadequate access to food				
Prevalence of undernourishment	FAO	1990–2011	■	
Share of food expenditure of the poor	FAO	partial	■	■
Depth of the food deficit	FAO	1990–2011		■
Prevalence of food inadequacy	FAO	1990–2011		■
Utilization (food-related anthropometric failures)				
Percentage of children under 5 years of age who are stunted	WHO/UNICEF	1966–2010	■	
Percentage of children under 5 years of age who are wasted	WHO/UNICEF	1966–2010	■	
Percentage of children under 5 years of age who are underweight	WHO/UNICEF	1966–2010		
Percentage of adults who are underweight	WHO	1974–2010		
VULNERABILITY/STABILITY				
Domestic food price volatility	FAO/ILO	1990–2010	■	■
Per capita food production variability	FAO	1980–2010		■
Per capita food supply variability	FAO	1980–2010		■
Political stability and absence of violence/terrorism	WB WGI	1996–2010		
Value of food imports over total merchandise exports	FAO	1990–2009		
Percentage of arable land equipped for irrigation	FAO	1990–2009		
Cereal import dependency ratio	FAO	1990–2009		

* Values for these indicators are available on the website for *The State of Food Insecurity in the World* (www.fao.org/publications/sofi/en/).
Note: WB WGI = World Bank Worldwide Governance Indicators.

Introducing a core set of additional food security indicators

Following the recommendation that emerged from the CFS Round Table on hunger measurement, an initial set of suitable indicators aiming to capture various aspects of food insecurity has been developed (see Table A2.2); the values for these indicators are available on the *State of Food Insecurity in the World* website (www.fao.org/publications/sofi/en/).

The choice of indicators has been largely informed by data availability with sufficient coverage to enable meaningful comparisons across regions and over the years. While most of these indicators are already being produced and published by FAO and other international organizations, other indicators have been introduced for the first time, to fill some of the recognized gaps in food security information systems, most notably with regard to capturing the socio-economic dimensions of food insecurity.

To facilitate interpretation of the proposed indicators, they are classified along two dimensions. First, a distinction is made between indicators that describe *determinants of food insecurity,* those that describe *outcomes*, and those that convey information on vulnerability/stability. The first set includes indicators that describe structural conditions that are likely to worsen food insecurity in the absence of adequate policy interventions, including emergency assistance; the second set aims to capture the end results of food insecurity, irrespective of policy interventions or coping strategies put in place. The third set of indicators aims to capture the conditions that determine the vulnerability to possible future food insecurity.

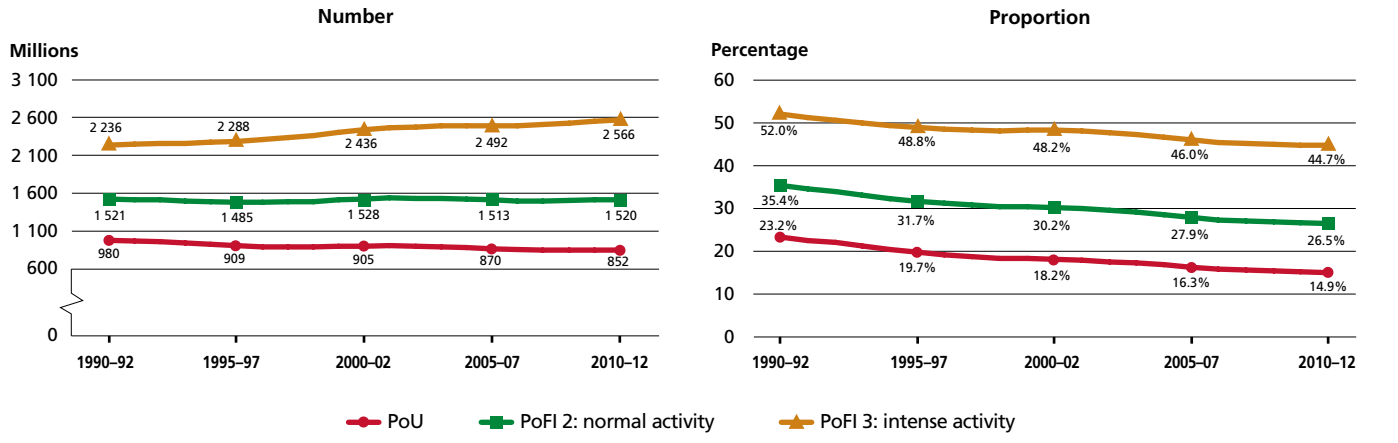
Within the first group, indicators are then classified based on the *dimension* of food insecurity on which they provide information, namely *availability*, *physical access, economic access (or affordability) and utilization*. Similarly, outcome indicators are classified in different groups, depending on whether they refer to outcomes in terms of *inadequate food access,* or to *anthropometric deficits due to inadequate food.*

The full list of proposed indicators is provided in Table A2.2. The table highlights the indicators that should form a core set and those that have been introduced for the first time. These new indicators are briefly described below.

- **Prevalence of food inadequacy**. This is conceptually analogous to the prevalence of undernourishment, but calculated setting the caloric threshold at a higher level corresponding to the energy need for moderate (physical activity level [PAL] = 1.75), normal (PAL = 1.85) and intense (PAL = 2.25) physical activity. It measures the percentage of the population at risk of not covering the food requirements associated with particular levels of physical activity. While the existing prevalence of undernourishment indicator is a conservative estimator of chronic food deprivation ("hunger"), such new estimators are less conservative measures of food inadequacy (see Figure A2.2).
- **Relative dietary supply index**. This is the ratio of the dietary energy supply in the country, expressed on a per capita basis, net of food losses, normalized by the country's average dietary energy requirement (ADER), a measure of the average caloric needs of the population depending on its age/sex structure and average height distribution. It provides indications on food scarcity relative to needs in each country.
- **Food price level index**. This is an index of the food price level in each country that is comparable across countries and over time. It is based on purchasing power parities (PPP) calculated for

FIGURE **A2.2**

Undernourishment and food inadequacy in the developing world
Impact on hunger estimates of alternative definitions of the minimum dietary energy requirements



Note: The graphs show estimates obtained with alternative definitions of the minimum dietary energy requirements, based on different assumptions of the coefficients for physical activity level (PAL). The standard prevalence of undernourishment indicator (PoU) assumes a PAL coefficient of 1.55, which corresponds to a sedentary lifestyle. Normal activity is associated with a PAL of 1.85, while intense physical activity is associated with a PAL of 2.25. The prevalence of food inadequacy (POFI) estimates in the graphic (calculated using PAL coefficients of 1.85 for normal activity and 2.25 for intense activity) appear to have declined less compared with the PoU (calculated using a PAL coefficient of 1.55 for a sedentary lifestyle).
Lacking disaggregated data on occupational status and physical activity levels by gender and age groups, in all cases shown, the threshold is calculated by applying the same PAL coefficient to the entire population, irrespective of gender, age and occupational status. For this reason, while the lower threshold yields a conservative estimate of food inadequacy, the higher threshold (corresponding to a PAL of 2.25) almost certainly overestimates the extent of food inadequacy, even where a large part (but not all) of the population is engaged in heavy physical work.
Source: FAO.

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the International Comparison Program by World Bank researchers. The PPP relative to the food aggregate, available for 2005, is projected over time by taking into account the food and general inflation rates for each country, as measured by the consumer price index (CPI) – both the food CPI and the general CPI – published by the International Labour Organization and FAOSTAT.

- **Share of food expenditure by the poor**. This indicator measures the average share of total expenditure spent on food by households belonging to the lowest income quintile (the first 20 percent). It is compiled based on data from household expenditure surveys, and aims to capture the economic consequences of rising food prices and poverty. A rising share of food expenditure reflects the hardship that poor families face when trying to maintain food consumption when either food prices rise or incomes fall, by sacrificing other household spending, whether for consumption or investment.
- **Domestic food price volatility**. This is an index of observed variability in the annual food price level index, aimed at capturing the consequences of all factors that determine local imbalances in the food market. Together with the other two indicators of variability, in domestic food production and food supply, it provides an indication of the past ability of a country to maintain food price stability.

Further reading

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