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CAN FAO's MEASURE OF CHRONIC UNDERNOURISHMENT BE STRENGTHENED?

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with a **Response** by

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ABSTRACT

In its *Sixth World Food Survey* released at the 1996 World Food Summit, the Food and Agriculture Organization of the United Nations (FAO) reported that 841 million people in developing countries are chronically undernourished. This number and its country- and regional-level disaggregations have proved tremendously useful to countless aid agencies and researchers. In the context of a recent wave of new nationally-representative household food consumption and expenditure data, this paper examines the estimation methodology underlying this food insecurity indicator, which relies on national aggregate measures of food availability and distribution. The paper finds that the measure is methodologically biased toward national food availability and does not fully account for the effects of poverty—the most widespread cause of food insecurity in developing countries. The implications of this bias for use of the indicator in cross-country comparisons of food insecurity and for tracking changes in it over time are drawn out. The paper concludes by arguing that the time has come to review the potential for employing the new household survey data for strengthening the empirical foundations of the FAO's measure of chronic undernourishment.

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FOREWORD

The generation of credible estimates of the numbers of individuals that are food insecure is an extremely difficult business. Getting beyond definitional concepts related to food security is no mean feat, and then there comes the unenviable task of operationalizing that concept, usually with data wholly unsuited to the purpose. The only food availability data source to cover a large number of countries and years is FAO's Dietary Energy Supply (DES) and the closely related estimates of what FAO terms the "numbers of undernourished people" as reported in the *Sixth World Food Survey* in 1996. These estimates are based on food balance sheet data, not on household surveys.

The paper by Lisa Smith outlines some of the methodological compromises that one is forced into if one relies on food balance sheet data to get estimates of the number of people with inadequate food access. She points out that several new household expenditure survey data sets have become available in the past few years, and that perhaps the time is right for a new approach to estimating the number of people with inadequate food access—one that can use existing and future household expenditure surveys.

Logan Naiken's response to the paper by Smith agrees with the need to use household expenditure data to strengthen the estimates of the number of people with inadequate food access. He points out, however, that the conversion of food purchase and acquisition data into nutrient data is far from straightforward and will require strong partnerships between national and international organizations.

IFPRI and FAO are responding to this expressed need by developing a joint project to explore ways of establishing a Global Database on Food Consumption, somewhat similar to the Global Database on Child Growth and Malnutrition established by WHO.

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1. INTRODUCTION

As the world reinvigorates its efforts towards alleviating food insecurity in developing countries following the 1996 World Food Summit, the availability of an accurate national-level indicator of food insecurity that is comparable across countries has become more imperative than ever. Just as monitoring food insecurity within countries is fundamental for generating adequate information for program planning and policymaking for individual countries (Babu and Quinn 1994), monitoring food security at national, regional, and global levels is essential for such planning and policymaking across countries. National-level indicators of food insecurity are needed by multilateral and bilateral development organizations for identifying where food insecurity exists and is most severe and for tracking changes in it over time.

The most widely-employed indicator of food insecurity currently available for such purposes is a measure of chronic undernourishment developed by the Food and Agriculture Organization of the United Nations (FAO). The measure gives the number and proportion of people in each country who are consuming insufficient dietary energy to meet their requirements. Along with the Plan of Action for the World Food Summit, the FAO released its *Sixth World Food Survey (SWFS)* in which it employed the chronic undernourishment measure to estimate that 841 million people in developing countries were food insecure in the 1990/1992 period, down from 918 in 1969/71 (FAO 1996a). The 186 countries adopting the Plan of Action agreed to a goal of cutting in half the 1990/1992 baseline number by the year 2015 (FAO 1996c). The developing regions

identified as having the highest prevalences of chronic undernourishment were Sub-Saharan Africa (43 percent) and South Asia (22 percent).

In addition to serving as the baseline for the World Food Summit goal, the FAO measure has been employed by a wide variety of institutions for several purposes. It has been utilized for educational, advocacy, and awareness raising for issues of food insecurity and hunger, being cited frequently in widely-disseminated publications (e.g., Bread for the World 1997; Pinstrup-Andersen, Pandya-Lorch, and Rosegrant 1997; FAO 1996b; Mason 1995). It has also been used for projecting future food insecurity (Alexandratos 1995) and for food security policy analysis at country and regional levels (e.g., FAO 1996a, 1996e; UN ACC/SCN 1993; Wiebe 1998). The heightened focus on the indicator, due to its high visibility during and following the Summit, instigated a debate over its use as a food security indicator for cross-country allocation of international development resources (e.g., Ferris-Morris and Smith 1997).

These examples show, first, the large influence the FAO measure has on policymakers' understanding of where food insecurity exists and how it has changed over time. Second, they show the strong demand for and many uses of a national-level indicator of food insecurity.

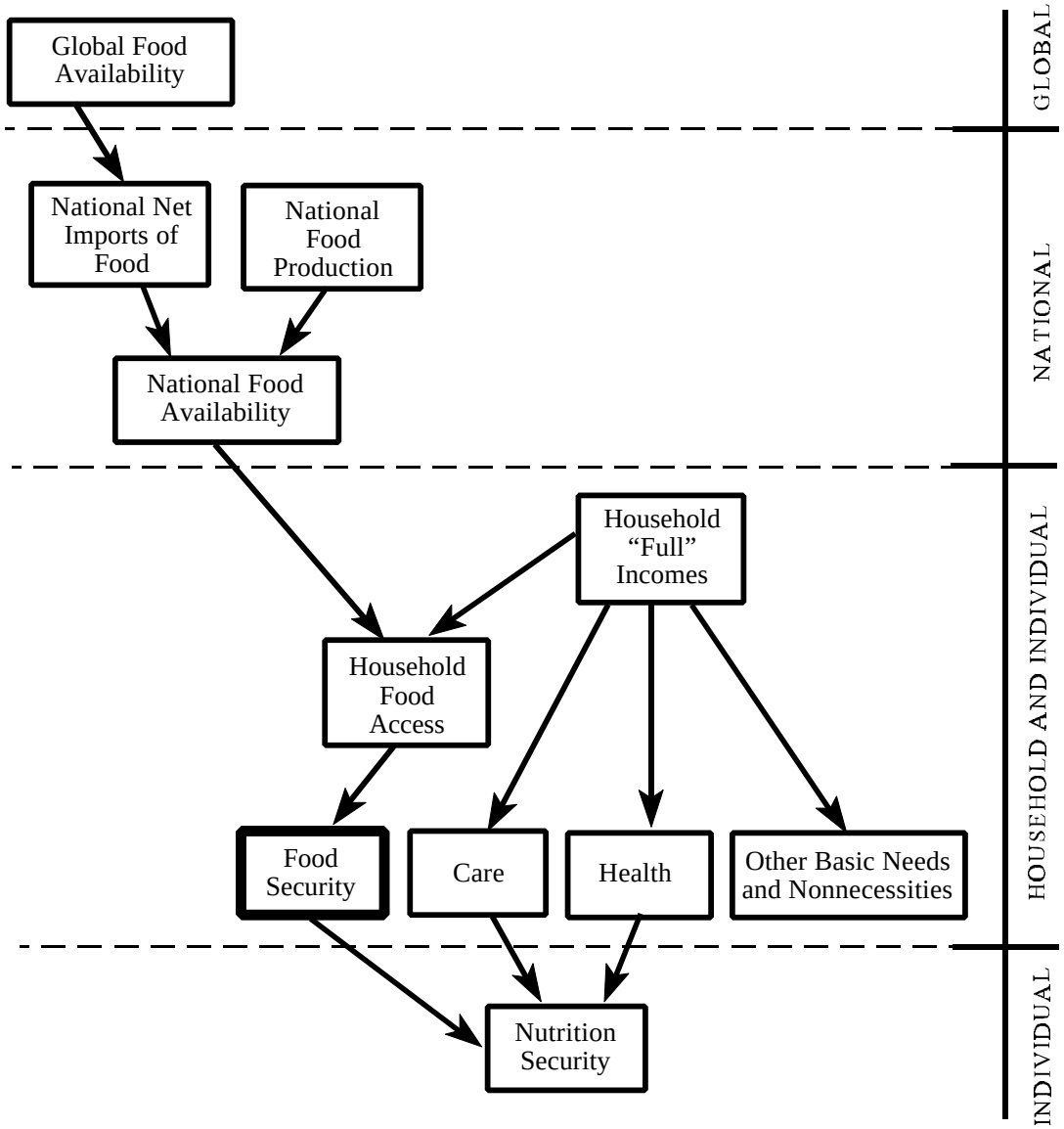
The aim of this paper is to examine the current methodology underlying the FAO measure of chronic undernourishment and to identify areas in which it can be strengthened. In the next section, a definition of food security is given. The two most basic causes of food insecurity—insufficient food available at a national level and household-level poverty—are discussed in the context of a conceptual framework linking global food availability with people's nutrition security. The section includes a brief

historical overview of shifts in the research and development communities' understanding of the causes of food insecurity. Section 3 presents the methodology underlying the FAO estimations. The implications of the measure's use for cross-country comparisons of food insecurity and for tracking changes in food insecurity over time are then discussed. The concluding section addresses areas in which, given a recent expansion of the availability of data on food consumption and expenditures from nationally-representative household surveys, the chronic undernourishment measure can be strengthened.

2. FOOD SECURITY, FOOD AVAILABILITY, AND ACCESS TO FOOD

Food security is defined as "access by all people at all times to enough food for an active, healthy life" (World Bank 1986). Ultimately, people are food secure when their consumption of food is sufficient, secure (they are not vulnerable to consumption shortfalls), and sustainable (D. Maxwell 1996). To aid in evaluating the FAO measure of chronic undernourishment, a simplified conceptual framework for food security is given in Figure 1.

Figure 1 Conceptual framework for food security from global food availability to people's nutrition security



Source: Adapted from UNICEF (1990) and Frankenberger et al. (1997).

Global food availability stands at the most macrolevel of the food security "equation." Enough food produced in the world, and enough food available in countries (through food production and imports) to feed all of their populations, are necessary conditions for achieving food security. At the time of the world's first global summits on food security, the World Food Conference of 1974, the world was in a "food crisis" marked by food shortages and rising grain prices. The conference focused on global and national food availability as the most immediate food security problems (FAO 1996d). Since this time, global food supplies have increased substantially, keeping pace with increases in population: global daily kilocalories available for human consumption per capita rose from 2,440 to 2,720 between 1970 and 1990 (FAO 1996a). Over this 20-year period, food availability at the national level improved for 62 out of 99 developing countries (FAO 1996a). While in 1970, 32 developing countries were dietary energy deficit, i.e., had dietary energy supplies (DES) that did not meet the aggregate energy needs of their populations; by 1990, the number had fallen to 26.[1]

As seen in Figure 1, while national food availability is a necessary condition for achieving food security, it is not sufficient. In addition, people must have enough income to be able to have access to available food while at the same time meeting their other basic needs. In particular, they must have sufficient “full incomes” that, in addition to cash income, include the value of goods produced (such as food) and services provided (such as child care) in households that do not enter the market, as well as in-kind transfers of goods and services. This full income factor is the main determinant of how aggregate

[1] A country is defined as dietary energy deficit when its per capita DES (see Appendix Table 5) is exceeded by its (average) per capita energy requirement. The concept of "dietary energy balance" is explained further in this paper.

food supplies are distributed among countries' populations. Access to food may be gained through (1) production or gathering of food by the household for its own members' consumption, (2) purchase of food on the market with cash income, and/or (3) receipt of in-kind transfers of food (whether from other private citizens, national or foreign governments, or international institutions) (Smith et al. 1998).[2]

Between the World Food Conference and the World Food Summit, it became clear that food insecurity can remain a problem even in countries where food availability is no longer a problem.[3] A broad consensus was reached that the cause of most peoples' food insecurity today is inadequate access to food by households, and by some people within them, due to poverty (S. Maxwell 1996; Serageldin 1995; Alexandratos 1995; von Braun et al. 1992; Foster 1992; Haddad et al. 1996b). Thus, for most countries with high food insecurity, the most "binding" constraint to improving food security is poverty rather than national food availability (Smith et al. 1998).

The problems of poverty and food access were thus an appropriate focal point at the World Food Summit, whose Plan of Action contained the following commitment: "We will implement policies aimed at eradicating poverty and inequality and improving physical and economic access by all, at all times, to sufficient, nutritionally adequate and safe food and its effective utilization" (FAO 1996c, 13).

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[2] As shown in Figure 1, a household's expenditures of its full income on food compete with its expenditures on other basic needs (e.g., child care, health, housing, and basic education) as well as nonnecessities. Because households may sacrifice their members' food security in order to meet such needs, they are an important part of the food security equation (Frankenberger 1996).

[3] This recognition was facilitated by the work of Amartya Sen (1981), who introduced an "entitlements" approach to food security.

The ultimate benefit of food in terms of human well-being is manifested in nutrition security, which stands at the most micro level of the food security equation. One widely available indicator of nutrition security is malnutrition, measured as the percent of underweight children under five years of age.[4] In the early 1990s, an estimated 78 percent of all developing country malnourished children under five (that is, 131 million out of 167 million) lived in countries with the highest prevalences of poverty and dietary energy *surpluses*, enough food at a national level available for everyone to meet their dietary energy needs for an active, healthy life (Smith et al. 1998). These statistics illustrate the relatively greater importance of poverty, as compared with national food availability, in influencing child malnutrition across developing countries in today's world.

In the analysis below, national child malnutrition prevalence will be employed as a proxy indicator of food insecurity for comparison with the FAO chronic undernourishment measure. In addition to food security, child malnutrition is determined by the quantity and quality of care for children, and by the quality of the health environment in which they live (see Figure 1).[5] These three factors may act independently and interact synergistically in influencing child malnutrition (Haddad et al. 1996a). Thus, child malnutrition can only serve as proxy indicator of food insecurity when accompanied by information about care

[4] A child under five is defined to be underweight if her/his weight divided by age falls greater than two standard deviations below the National Center for Health Statistics/World Health Organization median reference value.

[5] "Care" is defined as the "provision in the household and the community of time, attention, and support to meet the physical, mental, and social needs of the growing child and other household members (ICN 1992). Examples of caregiving behaviors are feeding (including breast-feeding), psychosocial and cognitive stimulation, hygiene practices, home health practices, and food preparation and storage (Engle, Menon, and Haddad 1997). Poor health affects nutrition security by depressing appetite, inhibiting the absorption of the nutrients in food, and competing for energy (leaving less energy and nutrients available for growth and weight maintenance) while a child is fighting off and recovering from illness (Ramalingaswami, Jonsson, and Rohde 1996).

and health (Maxwell and Frankenberger 1992). The health environment indicator that will be utilized for this purpose is a combined measure of people's access to health care, sanitation, and safe water. The indicator of the quality of care for children that will be utilized is a ranking of the developing countries on the basis of three variables believed to have a positive influence on care (Engle, Menon, and Haddad 1997): women's education, women's status, and breast-feeding duration. The ranking is from 1 to 91, with a higher ranking indicating better quality care.[6] These indicators, while not the focus of this paper, aid in evaluating the FAO measure.

3. THE 841 MILLION CHRONICALLY UNDERNOURISHED: HOW WAS IT CALCULATED?

The FAO chronic undernourishment measure endeavors to capture the proportion and number of people in each developing country "whose food access is deemed to be inadequate" (FAO 1996a, 33). In doing so, an attempt is made to go beyond national food availabilities to take into account the *distribution* of food within the countries as well. The measure is thus intended to reflect the role of both aggregate food supplies and household incomes in determining food insecurity. In the *SWFS*, estimates are given for three periods, 1969/71, 1979/81, and 1990/92 for 99 developing countries. They are based on three statistics:

[6] The health environment index is an average of three variables: percent of population with access to health care, with access to sanitation, and with access to safe water. The data are from UNDP (1993, Table 12). The country care rankings are an average of their rankings for the following three statistics: (1) gross female primary school enrollments in 1990 (or nearest available date not more than two years away), from UNESCO (1997, Table 3.2); (2) a ratio of female to male life expectancy at birth in 1990, from the World Bank (1997) (a proxy for women's status); and (3) the percent of mothers breast-feeding at six months in 1980-1992, from UNDP (1996, Table 11). Averages for groups of countries are reported as population-weighted means.

1. **Daily per capita dietary energy supply (DES)**: the energy (in kilocalories) available for human consumption per day from the food supply, divided by the population.

   DES is a measure of national food availability. It is calculated from FAO food balance sheets for each country, using food production and trade data. Taking into account use of food for seed, wastage of food, stock changes, and food utilized for animal consumption, the total amount of each food commodity available for human consumption each year is calculated. Per capita DES is then derived by adding up the commodities and dividing this number by the total population. For the 1990/92 period, the estimated developing country per capita DESs range from 1,590 (for Somalia) to 3,510 (for Turkey) (see Appendix Table 5, column [4]).

2. **Coefficient of variation (CV) in dietary energy intakes**: an estimate of the variability in dietary energy intake across a country's population.

   The CV is a measure of the *distribution* of dietary energy intake within a country. It is a summary measure of inequality in the distribution of total energy available, equal to the standard deviation of each country's dietary intakes divided by its mean. For 18 out of the 99 countries, the estimated CVs are based on nationally representative household food consumption or expenditures surveys. The rest of the countries' CVs are projected from measures of income (or total expenditure) distribution or set equal to the regional mean CV estimated for the other countries.

3. **Minimum daily per capita dietary energy requirement (DER)**: a cutoff point below which the average person in the country would not be meeting his or her minimum daily dietary energy requirements.

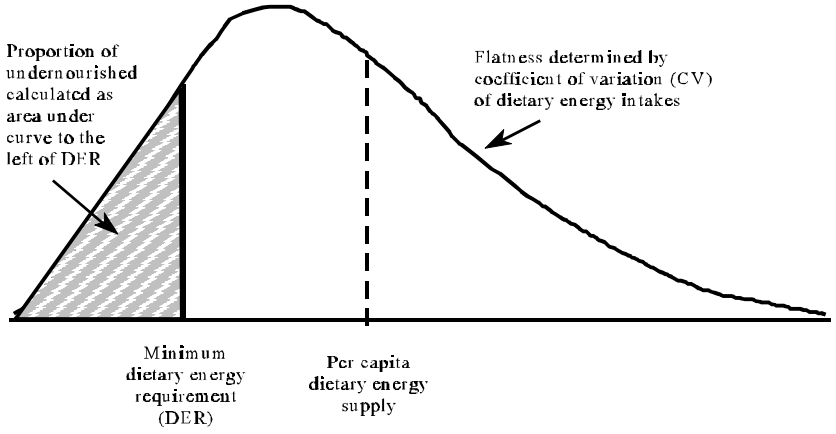
The minimum per capita daily DER for each country is calculated in two steps. The first is to determine the minimum energy needs of age- and sex-differentiated demographic groups. These needs are based on body weights and activity levels consistent with the energy intake needed to maintain body weight and to support light activity.[7] The second is to aggregate the energy requirements to arrive at the "typical" person's energy requirement through a population-weighted average of the age-sex groups' requirements. The smallest regional average DER employed in the *SWFS* is 1,790 kilocalories (kcals) per capita per day (for South Asia); the highest is 1,880 (for East and Southeast Asia).

It is assumed that the distribution of dietary energy intakes within each country can be described by a log-Normal probability distribution (Figure 2). Given a DER cutoff, such a distribution relies on the mean—estimated as the daily per capita DES—and CV of dietary energy intake to give a probability that the "average" person in the country will fall below the DER cutoff. This probability is then used as the percentage of chronically undernourished (see Appendix for a mathematical derivation). The number of undernourished in each country is calculated using the total population size.

[7] For adults and adolescents, the minimum of a range of DERs for each age-sex group was employed. For children (under ten-year-olds), the median was employed. A special allowance was made for the additional energy needs of pregnant and lactating women and physical growth in children (FAO 1996a).

Two key further assumptions underlie the methodology. The first is that an appropriate range for the CVs is 0.2 (relatively equal distribution) to 0.35 (relative unequal). Thus, any country for whom an estimated CV falls outside of this interval is assigned the closest endpoint of the allowable range. The second is that the CVs do not change over time. Thus the same CVs are employed for all three estimation periods.

Figure 2 Log-normal distribution of dietary energy intakes employed for estimating country-level chronic undernourishment prevalences



Columns (1) and (2) of Appendix Table 5 report the resulting estimates for each developing country for the 1990/92 period. South Korea had the lowest estimated prevalence of chronic undernourishment (1 percent), while Afghanistan had the highest (73 percent). Estimates of the prevalence of chronic undernourishment and numbers of chronically undernourished by region and for the developing countries as a whole for the three periods covered are given in Table 1.

The chronic undernourishment measure has been criticized on a number of grounds. First, the accuracy of its three components, dietary energy supplies (Svedberg 1990; FAO 1983; Gibson 1990), coefficient of variation of dietary energy intakes, and minimum dietary energy requirements (Svedberg 1990; Waterlow 1989), has been

Table 1 FAO estimates of prevalence of chronic undernourishment and numbers of chronically undernourished in developing country regions (1969/71 1990/92, percent)

Country region	1969/71		1979/81		1990/92	
	N	Percent	N	Percent	N	Percent
Sub-Saharan Africa	103	38	148	41	215	43
South Asia	238	33	303	34	255	22
East and Southeast Asia	476	41	379	27	269	16
Latin America and the Caribbean	53	19	48	14	64	15
Near East/North Africa	48	27	27	12	37	12
Total	918	35	906	28	**841**	**20**

Source: FAO (1996a, Table 14).

questioned. Concerns regarding the latter two components are addressed at length by the FAO in the *SWFS.*

Second, the inappropriateness of the indicator as a measure of food insecurity has been emphasized on the grounds that it disregards (1) protein and micronutrient consumption, (2) intra- and inter-seasonal fluctuations in food availability and access, and (3) those who are at risk of becoming dietary energy deficient in the future—i.e., whose caloric intake is *sufficient* but not *secure* (von Braun et al. 1992). This second set of concerns would face any cross-sectional, calorie-based, national-level indicator of food insecurity.

This paper emphasizes concerns in a third area: the validity of the methodology employed in calculating the chronic undernourishment measure, including the simplifying assumptions invoked. Specifically, do the methodology and assumptions represent a valid

procedure for estimating how many people consume insufficient dietary energy and for tracking how it changes over time?

4. WHAT IS THE CHRONIC UNDERNOURISHMENT MEASURE REALLY MEASURING?

Of the two parameters of the log-Normal distribution used to identify the prevalence of chronic undernourishment, it is the CV that distinguishes the FAO measure from a simple measure of national food availability. However, in effect, the CVs themselves make little difference in comparison to the DES to the calculated prevalences of undernourishment. In an effort to avert concerns over measurement errors plaguing the CV estimates, the *SWFS* makes this clear in the form of a sensitivity analysis. The *SWFS* analysis is based on 16 "hypothetical" country cases, each with a differing per capita DES and CV. The results are reproduced in Table 2.

The rows give the percent undernourished at four different CVs, starting at the minimum allowable of 0.2 and increasing by 20 percent increments until it reaches 0.35. The columns of the table give the percent undernourished at four different levels of per capita DES, starting from 1,700 and then increasing by 20 percent at each increment. Moving from a CV of 0.2 to 0.35, the percent undernourished varies relatively little for all levels of per capita DES. It is practically insensitive to changes in the CV at the lowest DES level. At the highest, it varies by only 10 percentage points. In contrast,

Table 2 Percent undernourished at different levels of per capita dietary energy supply (DES) and coefficient of variation of dietary energy intakes (CV)

Per capita dietary energy supply	Coefficient of variation of dietary energy intakes			
	0.2	0.24	0.29	0.35
1,700	65	64	63	63
2,040	30	34	38	42
2,450	7	12	17	23
2,940	1	2	6	10

Source: FAO (1996a, Table 13).

Note: The minimum dietary energy requirement is assumed to be 1,800 kcals per capita per day.

moving down the rows from a per capita DES of 1,700 to 2,940, the estimated percent undernourished increases dramatically for all CV levels, the smallest interval (at a CV of 0.35) being 53 percentage points. Overall, the sensitivity of the undernourishment measure to the DES is always greater than it is to the CV, even when the effect of the CV is at its maximum (at about 2,500 kcals). In the *SWFS*, it is concluded that "Given a cutoff point, therefore, the most important determining factor in the general level of food inadequacy[8] is the per caput DES" (FAO 1996a, 43).

It is clear that, while the chronic undernourishment measure takes into account both determinants of food insecurity, aggregate food supply and household incomes (as reflected in distribution), most of the variation across countries is being driven by the former. Accordingly, a strong statistical association exists between the prevalences of chronic undernourishment and the per capita DESs used to estimate them, as can be seen

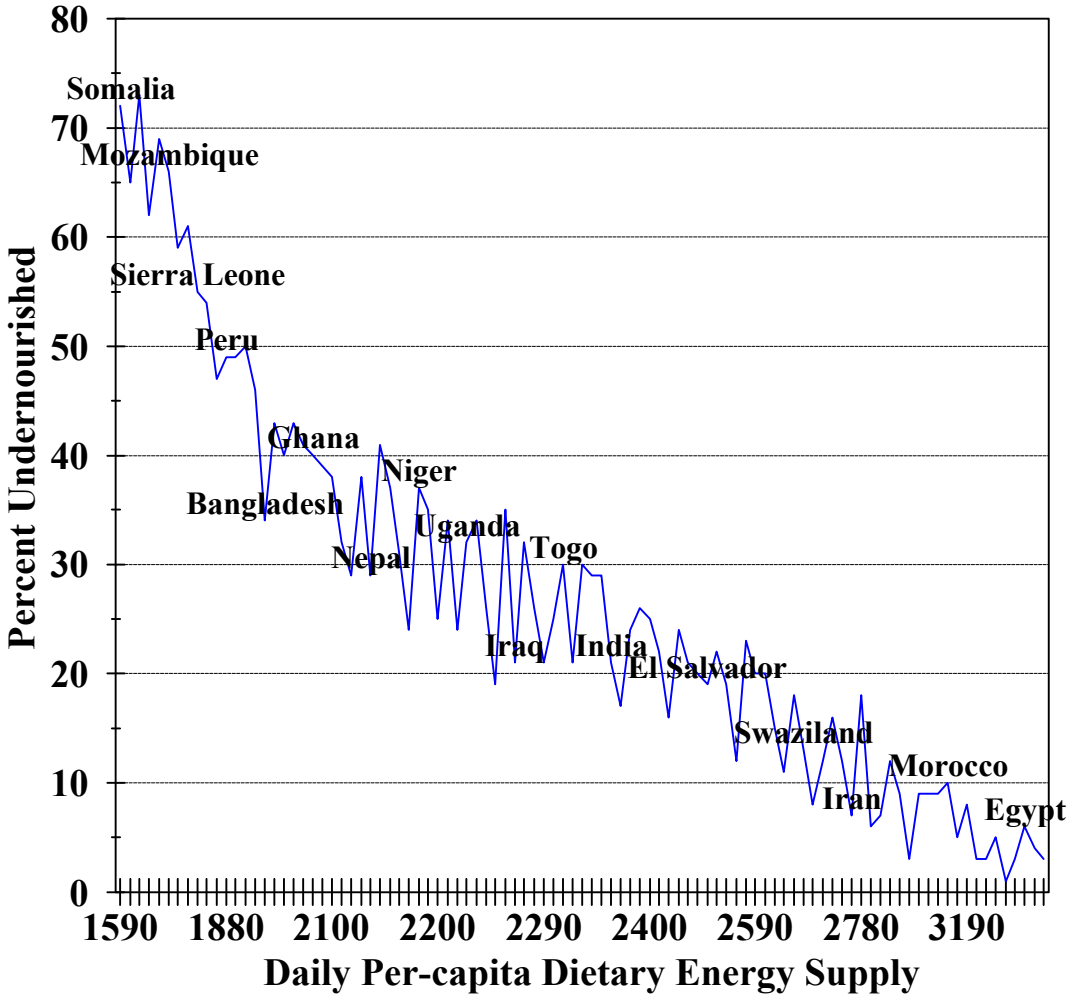
[8] "Food inadequacy" refers here to the total additional amount of dietary energy needed for those people who are currently undernourished to meet their requirements.

graphically for 1990/92 levels in Figure 3. In fact, an almost perfect and highly significant correlation exists between these two variables, their Pearson correlation coefficient being 0.91 ($p < .001$).

The relative insensitivity of the FAO measure to the estimated CVs may emanate from three possible sources. The first possibility is that the distribution of available dietary energy is, in actuality, a minor factor in undernourishment in developing countries compared to overall food availability. As discussed above, conventional wisdom is that (at least since the early 1980s) people's food security is determined primarily by their ability to acquire food, whether through cash income, exchange, growing it themselves, or receiving it in kind, rather than the overall quantity of food available in a country. However, the relative importance of the two factors has yet to be examined empirically in cross-country analysis.

The second possible source is that the CVs themselves are assumed to fall within a range that is smaller than the actual range. The rationale for the 0.2–0.35 range (from FAO [1975]) is as follows. The CV (standard deviation [SD] divided by the mean) range for developing countries is assumed to be the same as that of a "hypothetical population composed of adequately fed individuals" (FAO 1996a, 139). The SD of dietary energy intakes is therefore assumed to follow that of the intake *requirement* distribution of such a hypothetical population, giving an SD of 660 kcals. The upper and lower limits to the

Figure 3 Comparison of FAO chronic undernourishment prevalence estimates with per capita dietary energy supply (1990/92)



Source: Appendix Table 5 columns (1) and (4).

CV range are calculated by dividing this number by the approximate highest (1,900) and lowest (3,400) developing country per capita DESs (for the 1990/92 period) (see FAO 1996a Appendix 3, p. 139, footnote 5), leading thus to the approximate maximum and minimum CVs.

While data on true CVs of dietary intakes in developing countries are not readily available for verification purposes, the assumption of a 0.2-0.35 CV range can be questioned on both logical and empirical grounds. From a logical standpoint, the true variability of dietary intakes found in developing countries (which contains many people falling below their energy requirements) is likely to be higher than that of a population of adequately fed individuals. Analysis of variance data from five International Food Policy Research Institute household food consumption surveys (for Bangladesh, Kenya, Pakistan, the Philippines, and Zambia) presented in the *SWFS* (FAO 1996a, Appendix 3, Table 4) gives further insight. The analysis shows that the CVs indeed fall closely into the assumed range. However, the surveys analyzed are all subnational (from predominantly rural and homogeneous samples), focusing on fairly small proportions of each countries' population.[9] Thus, the national CVs for the countries are likely to be higher than those reported.

The third possible source of the undernourishment measure's relative insensitivity to the estimated CVs is that it is a product of the functional form chosen for the probability distribution, the log-Normal. The sensitivity analysis of Table 2 is based entirely on the assumption of a log-Normal distribution of dietary energy intakes. It is only to the extent

[9] The Bangladesh survey covers eight villages in Comilla, Pabna, Khustia, and Jessore; the Kenya survey covers Nyanza; the Pakistan survey covers the districts of Attock and Faisalabad, Dir, Badin, and Mastung; the Philippines survey covers Bukidnon Province; and the Zambia survey covers Eastern Province.

that this distribution represents the true distribution in any particular country that actual undernourishment prevalences will exhibit the same sensitivity.

The above concerns are focused on cross-country variations in undernourishment. With respect to variations over time, since countries' CVs are assumed to be temporally constant, all estimated changes in chronic undernourishment reflect changes in national food availability only. While no data on changes in the distribution of food consumption over time are available, recent studies of changes in income distribution over the last 30 years suggest that country-level distributional measures are not time-invariant (Deininger and Squire 1996).

5. IMPLICATIONS

This section presents further empirical arguments supporting a methodologically-induced bias towards national food availability in the chronic undernourishment measure by comparing it with other measures. It draws out the consequences of the bias for the measure's use in identifying where food insecurity exists and in tracking how it changes over time.

CROSS-COUNTRY AND REGIONAL COMPARISONS OF FOOD INSECURITY

Development agencies that have an international focus need information about where food insecurity exists and is most severe in order to most effectively allocate their

resource investments towards improving food security. Comparisons of the levels of food insecurity across countries and regions are also used for coordinating interventions across development institutions for an optimal use of international resources. To the extent that the resulting interventions are effective, the accuracy of the indicators used for making these decisions has a major influence on the prospects for improving food security.

Given a methodological bias in favor of food availability, comparisons of the food security situations of different countries using the chronic undernourishment measure will largely reflect differences in their dietary energy supplies. This means that countries in which food availability is a major food security problem will appear to have higher rates of chronic undernourishment than those in which poverty is the main problem but food supplies are adequate to meet people's needs.

A comparison between the estimated chronic undernourishment rates and food security situations of India and Ghana, as described by alternate data, illustrates this point (Table 3). India, with a per capita DES of 2,330 and a minimum DER of approximately 1,790 (2,110 for healthy and active individuals), has a dietary energy *surplus*.[10] As

[10] The dietary energy requirements cited are regional averages reported in FAO (1996a, Table 16).

Table 3 Comparison of food and nutrition security indicators for India and Ghana

Indicators	India	Ghana
Percent chronic undernourishment (*SWFS* method) (percent)	21	40
Daily per capita dietary energy supply (kcals)	2,330	2,090
Percent children under five underweight (percent)	53	27
Percent adults undernourished (BMI≤18.49) (percent)	49	20
Poverty rate (PPP)[a] (percent)	53	31

Sources: The first three indicators are from Appendix Table 5, columns (2), (3), and (4). The body mass index (BMI) measure is from FAO (1996a, Table 25). The poverty data are from the World Bank (1997, Table 2.5).

[a] Purchasing power parity-adjusted dollars for international comparability.

estimated using the *SWFS* methodology, it has a relatively low chronic undernourishment prevalence of 21 percent. Yet in the early 1990s, India's prevalences of child malnutrition (53 percent) and adult undernutrition (49 percent)[11] were among the highest in the world. Over half (53 percent) of all people in India are estimated to have real incomes of less than one dollar per day, leaving them without the resources to be able to purchase a nutritionally adequate diet year round. Despite its "embarrassment of food" in recent years (Punjab 1995), India has a serious food insecurity problem, mainly caused by its high poverty (Suryanarayana 1997).

Ghana's relatively low per capita DES of 2,090 (its per capita DER is about 1,800) corresponds to a prevalence of chronic undernourishment almost double that of India's, at

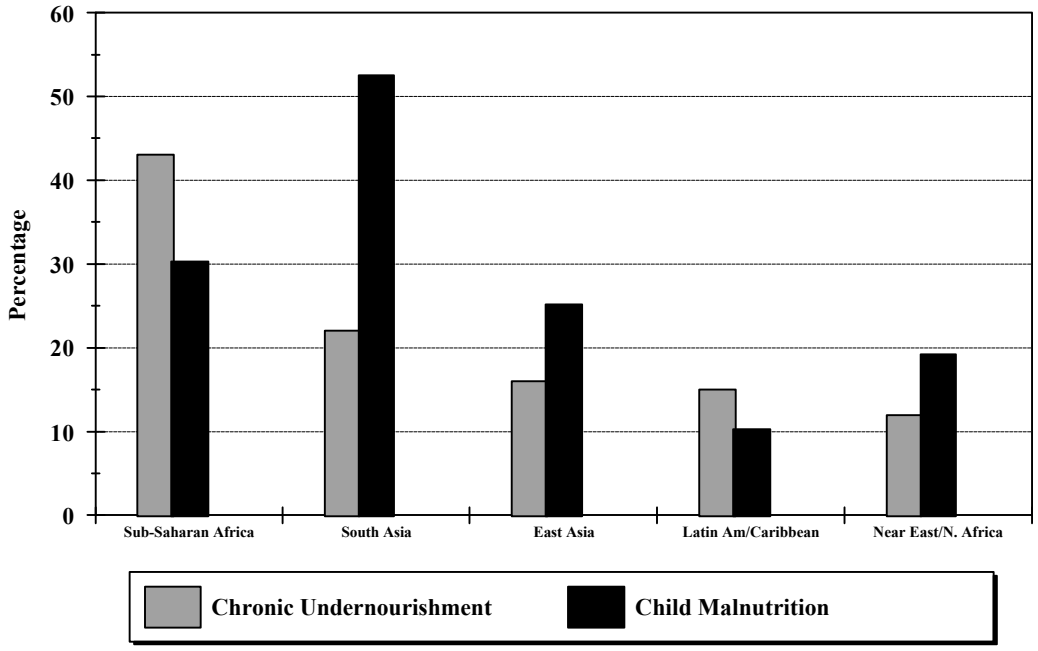
[11] The adult undernutrition data in Table 3 are calculated from FAO (1996a, Table 25) and are the percentage of adults with body mass indexes (BMI) less than or equal to 18.49, which is the cutoff below which a person is considered to be at high risk of chronic nutritional deficiency (principally, chronic energy deficiency).

40 percent. Yet by other measures, Ghana's food insecurity problem, while grave, is not nearly as severe as India's: Ghana's child malnutrition rate is 27 percent, its adult undernutrition rate is 20 percent, and its poverty rate is 31 percent[12] (see Table 3).

The general principle holds for regional comparisons as well. Figure 4 gives a breakdown of chronic undernourishment and child malnutrition prevalences by developing country region for the 1990/92 period. The estimated prevalence of chronic undernourishment for Sub-Saharan Africa (43 percent) is almost double that of South Asia (22 percent). Sub-Saharan Africa and South Asia have about the same poverty prevalences overall, at 39 percent and 43 percent, respectively (Ravallion and Chen 1996), which means that low incomes are likely a major factor in their food insecurity. Yet almost half of Sub-Saharan African countries have food availability problems (18 out of 40 had dietary energy deficits in the 1990-92 period), while most South Asian countries do not (only Bangladesh had a dietary energy deficit). Therefore, a methodological bias in favor of food availability likely understates the South Asian

[12] Note that the state of India's health environment and quality of care for children are probably partially responsible for its higher malnutrition rate than Ghana's. The percentage of people in India with access to a proper health environment is 44. For Ghana, the percentage is 54. Ghana's care ranking, at 59, is far higher than India's, which is 7.

Figure 4 Estimated prevalences of chronic undernourishment and child malnutrition by region (1990/92)



Source: Calculated from columns (1) and (3) of Appendix Table 5. Regional prevalences are calculated from population-weighted country prevalences.

prevalence and overstates the relative differences in food insecurity between the two regions.[13]

Note that the prevalence of child malnutrition in South Asia (53 percent) is almost double that of Sub-Saharan Africa (30 percent). In the *SWFS*, this reversal of the regional prevalences in comparison to the chronic undernourishment measure is explained by South Asia's high population density and monsoon climate, which make the spread of disease easier than in Sub-Saharan Africa (FAO 1996a). Ramalingaswami, Jonsson, and Rohde

[13] The relative differences could also be overstated due to systematic underestimations of food availability in Sub-Saharan Africa (Svedberg 1990).

(1996), by contrast, purport that South Asia's extremely high malnutrition rates compared to Sub-Saharan Africa are due to its poor disease environment and inadequate caring practices *in addition* to the critical food insecurity problems both regions share. Note that the regional percentages of people with access to a proper health environment are 46 percent for South Asia and 42 percent for Sub-Saharan Africa. The regional (country average) care ranks are 8 and 37, respectively.

A study by Broca and Oram (1991) provides an independent estimate of the regional differences in chronic undernourishment.[14] The authors utilize household survey-based data on food consumption and expenditures to estimate the prevalences of "food energy deficiency" in several developing country regions. They find that the prevalence in Sub-Saharan Africa (38 percent) is almost equal to that of the Asia region as a whole (35 percent). Since South Asia has a much higher poverty rate than does East Asia (South Asia's is 43 percent, while East Asia's is 26 percent),[15] we would expect that South Asia's undernourishment prevalence is much higher than the overall Asia average. The Broca and Oram results suggest that, contrary to the conclusion reached using the chronic undernourishment estimates, the undernourishment prevalence in South Asia may be on par with or higher than that of Sub-Saharan Africa.

TRACKING CHANGES IN FOOD INSECURITY OVER TIME

[14] Note that most of the data for this study are from rural areas and are not taken from nationally-representative surveys. The estimates of the differences in energy deficiency between regions are nevertheless informative.

[15] The poverty rates are for 1993 and are given for a dollar-a-day cutoff head-count measure, using 1985 purchasing power parity international dollars. Note that Sub-Saharan Africa's poverty rate is reported as 39.1 (Ravallion and Chen 1996, Table 5).

Information about changes in food insecurity in countries over time is used to trace progress towards national, regional and global food security goals. It can be used to make decisions about whether to change approaches or strengthen efforts if the desired progress is not being made and to reallocate scarce resources elsewhere if the goal is achieved. It can also be employed to foster accountability to goals. As in the case of cross-country comparisons, the accuracy of the measures used for these purposes is critical to the success of efforts to improve food security.

The FAO reports a reduction in the prevalence of chronic undernourishment over the 1969/71 to 1990/92 period, from 35 percent to 20 percent. The corresponding numbers of chronically undernourished fall by 9 percent, from 918 to 841 (see Table 1). As noted above, due to the assumption of a constant CV of dietary energy intakes, all of the estimated reduction is based on improvements in food availability over the 20-year period. However, in countries in which poverty is the most binding constraint to food security, if an increase in food availability is not accompanied by an increase in the real incomes of the food insecure (or reductions in prices of the food they purchase), no increase in their dietary energy intakes will take place.

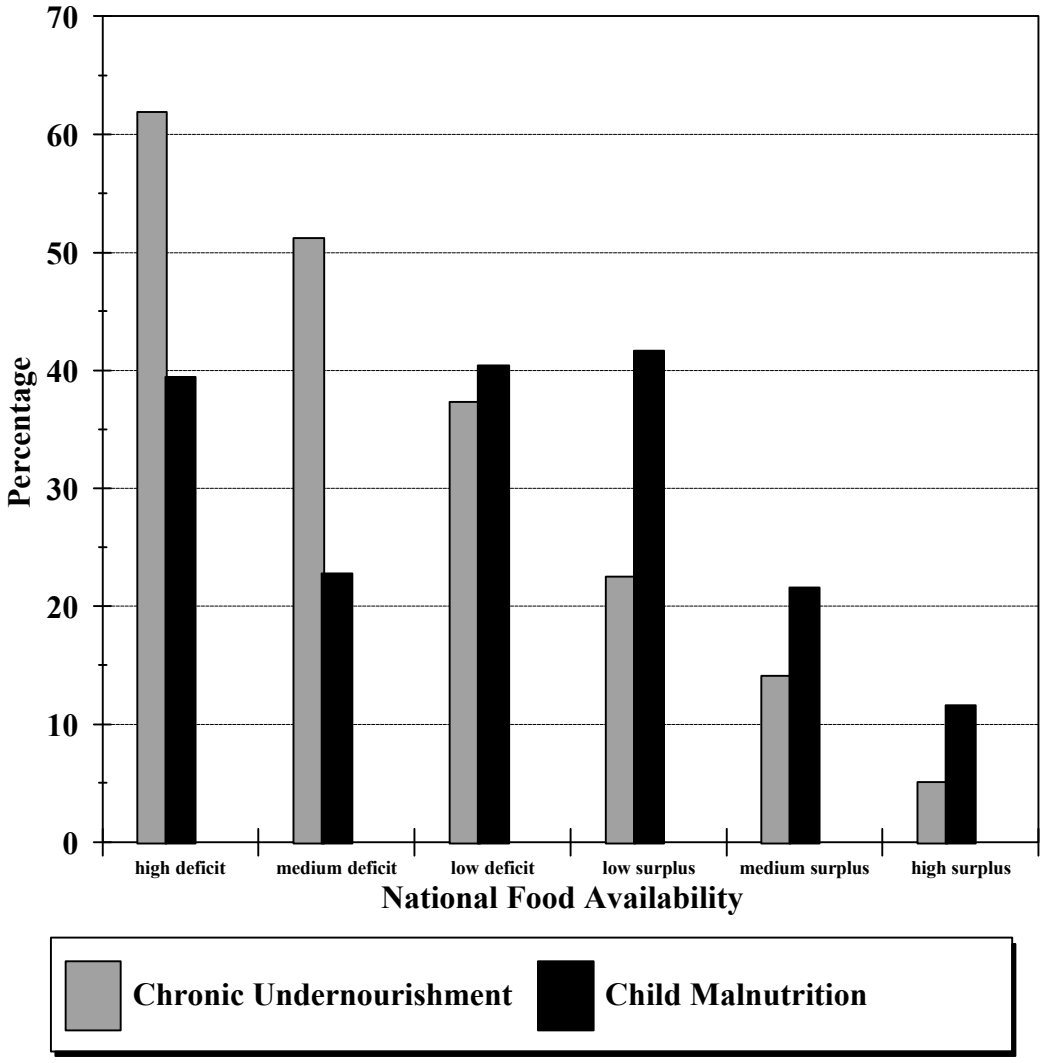
Yet the methodology underlying the chronic undernourishment measure is based on an implicit assumption that increases in per capita DES *always* lead to improvements in chronic undernourishment.[16] This feature is illustrated in Figure 5. In the figure,

[16] There are three countries for whom per capita DES increased between the 1969/71 and 1990/92 FAO calculations, yet the estimated percentage chronic undernourishment increased rather than decreased: Vietnam, Jamaica, and Guyana. Since the methodology itself precludes such increases, they can presumably be attributed to one of several changes instigated between the studies. The changes from the *Fifth World Food Survey (FWFS)* to the *SWFS* are listed in FAO 1996a, Appendix 3, Table 5. In the *FWFS*, the CVs were not restricted to the .2 to .35 range and were not adjusted to remove the effect of short-term random and seasonal variations as in the *SWFS*. There are several differences in the DER calculations between the two surveys as well.

developing countries are divided into six groups based on the sufficiency of their DESs for meeting the needs of their populations in the 1990/92 period, or the "dietary energy balance." A country is classified "dietary energy surplus" if its per capita DES is sufficient to meet its per capita DER. Otherwise, it is classified "dietary energy deficit".[17] Moving from left to right, the figure shows how the estimate of chronic undernourishment prevalence changes as the dietary energy balance ranges across the six categories from "high deficit" through "high surplus." Prevalences of child malnutrition are also given for comparison. As expected, Figure 5 shows a continual downward trend in the estimated prevalence of chronic undernourishment as countries' food availability positions improve.

[17] Dietary energy balance is defined to be per capita DES minus per capita DER. The *average* rather than the *minimum* energy requirement is used. The former corresponds to a body mass index observed among healthy, active people, while the latter corresponds to the energy required for weight maintenance and light activity, i.e., survival (FAO 1996a, Table 16). Column (5) of Appendix Table 5 gives the balances for each developing country.

Figure 5 Estimated prevalences of chronic undernourishment and child malnutrition by dietary energy balance country groupings (1990/92)



Source: Calculated from columns (1) and (3) of Appendix Table 5. Group prevalences are calculated from population-weighted country prevalences.

The same close inverse relationship between national food availability and prevalences of child malnutrition, the latter estimated from household survey data, is not apparent. The probability that a child will suffer from malnutrition is about the same in countries with low dietary energy surpluses as it is in those with high deficits. Similarly, countries with medium dietary energy deficits show a tendency to have about the same child malnutrition rates as do those with medium surpluses. Note that health environment quality improves continuously over the six groups (the access rates are 30, 47, 49, 50, 79, and 85 percent, respectively), indicating that the child malnutrition differences across them are not driven primarily by variations in their health environments. Care rankings across the groups are negatively correlated with their malnutrition prevalences (the group average rankings are 24, 50, 42, 22, 45, and 58, respectively), however. This suggests that, in addition to food insecurity, care factors may be partially responsible for the differences in the groups' child malnutrition rates.

Mauritania is an example of a country in which there is a weak link between child malnutrition and national food availabilities. Even though its per capita DES increased from 2,160 to 2,557 kcals from 1981 to 1991—improving national food availability by almost 20 percent, the prevalence of child malnutrition increased from 31 percent to 48 percent over this same period (FAO 1996a, Table 22 and Appendix 2, Table 1). Table 4 lists several additional countries for which children's malnutrition has worsened at the same time that national food availability has improved in the last two decades.

Table 4 Countries in which children's malnutrition has worsened at the same time as national food availability has improved

Country	Period	Percent increase in per capita dietary energy supply	Percent increase in the prevalence of child malnutrition (weight-for-age)
		(percent)	(percent)
Mauritania	1981–91	18.4	53.6
Nigeria	1990–93	14.0	10.8
Ghana	1987–93	10.0	0.7
Algeria	1987–95	8.4	40.7
Mexico (rural)	1974–89	8.3	9.2
Malaysia	1986–93	7.8	36.3
Philippines	1987–92	5.5	1.5
Lesotho	1976–94	4.3	23.7
Bolivia	1989–93	4.0	12.9
Myanmar	1983–95	3.8	12.9
Bangladesh	1982–85	3.7	4.3
Egypt	1990–94	3.5	61.5
Mali	1987–95	2.3	30.7
Jamaica	1989–93	2.2	41.7
Sri Lanka	1987–93	2.0	1.1
Honduras	1991–93	1.5	1.7
Uganda	1988–95	0.7	10.9

Sources: For Mauritania and Malaysia, the child malnutrition data are from FAO (1996a, Table 22); the rest of the countries' child malnutrition data are from WHO (1997). The per capita dietary energy supply data are from the FAOSTAT Database.

Overall, the analysis in Figure 5 and these country examples suggest that food availability is not the only force driving changes in food insecurity over time. Relying on it alone as a predictor will produce inaccurate estimates of these changes.

6. CONCLUSION: HOW CAN THE CHRONIC UNDERNOURISHMENT MEASURE BE STRENGTHENED?

In recognition of the need for food security indicators that are comparable across countries, the World Food Summit Plan of Action states that "To improve subregional, regional and international cooperation and to mobilize, and optimize use of, available resources to support national efforts for the earliest possible achievement of sustainable world food security," governments and international institutions will "encourage relevant agencies within the UN system to initiate . . . consultations on the further elaboration and definition of a food insecurity and vulnerability information and mapping system . . ." (FAO 1996c, 39). For such a system to contribute most effectively to improvements in food security, it is imperative that, in addition to measures of its main determinants (national food availability and household incomes) and its consequence (malnutrition), an accurate national-level measure of food insecurity be included.

Due to past data limitations, the chronic undernourishment measure employed in the *Sixth World Food Survey* is based on national aggregate measures of food availability and distribution rather than directly on household survey data. This paper has found that, due to the methodology employed in its estimation, the measure is biased toward national food availability and does not adequately capture the influence of poverty on food insecurity.

The chronic undernourishment measure has been extremely valuable in focusing the world's attention on the issue of food insecurity in developing countries. It has helped to establish that there are indeed large numbers of food-insecure people in the world. It has also been useful for focusing governments' and other international development actors' attentions on a numerical goal and generating the political will to attain it as part of the

World Food Summit agenda. However, the measure has its limits. These limits become harder to ignore with the increasing numbers of nationally representative household food consumption and expenditures surveys that have become available in the past few years (FAO 1986, 1988, 1993a, 1993b).

In order to be a useful component of a global food insecurity and vulnerability mapping system, two steps can be taken to strengthen it. First, chronic undernourishment prevalences can be estimated directly from currently existing household survey data. Second, the new data, along with a plethora of national-level data sets containing socioeconomic and demographic data for developing countries can be used, employing appropriate extrapolation techniques, to estimate undernourishment prevalences for countries for which data are not available. The assumption of an analytic probability distribution with a predetermined shape common to all countries can be dropped and replaced with that of country-specific, empirically-derived distributions. In the estimation of these distributions, a wide variety of factors affecting food insecurity, in addition to dietary energy supplies, can be taken into account.

As the lead actor within the United Nations system for the development of a food insecurity and vulnerability mapping system, it will require FAO's leadership for such a change in methodology to take place. Ultimately, an effort should be made to periodically collect food consumption data for every developing country, as is done for most developed countries. In this way, changes in food insecurity over time, including progress toward the World Food Summit goal, can be tracked. While such surveys are costly, investment in them is critical for developing an accurate information base from which to make informed decisions for improving food security.

RESPONSE

by Logan Naiken[18]

The paper by Lisa Smith reviews the methodology underlying FAO's estimates of the number of undernourished in the developing countries presented in The Sixth World Food Survey and highlights some of the associated problems, particularly in the context of monitoring food insecurity at the country level. It finds that because of a "bias" in the FAO methodology towards food availability, as reflected by the per caput dietary energy supply (DES), the resulting estimate does not adequately reflect the effect of poverty, which is the primary cause of food insecurity in developing countries. In view of this, the paper emphasizes the need to improve the methodology by relying as far as possible on data referring to the distribution of food consumption potentially available in the nationally representative surveys investigating on household consumer expenditures—generally called as household income/expenditure surveys (HIES)—that have been increasingly carried out in recent years.

The emphasis on HIES data is not only quite appropriate but also timely. The principal aim of the FAO's periodic exercises of estimating the prevalence of undernutrition has been to provide information on the broad dimensions of the hunger problem in the developing world. In fact, although the estimates have been derived on a country by country basis, only the global and regional aggregates have been presented. The country-level estimates have not been made public precisely because of the

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acknowledged limitations in the data used and/or the assumptions that had to be made. With the World Food Summit held in 1996, the situation has actually changed. On this occasion, FAO had released, through a poster, the country estimates underlying the figure of 840 million undernourished in the developing world, given in The Sixth World Food Survey. These were released as part of a process for improving the estimates in collaboration with the countries, particularly in the context of the need of setting up benchmarks for monitoring progress toward the World Food Summit Plan of Action target of halving the number of undernourished by the year 2015. In this new context, it is evident that the approach taken needs to be reviewed and improved with the aim of deriving reliable country-level estimates. It is also clear that this process should make full and better use of the food consumption data collected through the HIES.

The "bias" in the FAO methodology towards food availability is substantiated in the paper by referring to the sensitivity analysis in The Sixth World Food Survey, which shows that, given a fixed cutoff point defining food inadequacy, the percentage of the population undernourished is much more sensitive to the per caput DES (food availability) than to the coefficient of variation (CV), which reflects the extent of inequality in the distribution of household per caput food consumption. This preponderant role of the per caput DES in determining the percentage of the population deemed to have inadequate food is highlighted by the high correlation between these two variables. The implication that the resulting estimate of the percentage of the population undernourished does not adequately reflect poverty is further demonstrated by a comparison with other measures associated with food insecurity, e.g., the World Bank's poverty estimates (percentage of the population living in poverty) and anthropometric measures of the prevalence of

malnutrition among children (also presented in The Sixth World Food Survey). In considering the particular issue raised here, it is necessary to take into account two points as mentioned below.

First, the World Bank poverty estimates are also generated by a procedure that is analogous to the FAO methodology in the sense that it is based on a frequency distribution and a cutoff point (poverty line), the only difference being that while in the FAO measure the distribution refers to household per caput food availability (consumption) expressed in terms of dietary energy, in the case of the poverty measure it refers to household per caput consumption expenditure expressed in monetary terms. Therefore, as the distribution of the latter could also be represented by the log-normal model, a sensitivity analysis similar to that undertaken by FAO is conceivable also with respect to the prevalence of poverty. In this context, the per caput DES would be replaced by the mean of the household per caput consumption expenditure distribution and the minimum per caput requirement (cutoff point) by the poverty line. The CV would refer to the household per caput consumption expenditure. This sensitivity analysis would reveal the predominant role of the mean household per caput consumption expenditure (as compared to the CV) in determining the prevalence of poverty so that a significant correlation between these two measures can also be expected. This principle stems from the fact that in any frequency distribution of the kind dealt with here, the proportion below a cutoff point fixed on the lower tail is likely to be, to a large extent, determined by the distance between the mean and the cutoff point. In other words, the greater is the mean in relation to the cutoff point, the smaller is the proportion below the cutoff point. It is for this reason that the CV, which reflects the dispersion around the mean, has a relatively minor effect.

Second, both the food inadequacy and poverty estimates are indeed analytical measures that usually reflect the respective analyst's or organization's own views or judgments regarding certain factors taken into account in specifying the distribution as well as the cutoff point. Hence, even if the data source used is the same, differences in the results and conclusions still occur. In this connection, it is worth noting that while the World Bank's poverty estimate for India is about 53 percent, the official preliminary estimate of the Government of India for the period 1993–94 is only 19 percent (India 1997).[19] Equally telling are the divergent conclusions regarding poverty in the United States reached by two economists—Dale Jorgensen (of Harvard University) and Robert Triest (of the Federal Reserve Bank of Boston) (1998). Although both appear to have used the same data source, i.e., the U.S. Consumer Expenditure Surveys, one concluded that poverty has increased since 1973 while the other concluded that the reverse has occurred. In both cases, the estimates are lower than the official poverty index.

Taking into account the above two points and the fact that the paper is emphasizing the full use of distribution data from the HIES in improving the estimate of the prevalence of food inadequacy, it may be realized that the issue is actually related to the fact that in the FAO methodology, the mean of the food consumption distribution is represented by the food balance sheet (FBS) estimate of the per caput DES rather than corresponding mean household per caput estimate derivable from the HIES. Although the concept of food consumption in the FBS is similar to that obtained in the HIES at the national per caput aggregate level, significant differences have been noted in the figures emerging from

[19] The estimate for 1987–88 is 25 percent.

the two sources. Thus, the choice of the FBS rather than the HIES national per caput estimate does imply a "bias" in favor of the former source. Furthermore, as the poverty estimates are based entirely on data from the HIES, the full use of the food consumption data from this source (i.e., not merely for the purpose of providing a measure of the inequality in distribution) can be expected to improve consistency between the food inadequacy and poverty estimates. This approach would, however, lead to inconsistency between the resulting estimate of food inadequacy and the average food consumption level reflected by the FBS estimate of per caput food availability. The importance of the latter as the only food consumption information that is available for practically all countries and is being regularly updated by FAO should not be overlooked. Therefore, what seems to be more plausible is to make attempts at reconciling the estimates of the mean food consumption level from the two sources. In fact, the food consumption data from the HIES can serve to improve the FBS estimates, particularly with respect to the consumption of minor food crops and the self-produced food (own consumption), which are usually not fully captured in the production statistics entering the FBS.

The above point of view, in fact, emphasizes the role of the HIES in improving the database underlying the FAO estimates of the proportion of the population undernourished rather than in modifying the basic features of the methodology that has evolved through experience, accumulated over decades, in the use of both FBS and HIES data for the purpose of quantifying the food inadequacy problem. This methodology, which links the FBS per caput food availability estimate with a measure of the inequality in distribution (derived from household survey data) through a theoretical probability distribution model, has distinct advantages. At the national level, it provides a mechanism

for assessing the effect of short-term changes in food availability as well as its components (i.e., production, import, etc.) on the distribution within the population and hence the prevalence of food inadequacy. At the global level, due to the fact that the FBS data are available annually and on a comparable basis for practically all countries and that the inequality in distribution parameter is not expected to change significantly in the short-term, it provides a convenient means to derive country distributions corresponding to common reference periods and based on a common methodology. This is important for aggregation purposes. The use of a probability framework is appropriate also from the point of view of the need to consider the variation in energy requirement in estimating the prevalence of food inadequacy (Naiken 1998). There is, of course, ample room for improvements and refinements in the application of the methodology by making better use of the food consumption data available in the HIES.

Within FAO, the need for a better and enhanced use of the food consumption data from the HIES has been recognized for some time (Naiken and Becker 1990). However, the problem is that the data that are normally processed and tabulated by the respective national statistical organizations refer to the monetary values of the food consumed. In this form, the information is not directly usable either as an input for improving the FBS estimates or for deriving reasonably accurate estimates of the CV of the household per caput dietary energy consumption. For the purpose of the former, it is necessary to obtain access to the estimates of the national per caput quantities corresponding to the various items of food expenditure, while for the latter, the process is more complex as it requires the conversion of the quantities of food items consumed at the household level into their dietary energy equivalents before the appropriate tabulations can be derived.

The process of converting and tabulating the food consumption data from the HIES for the purpose of analysis in terms of the dietary energy has been undertaken in a few countries, e.g., India, Bangladesh, Sri Lanka, and Indonesia, but in most of these cases, it has been done on an ad hoc basis for specific research purposes, often at the request of or in collaboration with certain external organizations. FAO itself, primarily for the purpose of expanding its data base for the preparation of The Sixth World Food Survey, has provided assistance to a few countries, e.g., China, Mexico, Peru, Bangladesh, and Pakistan, in undertaking the required data processing and tabulation. However, even these were of an ad hoc nature. Nevertheless, subject to availability of funds, attempts are being made to at least promote the idea through occasional regional workshops/seminars.

In any event, it is clear that, for the required data processing and tabulation work to become a regular feature of the respective national statistical organizations' programme and for the resulting information to be readily accessible, a concerted effort is needed on the part of the national as well as international organizations interested or involved in the use or analysis of food consumption statistics. This effort should include the preparation of appropriate technical guidelines and the provision of technical assistance to build up national capacity, not only in undertaking the required data processing and tabulation work, but also in the analysis of the data.

The World Food Summit Plan of Action included a commitment stipulating that "Governments, in partnership with all actors of civil society, as appropriate, will develop and periodically update, where necessary, a national food insecurity and vulnerability information and mapping system, indicating areas and populations, including at local level, affected by or at risk of hunger and malnutrition, and elements contributing to food

insecurity, making maximum use of existing data and other information systems in order to avoid duplication of efforts." In this context, FAO was requested to act as a catalyst in the development of the national Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) in close collaboration with all concerned agencies. As a consequence of this, an international FIVIMS program is being developed through the Inter-Agency Working Group on FIVIMS, which comprises representatives from the key international agencies concerned with food security issues (including IFPRI). The aim of this program is to contribute to the improvement of the relevant national data through definition of common standards and methods and the provision of technical support for their applications in the development of national FIVIMS. It is hoped that the concerted effort mentioned above would materialize through this endeavor.

APPENDIX

FAO METHODOLOGY FOR CALCULATING THE PREVALENCE OF CHRONIC UNDERNOURISHMENT

Dietary energy intake in each country is assumed to follow a log-Normal distribution. This distribution is positively skewed with underlying parameters mean and standard deviation. The area beneath the energy intake distribution curve to the left of the minimum per capita dietary energy requirement (denoted y^*) gives the percent undernourished. Mathematically, the calculation (FAO 1996a, Appendix 3) is as follows.

Let μ^* be a country's per capita dietary energy supply and CV^* be the country's coefficient of variation in dietary energy intakes.[20] Then the standard deviation (σ) and mean (μ) of the log-Normal distribution are calculated as follows:

$$\sigma = \sqrt{\ln(CV^{*2} + 1)}$$

$$\mu = \ln(\mu^*) - \frac{\sigma^2}{2}.$$

These numbers are used to compute a Z-score,

$$z = \frac{\ln(y^*) - \mu}{\sigma},$$

which can then be looked up in a table of standard normal probabilities to find the estimated percent undernourished.

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[20] Note that while a coefficient of variation for a variable is defined to be its standard deviation over its mean, the CV is estimated independently of countries' per capita DESs. Thus the mean used to calculate the CV (estimated from survey samples) will differ from the per capita DESs (see FAO [1983] for estimates of the magnitudes of such differences).

Appendix Table 5 Food security data for developing countries

Country	Chronic undernourishment (1990/92) Percent	Chronic undernourishment (1990/92) Number	Percent children underweight[a] (1988–92)	Per capita dietary energy supply[b] (1990/92)	National dietary energy balance[c] (1990/92)
		(millions)	(percent)	(kcals)	(kcals)
Sub-Saharan Africa					
Angola	54	5.1	35.3	1,840	–260
Benin	20	1.0	23.5	2,520	420
Botswana	29	0.4	26.8	2,320	220
Burkina Faso	41	3.8	27.1	2,140	40
Burundi	50	2.9	29.1	1,950	–150
Cameroon	43	5.1	13.6^	2,040	–60
Central African Republic	62	1.9	31.9	1,720	–380
Chad	61	3.5	30.6	1,810	–290
Congo	34	0.8	27.5	2,210	110
Côte d'Ivoire	22	2.7	12.3	2,460	360
Ethiopia	65	31.2	39.8	1,620	–480
Gabon	24	0.3	15.1	2,490	390
Gambia	29	0.3	17.1	2,320	220
Ghana	40	6.2	26.7	2,090	–10
Guinea	25	1.5	24.0	2,400	300
Kenya	46	11.3	17.4	1,970	–130
Lesotho	35	0.6	17.5	2,260	160
Liberia	59	1.6	20.1	1,780	–320
Madagascar	31	3.8	38.1	2,160	60
Malawi	49	4.8	23.5	1,910	–190
Mali	34	3.3	21.6	2,230	130
Mauritania	20	0.4	15.7	2,610	510
Mauritius	18	0.2	17.0	2,780	680
Mozambique	66	9.6	46.8	1,740	–360
Namibia	35	0.5	26.2^	2,190	90
Niger	37	2.9	44.0	2,190	90
Nigeria	38	42.9	35.4	2,100	0
Rwanda	47	3.4	31.7	1,860	–240
Senegal	30	2.3	19.6	2,310	210
Sierra Leone	55	2.4	25.9	1,820	–280
Somalia	72	6.4	38.8	1,590	–510
South Africa	n.a.	n.a.	n.a.	2,810	710
Sudan	37	9.7	33.7	2,150	50
Swaziland	13	0.1	8.8	2,680	580
Tanzania	38	10.3	25.2^	2,110	190
Togo	30	1.1	18.4	2,290	120
Uganda	32	5.8	23.3^	2,220	10
Zaire	39	14.9	33.2	2,090	–10
Zambia	43	3.6	25.1^	2,020	–80
Zimbabwe	41	4.2	14.1	2,080	–20

Table 5 continued

Appendix Table 5 (continued)

Country	Chronic undernourishment (1990/92) Percent	Chronic undernourishment (1990/92) Number	Percent children underweight[a] (1988–92)	Per capita dietary energy supply[b] (1990/92)	National dietary energy balance[c] (1990/92)
		(millions)	(percent)	(kcals)	(kcals)
Near East and North Africa					
Afghanistan	73	12.9	40.3	1,660	–490
Algeria	9	2.4	9.2^	2,900	750
Egypt	6	3.2	10.4^	3,340	1190
Iran	7	4.2	39.0	2,760	610
Iraq	21	4.0	11.9	2,270	120
Jordan	3	0.1	12.7	2,900	750
Kuwait	16	0.3	5.0	2,460	310
Lebanon	5	0.1	8.9	3,260	1110
Libya	3	0.2	4.0	3,290	1140
Morocco	10	2.6	12.0	3,000	850
Saudi Arabia	12	1.9	12.6	2,730	580
Tunisia	3	0.2	8.9	3,260	1110
Turkey	3	1.8	10.5	3,510	1360
United Arab Emirates	4	0.1	7.0	3,370	1220
Yemen	24	3.0	30.0^	2,160	10
Latin America and the Caribbean					
Argentina	9	2.9	1.2	2,950	750
Bolivia	40	2.9	11.4^	2,030	–170
Brazil	6	9.7	7.1^	2,790	590
Chile	22	2.9	2.0	2,540	340
Columbia	18	5.9	10.1^	2,630	430
Costa Rica	12	0.4	8.1	2,870	670
Cuba	9	1.0	8.4	3,000	800
Dominican Republic	32	2.4	10.4^	2,270	70
El Salvador	19	1.0	19.4	2,530	330
Guatemala	26	2.4	25.0	2,280	80
Guyana	24	0.2	18.0	2,350	150
Haiti	69	4.6	24.4	1,740	–460
Honduras	21	1.1	19.8	2,310	110
Jamaica	23	0.6	7.2^	2,580	380
Mexico	8	7.2	13.9	3,190	990
Nicaragua	25	1.0	18.7	2,290	90
Panama	19	0.5	11.0	2,240	40
Paraguay	15	0.6	3.7^	2,620	420
Peru	49	10.7	10.8^	1,880	–320
Suriname	21	0.1	n.a.	2,510	310
Trinidad and Tobago	11	0.1	9.0	2,630	430
Uruguay	8	0.3	7.0	2,680	480
Venezuela	20	4.0	5.9	2,590	390

Table 5 continued

Appendix Table 5 (continued)

Country	Chronic undernourishment (1990/92) Percent	Chronic undernourishment (1990/92) Number	Percent children underweight[a] (1988–92)	Per capita dietary energy supply[b] (1990/92)	National dietary energy balance[c] (1990/92)
		(millions)	(percent)	(kcals)	(kcals)
South Asia					
Bangladesh	34	39.4	66.5^	1,990	–120
India	21	184.5	53.0^	2,330	220
Nepal	29	5.9	50.5	2,140	30
Pakistan	17	20.5	40.4^	2,340	230
Sri Lanka	26	4.6	42.0	2,230	120
East and Southeast Asia					
Cambodia	29	2.5	37.7	2,100	–120
China	16	188.9	21.0	2,710	490
Hong Kong	5	0.3	n.a.	3,150	930
Indonesia	12	22.1	38.0	2,700	480
Korea-Democratic Republic	9	2.0	n.a.	2,930	710
Korea-Republic	1	0.3	n.a.	3,270	1050
Laos	24	1.1	34.0	2,210	–10
Malaysia	7	1.3	17.6	2,830	610
Mongolia	32	0.7	12.3^	2,100	–120
Myanmar	12	5.2	32.4^	2,580	360
Philippines	21	13.1	33.5^	2,290	70
Thailand	26	14.4	13.0^	2,380	160
Vietnam	25	17.2	41.9^	2,200	–20

Sources: Percent and number of chronic undernourished data are from FAO (1996b); percent children underweight data are from UN ACC/SCN (1993, Table 2.1), with the following exceptions: the Namibia and Mongolia rates for 1992 are from FAO (1996a, Appendix 2, Table 8) and the rate for India for 1992/93 is reported in Gillespie, Mason, and Martorell (1996); per capita dietary energy supply data are from FAO (1996a, Appendix 2, Table 1).

n.a. = data are not available.

[a] A child is considered underweight when his or her weight falls below –2 standard deviations of the expected weight of healthy children of her or his age, using National Center for Health Statistics norms. Country underweight rates with the superscript "^" are from nationally-representative surveys that took place over the period 1989 to 1992. For the remaining 74 countries, data close to the 1900–92 period are not available. For these countries, UN ACC/SCN-predicted 1990 underweight rates are employed. These are estimated using data from nationally representative surveys that took place from 1975–1991, using two multivariate regression models: (1) a global model estimated with data from 100 surveys in 66 countries; and (2) a Sub-Saharan Africa model using data from 20 surveys in 20 countries. The independent variables employed in the global model were per capita dietary energy supply, female secondary education, percent government social support, child population under five, and regional dummies. For the Sub-Saharan Africa model, the independent variables employed were per capita dietary energy supply, female secondary education, percent calories from root crops, percent calories from animal sources, and population size. The global and Sub-Saharan African models had (adjusted) R^2s of .9 and .82, respectively. The predicted values are given in UN ACC/SCN (1993, Table 2.6). See UN ACC/SCN (1993, Chapter 2) for further explanation.

Table 5 continued

Appendix Table 5 (continued)

[b] Data given are averages of the daily per capita dietary energy supplies (DES) for human consumption for 1990, 1991 and 1992.

[c] Calculated as per capita DES (using the data in Appendix Table 5, column 4) minus average per capita dietary energy requirements. A negative national food energy deficit indicates that a country's DES is insufficient for meeting the dietary energy requirements of its population. A positive national food energy deficit indicates sufficiency. Regional requirements given in FAO (1996a, Table 16) are used as proxies for national requirements. These are Sub-Saharan Africa (2,100), Near East and North Africa (2,150), East and Southeast Asia (2,220), South Asia (2,110), and Latin America and the Caribbean (2,200).

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