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Abstract. In this article, we critically review the three most common approaches of assessing chronic food insecurity and undernutrition: (i) the FAO indicator of undernourishment, (ii) household food consumption surveys, and (iii) childhood anthropometrics. There is a striking and worrying degree of inconsistency when one compares available estimates, which is due to methodological and empirical problems associated with all three approaches. Hence, the true extent of food insecurity and undernutrition is unknown. We discuss strengths and weaknesses of each approach and make concrete suggestions for improvement, which also requires additional research. A key component will be the planning and implementation of more comprehensive, standardized, and timely household surveys that cover food consumption and anthropometry, in addition to other socioeconomic and health variables. Such combined survey data will allow much better assessment of the problems' magnitude, as well as of trends, driving forces, and appropriate policy responses.

Keywords. Food security measurement; hunger; undernutrition; FAO indicator of undernourishment; household surveys; anthropometrics

1 Introduction

There are numerous indicators reporting on food insecurity and undernutrition at global, country, household, and individual levels.[1] Unfortunately, the different indicators are not always consistent. For instance, a study by the International Food Policy Research Institute (IFPRI), which used representative household survey data from 12 countries in Sub-Saharan Africa, reported that 59% of the population in these countries was calorie deficient in the late-1990s (Smith et al., 2006). By contrast, the widely used FAO indicator suggests that only 39% of the population in the same 12 countries was calorie deficient during that period. There is not even a close correlation between the two estimates in terms of country rankings (Smith et. al., 2006). Similar inconsistencies are found for other regions and between other indicators (Svedberg, 2002; Klasen, 2008; Barrett, 2010; Masset,

[1] A comprehensive overview of available or conceivable indicators can be found under the Food Insecurity and Vulnerability Information and Mapping Systems initiative (http://www.fivims.org).

2011), underlining that there are open questions about the extent of food insecurity and the suitability of existing metrics and indicators. In this article, we review the main approaches, discuss scope for improvement, and point out further research needs.

The World Food Summit in 1996 determined that food security exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life. This widely accepted definition emphasizes the multidimensional nature of food security, comprising level and stability of food access and availability, as well as adequacy of food use and nutritional status. Hence, food insecurity is not easy to measure. The same applies to hunger, which is commonly understood as a sensation of not having enough to eat. On the one hand, the extent of hunger can be measured as a lack of essential nutrients in the diet, for which a widely used indicator is food energy deficiency. On the other hand, hunger may also be the result of humans' inability to absorb and use food energy and specific nutrients for body functions, implying that the overall nutritional status is also affected by people's health.

Furthermore, one needs to differentiate between two quite distinct purposes of measurement. The first is to be informed about the extent and consequences of an acute food emergency, caused by a sudden drop in supply or access to food. In such situations, indicators must provide information about people's immediate needs of essential nutrients to ensure survival. The second purpose relates to chronic food insecurity, caused by long term food deprivation linked to structural poverty and poor nutrition. In this article, we focus on indicators of chronic food insecurity.

To be useful for a comprehensive assessment, indicators should provide answers to at least three questions, namely: Who are the food insecure? How many are they? And where do they live? If the purpose of measurement goes beyond assessment and includes the design of policy responses, indicators should also help answering the more ambitious questions: What causes people to be food insecure? And what is the impact of programs and policies to address their food insecurity?

The most frequently used approaches are: (i) the FAO indicator of undernourishment, (ii) household food consumption surveys, (iii) anthropometric measurements, and (iv) medical assessments.[2] The first three approaches currently represent the principal tool kit and are the focus of

[2] There are also composite indicators, which were reviewed recently by Masset (2011).

our analysis. We critically review each of these three approaches separately, before comparing and discussing options for improvement.

2 The FAO indicator of undernourishment

2.1 Definitions and assumptions

The FAO indicator measures the prevalence of undernourishment, expressed as the share of people in a national population not meeting their minimum food energy requirements. The approach is based on three parameters (FAO, 1996; FAO, 2003): the mean quantity of calories available in a country for human consumption, the inequality in access to those calories among the country's population, and the mean minimum amount of calories required by that population.

The quantity of food available for human consumption is calculated from national food balance sheets (FBS), compiled as the balancing item after considering production, trade, stock changes, non-food uses, and extra-household waste. Based on this, using food composition tables, the food quantity is converted into calories and divided by the population to derive the per capita dietary energy supply (DES), expressed in kilocalories per day. Obviously, DES measures food availability and not intake, but it is used as an approximation of mean calorie consumption. Inequality in access to calories is estimated assuming a log-normal distribution function,[3] which is defined by the mean DES and the coefficient of variation (CV). The CV is based on sample distributions of calorie consumption or food expenditures from available household surveys. Where suitable surveys are not available, data from comparable neighboring countries are used. The third parameter is the aggregated minimum dietary energy requirement (MDER). This is the amount of food energy needed, in order to maintain an acceptable minimum body weight, body composition, and a level of minimum ('sedentary') physical activity, consistent with long-term good health. The MDER for the average of a population is the mean energy requirement of the individuals who constitute that population (FAO, 2001).

FAO has published estimates of undernourishment in irregular intervals in its World Food Surveys since the 1960s, although country coverage and details of the methodology were gradually adjusted (FAO, 1996). Since 1999, the indicator has been published annually as a three-year average

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[3] This function with its short lower and longer upper tail was chosen because it reflects the fact that wastages, food fed to pets etc. are likely to be confined to the upper tail representing the richer households (FAO, 2003).

in 'The State of Food Insecurity in the World (SOFI)' publications. The SOFI 2010 reported that the total number of undernourished worldwide was 847 million people in 2005-2007 (FAO, 2010). The main purpose of publishing the indicator regularly for a very large number of countries is to inform the global community about levels and trends of undernourishment and thus facilitate global and regional governance of food security. It is also one of the indicators used to track progress towards the first millennium development goal (MDG). The FAO approach measures chronic food insecurity at national levels. It does not inform about the actual distribution of the number of hungry within countries, nor does it intend to provide actionable information for policy responses at sub-national levels.

2.2 Strengths and weaknesses of the FAO indicator

Undoubtedly, the main strength of the FAO indicator is its global coverage with estimates for more than 100 countries, which allows monitoring of national trends and tracking of progress and setbacks using the same methodology across countries. At the same time, all three parameters used in its calculation have been criticized.

2.2.1 Mean dietary energy supply (DES)

FAO compiles the DES from FBS and uses it as a proxy of food energy consumption. This raises several questions. The first is whether food energy deficiency is an adequate indicator of food insecurity. According to FAO (2001), dietary energy needs and recommendations cannot be considered in isolation of other nutrients in the diet, because the lack of one will influence the others. As deficiencies in micronutrients – such as iron, zinc, and vitamin A – are widespread, comprehensive nutritional assessments should ideally not be limited to food energy alone. In principle, FBS data could also be used to assess the level of micronutrient supply (Wuehler et al., 2005), but aggregation problems with country level data weigh more heavily for micronutrient than for calorie assessments. A second question concerns the accuracy of the FBS data, which build on the FAOSTAT data base. Svedberg (2002) argues that food availability is underestimated by FAO in most parts of the developing world, and especially so in Africa. He suggests that the FBS data underestimate subsistence production, leading to an overestimation of undernourishment. On the other hand, the IFPRI study of 12 African countries mentioned above (Smith et al., 2006) claims that the FAO indicator underestimates undernourishment.

Testing the validity of such claims is not easy. Conceptually, FBS capture all components of supply and utilization, including subsistence production. However, the estimates are subject to possible errors. In particular, assumptions regarding post-harvest losses are often not transparent. The case of India is worth mentioning here, as FAO's estimates of rising numbers of undernourished people are rather surprising against the background of the country's strong economic growth. Whereas one would assume that recent economic growth should have increased calorie consumption significantly, FBS data do not confirm this: mean per capita consumption has stagnated at around 2300 kcal per day between 1999-2001 and 2005-2007. National surveys even show a steady decline in per capita consumption during this period (Chattapadhyay and Sibrian, 2010). A thorough analysis to explain this paradox is urgent, also because the development in India is of great significance for global trends (Deaton and Drèze, 2009; also see further discussion below).

2.2.2 Coefficient of variation (CV)

FAO's method of compiling the CV of dietary energy supply has been subject to intensive debate. One question relates to the assumed magnitudes of the parameter, but there is critique in contradictory directions. Svedberg (2002, p. 25) argues that "FAO must have overestimated the variance in the calorie-availability distribution across households, because the ensuing habitual intakes in the lower tail are impossibly low for living households". Based on household consumption surveys, Smith et al. (2006) come to the opposite conclusion: in the 12 African countries, they estimate an average CV of calorie supply of around 0.6, whereas the FAO estimate is much lower at 0.3. Other household surveys also result in higher dispersion parameters for calorie consumption (Ecker et al., 2010).

FAO itself recognizes that the CV cannot be completely specified, even without considering problems associated with survey practices, measurement errors, and sample design (FAO, 2003). Hence, the CV resulting from the analysis of survey data is occasionally adjusted to remove components of variation that are considered implausible. Moreover, as the log-normal distribution would not exclude energy intake levels below the absolute minimum for survival or above possible maximum food intake levels, lower and upper bounds for the CV range are set at 0.2 and 0.35. According to Smith et al. (2006), these adjustments contribute to the possible downward bias in the FAO estimates. However, the empirical evidence for such a conclusion is limited.

Another question relates to the fact that FAO has so far kept most CVs constant over time, which may have considerable implications for the estimates of undernourishment. First, income and expenditure inequality increased in most developing countries between the early-1980s and the mid-1990s; since then trends have been more heterogeneous (Gruen and Klasen, 2008). Second, even if relative income distribution remains unchanged while average incomes grow, food demand and calorie consumption will grow faster in the lower income brackets, due to their higher demand elasticities. This alone would make it likely that the actual CVs would decline with rising incomes. Similarly, one would presume that drastic rises in global food prices, as witnessed in 2007/08 and again 2010/11, have differential impacts on calorie consumption patterns across different income groups. More generally, keeping the CVs constant means that changes in measured undernourishment are driven by changes in the DES alone, erroneously implying that changes in hunger would only be a problem of food availability, rather than changes in economic access to food. Situations where hunger in a population goes up despite stable or rising DES are ruled out by definition.

A more technical issue is whether the CV is actually the best measure of dispersion to use. As is well-known, the CV is particularly sensitive to the shape in the upper parts of the distribution, so that it is heavily influenced by the distribution of calories among the non-hungry. There are ready alternatives to the CV, including the Atkinson inequality measure or the Theil family of inequality measures, which are both more sensitive to the distribution of calories at the more relevant bottom end of the distribution.

2.2.3 Minimum dietary energy requirement (MDER)

The MDER is defined as the consumption level that will balance energy expenditure. A first question is whether the assumptions used are correct for different age-sex groups of the population.

Components of energy expenditure comprise the basal metabolic rate (BMR), the energy needed for digesting food, metabolizing food, and storing an increased food intake, and the energy required for performing physical activity. The BMR ranges between 1300 and 1700 kcal/day for adults, depending on age, sex, height, and body weight; to this, 50% are added for light physical activity for male and female adults, respectively. The energy required for growth of children and for pregnancy and lactation of women is also taken into account. FAO specifies the MDER through joint expert consultations with other international organizations (FAO, 2001), but different values are also being used and promoted (e.g., Svedberg, 2002, Smith et al., 2006). Further nutritional science research is needed to examine how good and realistic different assumptions are.

Another question is whether a single cutoff point is a good approximation of a population's minimum dietary energy needs. The MDER is derived by aggregating the estimated age-sex-specific requirements, using the relative proportion of the population in the corresponding groups as weights. As the age-sex distribution changes over time, the cutoff point is adjusted regularly (FAO, 2003). However, by aggregating the age-sex distribution to generate a single cutoff, the implicit assumption is that actual calorie consumption is proportional to the total population's age-sex distribution, which is probably too simplistic (Svedberg, 2002). It is also likely that the relationship differs between countries.

2.3 Ex post projections to the current year

Due to delays in the availability of complete FBS data, the FAO indicator is published with a considerable delay of three years. For example, SOFI 2010 covers the 2005-2007 three-year average (FAO, 2010). Therefore, since SOFI 2008 the FAO has additionally included preliminary estimates that extend up to the year of publication. These estimates are based on ex post projections, using recent data but only covering cereals, oils, and meats available for human consumption. These commodities cover 80% of dietary energy supplies. The effect on undernourishment is projected using the historical statistical relationship between the quantities of these commodities and past estimates of undernourishment. The estimates are published at global and regional levels, yet not for individual countries. An assessment of this methodology is not yet possible, as a full documentation is not available. For instance, it is unclear to what extent these projections allow for changes in the CVs as a result of rising food prices.

2.4 Overall assessment of the FAO indicator

One way of evaluating the reliability of the FAO indicator is to examine the robustness of the estimates with respect to changes in the three key parameters (DES, CV, MDER). As discussed, all three are subject to criticism. Hence, we carry out a sensitivity analysis, using the FAO approach and data for individual countries, but varying the country-specific values for the three parameters in a range from -10% to +10% of the original values used. Figure 1 shows the results of these simulations, referring to the 2005-2007 period.

With zero parameter variation, the estimated worldwide number of undernourished people is 847 million, which is what FAO estimated in its SOFI 2010 report (FAO, 2010). However, when the parameters are varied, the number of undernourished changes substantially. The elasticities of the global number of undernourished with regard to changes in the national DES, CV, and MDER are 4.8, 1.6, and 4.7, respectively. Given this very high sensitivity, the problems associated with the three parameters require serious attention.

3 Household food consumption surveys

3.1 Survey formats and summary description

Surveys conducted with the purpose of measuring household living standards usually contain a module on household expenditures (Deaton, 1997). The World Bank also uses such expenditure modules for compiling its poverty statistics (Chen and Ravallion, 2007). Often, the general World Bank format for Living Standards Measurement Surveys (LSMS) is followed. Nonetheless, details of the survey instruments vary between countries and situations. Nationally representative household surveys are usually planned and carried out by the countries' statistical offices, sometimes supported by other national and international organizations. Depending on the size of the country and the resources available, they contain from a few thousand up to more than 100,000 household observations. For many developing countries, surveys are available for individual years, either through the national statistical offices or the World Bank (http://www.worldbank.org/lsms). In some countries, living standard surveys are carried out regularly, so that data sets exist for several years, while for other countries no data are available at all.

The expenditure module of some living standard surveys only considers monetary values spent on broad aggregates of purchased goods (e.g. food, housing, transportation, education); such data can hardly be used for nutritional analysis. Yet, especially more recent surveys usually contain many additional details. Since poor people tend to spend a significant share of their total budget on food, expenditure modules of recent living standard surveys often comprise a relatively detailed breakdown of food expenditures, including food quantities and monetary values. In most cases, expenditures are defined broadly; in addition to market purchases, self-produced foods as well as food gifts and transfers are captured. Hence, all food that enters the household over a certain recall period is measured, so that a reasonable indicator of household food consumption can be derived. This is also the reason why we use the term "household consumption surveys" here to refer to all living standard surveys that contain detailed information on food quantities consumed at the household level, regardless of the source.[4] Commonly, household consumption surveys use 14 or 30 day recall periods for food items. Longer recall periods can lead to unacceptable inaccuracies. There are also a few consumption surveys that use a 7-day recall period, which is preferable from a nutritional perspective.[5]

Using food composition tables, data on the quantity of different food items consumed can be converted to calories to get an estimate of household calorie consumption. Comparison of these consumption estimates with energy requirement cutoffs, which consider the age and sex structure of the household, allows one to identify households in which members are undersupplied with calories. In so far as surveys are nationally representative, the share of households in the sample falling under the cutoff can be interpreted as the prevalence of undernourishment in the country. This method has been used in the literature, mostly concentrating on individual countries (e.g., Dowler and Seo, 1985; Ecker and Qaim, 2011). It has not yet been used for providing a global overview of hunger and food

[4] Other authors use the term "household expenditure surveys" in this connection (e.g., Smith et al., 2006). We prefer "consumption" over "expenditure", because the term "consumption" makes more explicit that data on physical quantities of food are included and that self-produced and other non-purchased goods are also captured.

[5] Another survey format is a 24-hour recall, which does not measure the food entering the household but the food actually eaten by household members during the past one day (Gibson, 2005). Therefore, actual food intake is measured, which is more accurate than food consumption from a nutritional point of view. However, 24-hour recalls are usually carried out for specific nutritional purposes and are not included as part of living standard surveys.

insecurity. The mentioned IFPRI study by Smith et al. (2006) has used such household consumption surveys to calculate the prevalence of undernourishment in 12 African countries.

3.2 Strengths and weaknesses of consumption survey based approaches

When using household level data from high-quality and nationally representative surveys, the information on calorie consumption and deficiency of people is more accurate than when macro level FBS data are used. The reasons are fourfold. First, food consumption is measured where it actually occurs, so that fewer assumptions about missing data on agricultural production, trade, post-harvest losses and non-food uses have to be made. Second, the foods considered better reflect what is actually consumed (e.g., milled rice vs. unmilled paddy). Especially with a high disaggregation of locally consumed food items, the conversion of quantities into calories can be made with greater precision. This also allows one to go beyond calories and analyze the degree of dietary diversity and the prevalence of micronutrient deficiencies (Babatunde and Qaim, 2010). Third, distributional assumptions across households and income levels are not required, because the analysis is carried out for all households in the sample, so that the data themselves determine the distribution. This is also the reason why the household survey approach is sometimes referred to as a non-parametric method (Ricardo et al., 2007). Fourth, while FAO uses data on the average population structure at the country level to derive minimum dietary energy requirements, the survey-based approach takes the actual demographic structure of households into account.

Beyond data accuracy, another big advantage of the survey based approach is that it allows disaggregation of food insecurity by geographic areas or socioeconomic groups within countries. Such "hunger mapping" provides actionable information for designing, implementing, and monitoring policy responses at sub-national levels. Moreover, in addition to merely describing the situation of food insecurity, causes and determinants of undernourishment can be analyzed, because consumption and living standard surveys also include data on a multitude of socioeconomic household characteristics, such as educational levels, occupation, ethnicity, and infrastructure conditions, among others. Likewise, food consumption data can be used to determine the income and price responsiveness of food energy and nutrient consumption, which is crucial in order to predict nutritional impacts of policies and external shocks. In this way, food consumption surveys can be used to simulate the impact of food price or food supply shocks on food insecurity by population groups (Behrman and Deolalikar, 1987; Ecker and Qaim, 2011).

But the approach is also associated with a few drawbacks. First, surveys that are carried out in a single round may not properly capture seasonal variation in food consumption.[6] This can be a particular problem in rural areas where seasonal fluctuations in consumption are more pronounced than in urban areas. It should be stressed that many surveys account for this problem by collecting data in seasonal waves or by extending the survey over a 12-months period (Smith et al., 2006). If household surveys are evenly spread over the year, unbiased estimates of mean consumption levels may indeed be obtained, but the individual household data may still be biased. Second, while food entering the household is captured relatively well, food eaten away from home is often not properly accounted for. In a survey, it may be relatively easy to elicit the value of outside meals consumed, but details about the exact food items consumed away from home, which are needed for converting into calories, are much more difficult to obtain. This can be of particular importance for households where members eat regular meals at work or in school. In such cases, actual calorie consumption will be underestimated (Bouis et al., 1992).

Similarly, as consumption surveys measure the total food entering the household, they do not capture waste, losses, and non food use within households. As some amounts might be fed to pets, wasted, or given to guests or hired laborers, one cannot rule out an overestimation of actual food intakes, especially in richer households (Bouis, 1994). And finally, there may be non-sampling errors caused by general issues of misreporting and mis-recalling, uncompleted questionnaire forms, retroactive corrections by enumerators, extensive data cleaning, etc. The risk of mis-recalling by survey respondents usually increases with the length of the recall period chosen in the survey format and the complexity and length of the survey instrument.

[6]The FAO method is also not able to capture seasonal variation but may possibly be less prone to biases in estimating average food consumption, as it is based on annual data rather than recall periods during parts of the year.

3.3 Overall assessment of consumption survey based approaches

The household survey based approach has several advantages over the FAO approach in terms of data accuracy and distributional assumptions. Analysis based on household consumption surveys also yields more actionable information, because the results can be presented in a disaggregated way and used for policy analysis at sub-national levels. Another plus is that the household data are collected and owned by national statistical offices, so that a bigger degree of national ownership is likely when these data were to be used for a global food security assessment by international organizations. However, a clear limitation for using household consumption surveys for regular global food security assessments is the bigger amount of data required as well as its timeliness. While the availability of living standard surveys has improved significantly over the last 10 years, there are still many countries for which no nationally representative food consumption data are available at all, let alone a series of updated surveys in regular intervals. Until all countries can afford to conduct representative national household surveys on a periodic basis, this approach to measuring hunger cannot substitute but merely provide a complementary perspective to the FAO approach.

4 Anthropometric measurements

While the first two approaches measure inadequate food consumption at the household level, anthropometric measures assess nutritional outcomes at the level of the individual. As household level food consumption is only one factor that determines individual level nutritional outcome, it should not surprise that estimates may differ. Other factors that influence nutritional outcomes are food losses, intra-household food distribution, individual health and activity levels, among others. Also, the anthropometric approach is non-specific with regard to which particular nutrients might be lacking. Thus, food consumption and nutritional outcome approaches are essentially measuring different concepts, which may complement each other.

4.1 Indicators of anthropometric measurement

While there is a very broad range of anthropometric measures that can be used for nutritional assessment (WHO, 1995), the most commonly used indicators all relate to the height and weight of individuals. Given that height is unchanged for adults but changing for children, anthropometry has different indicators for both groups. The greatest consensus exists for anthropometric indicators for children aged 0-5; they will therefore be the focus of the discussion here. The three most commonly used indicators – child stunting, wasting, and underweight – offer insights into different dimensions of nutritional problems. Wasting (low weight for height) is an indicator of acute undernutrition particularly relevant to monitor acute food shortages. Stunting (low height for age) is an indicator of chronic undernutrition, while underweight (low weight for age) is a summary indicator combining both facets.

These indicators are usually determined with the help of a Z-score, which is calculated by dividing the difference between the age-and sex-specific anthropometric indicator of an individual child (e.g., height of a girl aged 38 months) and the median of the same indicator from a reference population by the standard deviation of that indicator in the reference population.[7] Thus, the Z-score measures the distance (expressed in standard deviations) between the anthropometric performance of a particular child and the median of the reference population. Values of less than -2 indicate moderate undernutrition, whereas values of less than -3 reflect severe undernutrition (UNICEF 1998).[8]

The calculation of Z-scores critically depends on the reference standard. Until 2006, the WHO reference standard for child growth had been constructed using two sets of children from the US. For a number of conceptual and technical reasons (WHO, 1995), this standard was seen as problematic, so that it was decided to undertake a multi-center child growth study to derive a new reference standard (de Onis and Garza, 2006). This new WHO standard is based on the growth and weight development of children in six countries (Brazil, Oman, Ghana, India, USA, and Norway) where a sample of children was monitored that followed WHO feeding guidelines and were not constrained by inadequate access to nutrition or health care. In the four developing countries, this involved selecting children from extremely well-to-do backgrounds to ensure that they were not in any way hampered in their growth potential (WHO, 2006a). Two further points are worth noting. First, in contrast to the previous reference standard, which was based on the descriptive height and weight development of

[7]Nowadays, a new reference standard is used (see details below), which is not exactly normally distributed. This requires some slight adjustments in the calculation of Z-scores.
[8] As these Z-scores reflect essentially a probabilistic assessment, they can be inaccurate at the individual level, depending on whether the child has genetically tall or short parents. Z-scores are also subject to type II error in the sense that children with a positive score might still be undernourished.

two samples of US children, the new standard is explicitly constructed as a ‘normative’ standard of ‘optimal’ child growth and weight development (de Onis and Garza, 2006). To achieve this, only children were enrolled in the study where parents were of high socioeconomic status, were non-smokers, and (largely) followed the WHO recommendations on infant and child feeding. In addition, children that fell ill, were obese, or strongly fell behind in growth and weight gain were dropped from the final calculation of the standard. Second, since the growth and weight charts of the children in the six countries looked very similar, a decision was taken to pool them to create a single new growth standard from these pooled data using statistical averaging procedures (WHO, 2006b).[9]

For children beyond five years of age and adolescents, there is no similar consensus on a growth reference standard. Also it appears that genetic differences and, in the case of girls, the age at menarche make it difficult to design a universal growth standard (WHO, 1995; Butte et al., 2007). Likewise, for adults there is no clear consensus on what anthropometric status constitutes undernutrition. Generally, recourse is made to the body mass index (BMI), whereby a BMI below 18.5 and 17.5 is seen as indicating undernutrition and severe undernutrition, respectively. But the heterogeneity across age, gender, body composition, climate, and populations make it difficult to use uniform BMI cutoffs as definitive measures of undernutrition. Also, it is not clear to what extent undernutrition using the BMI among adults and undernutrition using wasting and underweight among children are comparable (WHO, 1995; Klasen, 2003).

Data for childhood anthropometry are collected at regular intervals across the developing world through the Demographic and Health Surveys (DHS) and related Multiple Indicator Cluster Surveys (MICS). These surveys use a standardized protocol to measure and weigh children; they are always based on national random samples, whereby sample sizes vary from around 3000 to over 100,000 children. Virtually all of these data are freely available in the public domain. Currently, there are several hundred surveys available for about 100 developing countries, in some cases spanning 6-8 time periods (particularly if the earlier World Fertility Surveys are also included). Childhood anthropometric data are thus much more broadly available than household consumption surveys.

[9]The switch from the old to the new reference standard has typically meant that rates of stunting and wasting have gone up, while rates of underweight have gone down (Deaton and Drèze, 2009; Misselhorn, 2010). The complete and selected sample of micro data is not yet available beyond the research team that contributed to the new standard, so that one cannot precisely assess possible biases that might have arisen from the sample selection procedures.

Unfortunately, DHS and MICS cannot be merged with data from household consumption surveys, because the two survey approaches are implemented separately by different organizations and based on different samples. There are only very few nationally representative surveys in individual countries that contain both anthropometric and food consumption data.

4.2 Strengths and weaknesses of anthropometric approaches

The use of anthropometry for the measurement of undernutrition has several advantages. First, it is measuring directly what we are essentially interested in, namely how undernutrition affects the health and well-being of individuals. There is overwhelming evidence that undernutrition that generates poor anthropometric outcomes contributes to higher morbidity and mortality (Pelletier, 1994; Klasen, 2008; Deaton and Drèze, 2009). Second, the availability of three different child anthropometric indicators gives a good sense of both chronic and acute undernutrition. It is therefore no surprise that relief organizations regularly use childhood anthropometry to monitor the success of relief operations in emergency situations.

Third, as the anthropometric data also come from household surveys, one can disaggregate undernutrition by groups and regions and thus identify groups and localities particularly affected. Fourth, the survey data also allow causal analyses to some extent. DHS and MICS include a wide variety of other variables that can be used to assess the factors driving undernutrition. In fact, a vast literature has emerged as a result of the wide availability of these data sets (e.g., Smith et al. 2003; Foraita et al., 2008; Kandala et al., 2009). Correspondingly, these surveys can be used to design and monitor nutrition interventions. Fifth, the broad and regular survey coverage and wide data availability allow monitoring of childhood anthropometry across space and time.

Despite these advantages, there are also several problems associated with the use of anthropometric measures as indicators of child undernutrition. First, while useful to track nutritional outcomes, poor anthropometric status can be the result of things that are unrelated to food security, such as presence of diseases. So we cannot be sure that a country or region with poor anthropometric indicators is necessarily an area where there are food security problems. Depending on what we are interested in, this can be a disadvantage (see first advantage above for a different perspective). Second, in spite of broad survey coverage, DHS or MICS are usually only conducted every 3-5 years in a country, in some countries only every 10 years. Therefore, anthropometric data from these surveys can only be used for medium-term assessment of nutritional problems, not for identification of short-term crises or reliable annual statistics on global hunger.[10]

Third, the focus on children neglects problems of food insecurity among adolescents and adults, which may be more or less severe in particular country contexts. Fourth, small sample sizes often preclude careful disaggregation of anthropometrics by sub-groups or regions or make them statistically unreliable. Related to this are the usual problems of household surveys including issues of drawing adequate samples in countries where census counts are often not reliable (Deaton and Drèze, 2009). Fifth, in spite of their comprehensiveness, DHS and MICS lack some critical variables to better analyze determinants of undernutrition; most seriously, data on household income or expenditures are not included. As a result, most studies building on these surveys use an asset index as a proxy for income, which partly remedies this issue but does not enable a link to food consumption patterns (Filmer and Pritchett, 2001).

Sixth, changes in nutritional practice, often referred to as the nutrition transition (Pingali, 2007), might affect the reliability of anthropometric measures as indicators of nutritional status. In particular, the worldwide move towards food with a high content in starch, fats, and sugar may affect the way one ought to measure undernutrition. Especially weight-based measures might be affected. In the new WHO child growth reference standard, overweight and obese children were excluded as they are not considered well-nourished; this allows easier identification of children that suffer from overnutrition, including children that are simultaneously stunted and overweight. However, it can generate problems in identifying undernourished children. Due to high fat and sugar contents in changing diets, undernourished children may still gain sufficient weight. So when compared to the new reference standard, such children may be erroneously classified as adequately nourished. It appears that the underweight indicator, which is currently the only anthropometric indicator used for monitoring the MDGs, is improving more rapidly over time than other anthropometric indicators

[10] Of course, one can use extrapolation and intrapolation to generate more up to date estimates with broader coverage, as is done for the global poverty counts (e.g., Chen and Ravallion, 2007). But a range of possibly debatable assumptions would be required.

(Misselhorn, 2010). Hence, progress in reducing undernutrition may be overstated. Changes in stunting are much slower, so that stunting may be a preferred indicator of undernutrition, which is less affected by a nutrition transition bias (Misselhorn, 2010).

Finally, it must be questioned whether one single growth reference standard is really appropriate for the measurement of children all over the world, as there may be genetic differences in height and weight potential between populations. While there is consensus that genetic differences preclude a single standard for children beyond 6 and adolescents (WHO, 1995; Butte et al., 2007), there is some debate whether the use of different standards would also be more appropriate for children below the age of five (MacFarlane, 1995; Klasen, 2008). Especially, in an Asian context, genetic differences in the growth of children could play a role (WHO, 2006c; Klasen, 2008); as reviewed in Klasen (2008), several studies including the results of the new growth standard suggest a lower height and weight potential of about 1-3% among well-to-do South Asian children. In this context, it should be pointed out that the share of children below a Z-score of -2 or -3 is highly sensitive to even small differences in the reference standard. In South Asia, where almost 50% of the children are classified as stunted or underweight, a difference of only 1% in the reference standard would lead to an 8 percentage point drop in the share of underweight children. With a 3% difference, South Asia's undernutrition rate in 1990 would have been below the rate observed for Sub-Saharan Africa, where there is little evidence of a similar genetic difference in child growth. Thus, child undernutrition in South Asia would be significantly lower if the reference standard differed by a relatively small amount.[11]

4.3 Overall assessment of anthropometric approaches

Despite the mentioned disadvantages, it is clear that anthropometric evidence provides critical insights into the global prevalence and development of undernutrition. Childhood anthropometry in particular is well developed with clear methods, indicators, and available data that can be used for

[11] The reason for this surprising sensitivity of undernutrition rates to small changes in the reference standard is related to the fact that in a country with high undernutrition rates, the mode of the Z-score distribution is close to the cutoff of -2.However, even if a single international reference standard were inappropriate, this would not suggest that undernutrition is not a problem in South Asia, it would merely indicate that the problem is not significantly worse than in Sub Saharan Africa. Nor would it explain the puzzling finding that undernutrition rates are falling very slowly in India despite high economic growth (Deaton and Drèze, 2009).

studying the prevalence as well as the drivers of undernutrition. At the same time, the issues discussed pose some difficult questions regarding comparisons of anthropometric indicators across space and time. Concerning timeliness of surveys and completeness of survey instruments, improvements are feasible. The most obvious improvement would be to link household surveys that contain income and expenditure (consumption) modules with anthropometric surveys. Regarding the other issues, more research is needed to assess to what extent one can remedy the possible biases introduced by the nutrition transition (where recourse to the stunting indicator might be the preferred solution) and genetic differences across populations.

5 Comparing the three approaches

5.1 Contradicting evidence

Using the example of 12 Sub-Saharan African countries, we already showed that the FAO approach can lead to estimates of undernourishment that may be quite different from those derived from household consumption surveys (Smith et al., 2006). Similar inconsistencies occur when comparing the FAO approach with anthropometric indicators. For reasons discussed above, one would not expect a perfect congruence, but the divergence in the regional distribution of undernutrition is staggering. Figure 2 shows a scatter-plot of FAO undernourishment rates and the prevalence of underweight children for a sample of countries. The correlation is quite weak. Of particular note are the remarkably high rates of underweight in countries of South Asia, compared to their much better performance in terms of the FAO undernourishment indicator. Conversely, in many Sub-Saharan African and some Caribbean countries, undernourishment is high but underweight comparatively moderate. The problem is compounded when one confronts childhood underweight rates with under-five mortality rates for the same sample of countries (see Figure 3). Given the health problems associated with undernutrition, one would expect a fairly strong correlation, but again the correlation is not as strong as one would expect. Of particular note is that now the South Asian (and some East Asian) countries stand out with particularly high childhood undernutrition but comparatively low under-five mortality rates.

The puzzle of the high childhood undernutrition indicators in South Asia has commonly been referred to as ‘the South Asian enigma’ (Ramalingaswami et al., 1996). Some have suggested that this is related to low status of women there, leading to the poor anthropometric outcomes for children. Yet, this is not supported by empirical evidence (Smith et al., 2003). Klasen (2008) showed that cross-country models of undernutrition regularly fail to explain the high rates of undernutrition in South Asia, supporting the concerns related to the child growth reference standard discussed above. Hence, major unanswered questions remain regarding the regional distribution of food insecurity and undernutrition and much may be related to the shortcomings of the various indicators.

5.2 Comparative strengths and weaknesses

All three indicators discussed – the FAO approach, the household food consumption survey based approach, and the anthropometric approach – have their strengths and weaknesses, but the evaluation also much depends on the specific purpose in mind. Table 1 tries to summarize how each approach performs with respect to different criteria that we consider important. The assessment is based on the indicators as they are currently being used and on present data availability. As can be seen, the different approaches are complementary. Each approach, as well as related data availability, can be improved, which might change the performance with respect to some, but not all, criteria. Such possible improvements are discussed in the next section.

None of the three approaches has a clear advantage in meeting all criteria. In particular, there is no conclusive evidence regarding the accuracy of the three approaches in assessing the prevalence of undernourishment or undernutrition. However, the consumption survey and anthropometric approaches have clear advantages over the FAO method in several criteria, especially in terms of measuring diversity and heterogeneity within countries. Although currently hardly done, they could potentially serve to generate even more information that is important for a complete assessment of undernutrition. For example, household consumption surveys are potentially very useful to assess dietary diversity and micronutrient status.

6. Options for improving food security and undernutrition indicators

Given that that there is currently no single indicator available that shows excellent performance with respect to all criteria, a suite of indicators is required for assessing different aspects of food insecurity. Indicators that are based on food consumption and anthropometric surveys are particularly complementary, and they also seem to be better than the FAO indicator in many respects. However, until the issues of timeliness, coverage, and consistency of food consumption surveys have been addressed, the FAO approach continues to be the only source of comparable and timely global information on food insecurity.

One of our central suggestions for improving and broadening the empirical data base is running more surveys with more standardized formats. In the longer term, results from regular and representative surveys could greatly enhance the worldwide information on food insecurity, eventually reducing the reliance on the FBS used in the FAO approach. However, even if this suggestion is followed, data availability would only improve gradually. Moreover, the possibility of continued problems with household data could still not be ruled out completely. Therefore, our recommendations are twofold. First, the FAO approach should be improved through better data and better methods. Second, household consumption survey and anthropometric approaches should be further improved, both conceptually and through improved data bases.

6.1 Improving the FAO indicator

To improve the FAO indicator, it is critical to increase the accuracy of estimates of DES by improving the quality and consistency of all data inputs for the FBS, and to update the CVs of food availability within countries by making wider use of representative consumption surveys in closer cooperation with national and international organizations conducting such surveys. The possibility of regular updates to reflect changes of CVs and of using other measures of dispersion that are sensitive to the bottom of the caloric distribution (such as Atkinson and Theil measures) should also be considered. Further, we recommend continuing inter-agency cooperation to determine best science-based estimates of MDERs.

6.2 Moving beyond the FAO indicator

Even with the suggested improvements, the FAO approach would not satisfy all information needs with regard to food insecurity, nor would it suffice to provide policy makers with actionable information needed to address the main obstacles to overcoming hunger through effective food security strategies at country level. For these purposes, improvements must go beyond the FAO indicator. In our view, the most important steps include the following:

- *Data availability.* Improvements are required, especially with respect to nationally representative household consumption surveys. Living standard surveys with sufficiently disaggregated food consumption modules should be carried out more frequently, and in a larger number of countries. This will require additional resources, but such data can be used for a variety of purposes. To the extent possible, the survey formats should be standardized internationally.
- *Anthropometric measurements.* Here the data base is much better, but anthropometric surveys contain little other socioeconomic variables and no information on food consumption. As nutrition, health, consumption, and income are so closely related, we propose linking anthropometric surveys with household living standard surveys. This will not only help improve the understanding of food security issues, but will also constitute a precious resource for broader micro level research related to food, nutrition, health, demography and overall welfare.
- *Research.* There are a variety of conceptual issues related to appropriate assumptions for minimum energy requirements, anthropometric reference standards etc., which need further research. Integrated research that compares food intake and nutritional outcome indicators, controlling for other health-related aspects, would be particularly useful to better understand the existing contradictions and complementarities and improve the methodologies. This requires the proposed link between (or integration of) anthropometric and household living standard surveys.
- *Dietary diversity.* More research is also required beyond a calorie focus, to better understand the role, determinants, seasonality and appropriate measurement of dietary quality and diversity. A simple count of different food groups consumed by households (food variety score) has been proposed as a good indicator of nutritional status and even of food security more generally, but questions remain on advantages and drawbacks of such dietary diversity measures in particular

situations (Ruel, 2003). Such research would also benefit a lot from wider availability of nationally representative linked anthropometric and food consumption data.

- *Policy impact simulations.* Concerning the simulation of nutritional impacts of policies and shocks at country level, household food consumption data currently seem to constitute the best starting point. Since these surveys also contain information on food prices and household incomes, calorie-price and calorie-income elasticities can be estimated for the population as a whole as well as for population subgroups. These elasticities, together with the results on household food security, can then be used to predict changes in the prevalence of undernourishment due to price and income changes. Ecker and Qaim (2011) have recently developed such an approach, which goes beyond calories and also captures micronutrient deficiencies. Anriquez et al. (2010) have used household survey data to assess the possible effects of staple food price increases on household food consumption and undernourishment. These approaches seem useful to simulate micro level nutrition effects of food price spikes or economic crises. If living standard surveys were linked with anthropometric surveys, as proposed here, such analyses could be extended to also simulate impacts of policies and shocks on the prevalence of child underweight, wasting, and stunting.

7 Conclusion

With the current state of evidence it is safe to conclude that the available estimates of chronic food insecurity are inaccurate, but it is not possible to conclude whether the real number of undernourished is above or below the available FAO estimates. It seems not even certain whether the direction of change has been correctly assessed for the different countries. Even with revised methods and more accurate data, estimates of food insecurity and undernutrition are bound to be subject to measurement errors and projections will remain uncertain.

In this article, we have identified the key strengths and weaknesses of the current approaches – especially the FAO approach, food consumption survey based approaches, and anthropometric indicators – and have suggested a range of improvements, which also requires further research. Critical to any process of improvement is a greater degree of transparency in terms of methods and data used, and a greater focus on country-level comparisons of the different approaches. In the short run, we suggest the establishment and regular updating of a Portal containing a complete inventory of estimates of all relevant national indicators of food insecurity. Such inventory would enable more comprehensive comparative assessments and identification of areas that require further research and data improvement. In the medium run, the focus should be on generating more timely, comprehensive, and consistent household surveys that cover food consumption and anthropometry. Such survey data will allow much better assessment of the prevalence of food insecurity and undernutrition, as well as of trends and driving forces. This is crucial for being better prepared for future food security challenges and for designing and monitoring appropriate policy responses.

References

Anriquez, G., Karfakis, P., Daidone, S., Mane, E., 2010. Measuring dietary energy deficiency and the impact of food price variations at the household level. FAO/ESA Working Paper No. 10-02, FAO, Rome.

Babatunde, R.O., Qaim, M., 2010. Impact of off-farm income on food security and nutrition in Nigeria. Food Policy 35(4), 303-311.

Barrett, C.B., 2010. Measuring food insecurity. Science 327, 825-828.

Behrman, J.R., Deolalikar, A.B., 1987. Will developing country nutrition improve with income? A case study for rural South India. Journal of Political Economy 95, 492-507.

Bouis, H., Haddad, L., Kennedy, E., 1992. Does it matter how we survey demand for food? Evidence from Kenya and the Philippines. Food Policy 17, 349-360.

Bouis, H.E., 1994. The effect of income on demand for food in poor countries: Are our food consumption databases giving us reliable estimates? Journal of Development Economics 44, 199-226.

Butte, N., Garza, C., de Onis, M., 2007. Evaluation of the feasibility of international growth standards for school-aged children and adolescents. Journal of Nutrition 137, 153-157.

Chattapadhyay, G., Sibrian, R., 2010. A review of food insecurity assessment and trends in India and provinces from 1987 to 2005. Paper presented at the Fifth International Conference on Agricultural Statistics, 12 October 2010, Kampala, Uganda.

Chen S., Ravallion, M., 2007. Absolute poverty measures for the developing world, 1981-2004. Proceedings of the National Academy of Sciences 104(43), 16757-16762.

Deaton, A. (1997). The Analysis of Household Surveys. The Johns Hopkins University Press, Baltimore, MD.

Deaton, A., Drèze, J. 2009. Food and nutrition in India: Facts and interpretations. Economic and Political Weekly XLIV(7), 42-65.

de Onis, M., Garza, S., 2006. Foreword. Acta Paediatrica Suppl. 450, 5-6.

Dowler, E., Seo. Y.O., 1985. Assessment of energy intake: estimates of food supply vs. measurement of food consumption. Food Policy 10(3), 278-288.

Ecker, O., Qaim, M., 2011. Analyzing nutritional impacts of policies: An empirical study for Malawi. World Development 39(3), 412-428.

Ecker, O., Weinberger, K., Qaim, M., 2010. Patterns and determinants of dietary micronutrient deficiencies in rural areas of East Africa. African Journal of Agricultural and Resource Economics 4(2), 175-194.

FAO, 2010. The State of Food Insecurity in the World. FAO, Rome.

FAO, 2003. Measurement and Assessment of Food Deprivation and Undernutrition. Proceedings of an international symposium, FAO, Rome.

FAO, 2001. Human Energy Requirement. Report of a joint FAO/WHO/UNU expert consultation. Food and Nutrition Technical Report 1, FAO, Rome.

FAO, 1996. Sixth World Food Survey. FAO, Rome.

Filmer, D., Pritchett, L.H., 2001. Estimating wealth effects without expenditure data – or tears: An application to educational enrollments in states of India. Demography 38(1), 115-132.

Foraita, R., Klasen S., Pigeot, I., 2008. Using graphical chain models to analyze differences in structural correlates of undernutrition in Benin and Bangladesh. Economics and Human Biology 6, 398-419.

Gibson, R.S. (2005). Principles of Nutritional Assessment. Second edition, Oxford University Press, New York.

Gruen, C., Klasen S., 2008. Growth, inequality, and welfare: Comparisons across space and time. Oxford Economic Papers 60(2), 212-236.

Kandala, N.B., Fahrmeir, L., Klasen, S., Priebe, J., 2009. Geo-additive models of childhood undernutrition in three Sub-Saharan African countries. Population Space and Place 15(5),461-473.

Klasen, S., 2003. Malnourished and surviving in South Asia, better nourished and dying young in Africa: What can explain this puzzle? In FAO (ed.). Measurement and Assessment of Food Deprivation and Undernutrition. FAO, Rome, pp. 283-287.

Klasen, S., 2008. Poverty, undernutrition, and child mortality: Some inter-regional puzzles and their implications for research and policy. Journal of Economic Inequality 6(1), 89-115.

Masset, E., 2011. A review of hunger indices and methods to monitor country commitment to fighting hunger. Food Policy 36, S102-S108.

MacFarlane, SB., 1995. A universal growth reference or fool's gold? European Journal of Clinical Nutrition 49(19), 745-753.

Misselhorn, M., 2010. Undernutrition and the nutrition transition: Revising the undernutrition aspect of MDG I. Courant Research Center Working Paper No. 35, University of Goettingen, Goettingen, Germany.

Pelletier, D., 1994. The relationship between child anthropometry and mortality in developing countries. Journal of Nutrition 124, 2047S-2081S.

Pingali, P., 2007. Westernization of Asian diets and the transformation of food systems: Implications for research and policy. Food Policy 32(3), 281-298.

Ricardo, S., Naiken, L., Mernies, J., 2007. The FAO Parametric Versus the IFPRI Non-Parametric Approach to Estimating the Prevalence of Undernourishment. Statistics Division Working Paper ESS/ESSG/012e, FAO, Rome.

Ramalingaswami, V., Jonsson, U., Rohde, J., 1996. The South Asian Enigma. In UNICEF. The Progress of Nations. UNICEF, New York.

Ruel, M.T., 2003. Operationalizing dietary diversity: A review of measurement issues and research priorities. Journal of Nutrition 133(11): 3911S-3926S.

Smith, L., Alderman, H., Aduayom, D., 2006. Food Insecurity in Sub-Saharan Africa: New Estimates from Household Expenditure Surveys. Research Report 146, IFPRI, Washington, DC.

Smith, L., Ramakrishnan, U., Haddad, L., Martorell, R., Ndyae, A., 2003. The Importance of Women's Status for Child Nutrition in Developing Countries. Research Report No. 131. IFPRI, Washington DC.

Svedberg, P., 2002. Undernutrition overestimated. Economic Development and Cultural Change 51(1), 5-36.

UNICEF, 1998. The State of World's Children: Focus on Nutrition. UNICEF, New York.

WHO, 1995.Physical Status: The Use and Interpretation of Anthropometry. Technical Report Series 854.WHO: Geneva.

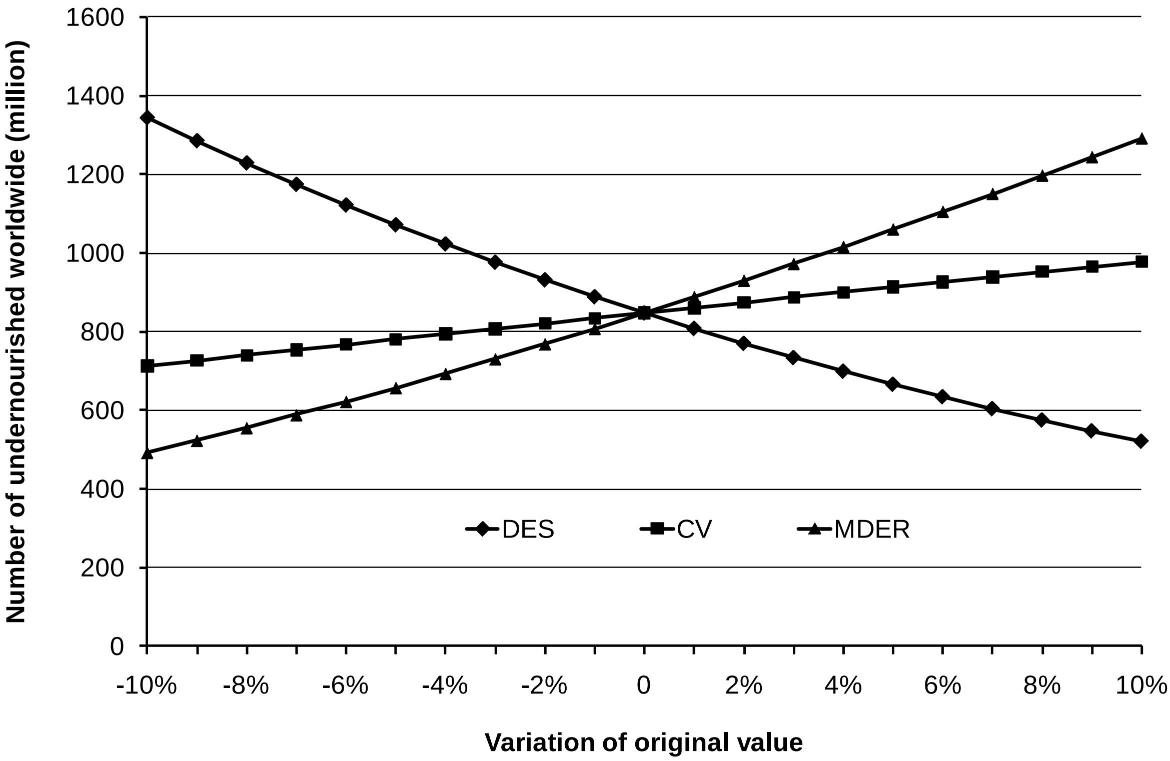
WHO, 2006a. Enrolment and baseline characteristics in the WHO multicentre growth reference study. Acta Paediatrica Suppl. 450, 5-15.

WHO, 2006b. WHO child growth standards based on length/height, weight, and age. Acta Paediatrica Suppl. 450, 76-85.

WHO, 2006c. Assessment of differences in linear growth among populations in the WHO multicentre growth reference study. Acta Paediatrica Suppl. 450, 56-65.

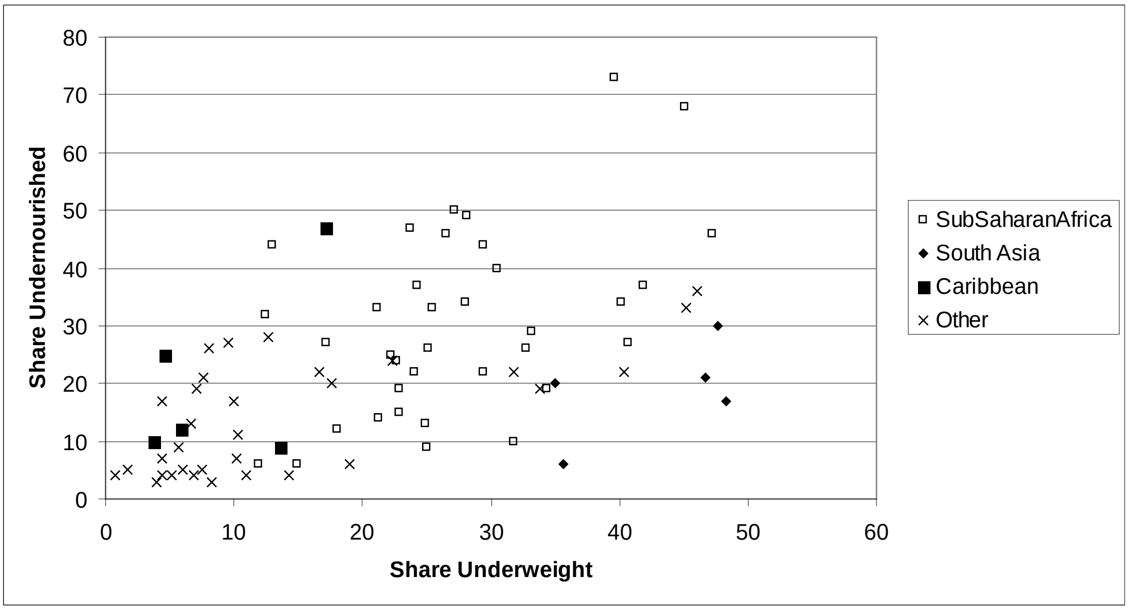
Wuehler, S.E., Peerson, J.M., Brown, K.H., 2005. Use of national food balance data to estimate the adequacy of zinc in national food supplies: Methodology and regional estimates. Public Health Nutrition 8, 812–819.

Figure 1: Sensitivity of FAO estimates with respect to the three key parameters (2005-2007)



Source: Own simulations based on FAO data.

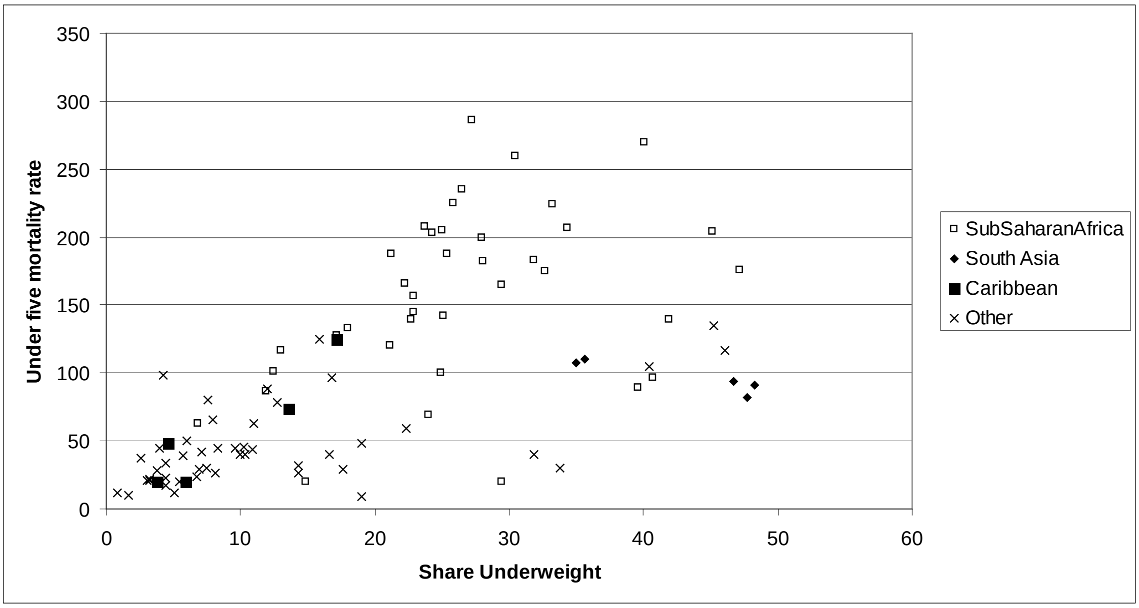
Figure 2: Undernourishment and childhood underweight rates (2000)



Note: The share of undernourished people is based on the FAO indicator, while the share of underweight refers to the share of children under five with a weight for age score of less than -2.

Source: Klasen (2008).

Figure 3: Childhood underweight and under-five mortality rates (2000)



Source: Klasen (2008).

Table 1: Comparative performance of the three approaches

Criterion	FAO approach	Consumption surveys	Anthropo-metry
Ability to draw a regular picture for global, regional, and national populations	++	–	+
Ability to draw a regular picture for special population groups at global level	–	–	++
Usefulness to assess inequality of food consumption within countries	– –	++	– –
Usefulness to assess consumption consistent with national supply and demand	++	–	– –
Accuracy in terms of measuring the adequacy of food intake	+	++	– –
Accuracy in terms of measuring and identifying determinants of nutritional status at a point in time	–	+	++
Accuracy in comparing nutritional status across space and over time	– –	+	?
Ability to assess dietary diversity and micronutrient status	– –	++	–
Ability to portray regional and socioeconomic heterogeneity within countries	– –	++	++
Ability to portray seasonal variation	– –	–	–
Ability to inform global governance	++	–	++
Usefulness to guide national policy decisions (e.g., targeting)	– –	+	++
Usefulness to simulate nutritional impacts of policies and shocks at country level	– –	++	–

Notes: + and – signs indicate whether or not the approach is suitable. Double signs indicate very suitable or very unsuitable.