The MDG on poverty and hunger: how reliable are the hunger estimates?

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The MDG on poverty and hunger: How reliable are the hunger estimates?

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Two hunger related indicators are used for tracking progress towards MDG-1. The prevalence of people with inadequate food intake (undernourishment) is based on national food statistics, which are not very reliable in Sub-Saharan Africa. The other indicator (prevalence of underweight among underfives, based on anthropometric surveys) appears to be more reliable. The measurement of height in addition to weight allows a more refined classification of anthropometric failure. A specially designed cross-tabulation (called 'Anthro Table') facilitates the inspection of the resulting interconnected prevalence data. An example from Kenya confirms the reliability of underweight as a sound overall indicator of child growth, while the prevalence of stunting (low height) remains a useful additional indicator that can help attribute any trends in underweight to chronic and/or acute undernutrition.

Introduction

The first of the eight Millennium Development Goals (MDG) is to eradicate extreme poverty and hunger, with one of the targets being to halve the proportion of people suffering from hunger by 2015 compared to the 1990 figure.[1] To measure progress, two indicators have been selected by the United Nations: the proportion of children under five whose weight-for-age is below the WHO

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[1] The other targets of MDG-1 are to 'Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day' and to 'Achieve full and productive employment and decent work for all, including women and young people' (United Nations Statistics Division 2008).

cut-off point for undernutrition,[2] and the proportion of the population whose food consumption is below minimum dietary energy requirements. In this chapter, the first is referred to as 'prevalence[3] of underweight in children' or 'prevalence of underweight' and the second is referred to as 'prevalence of undernourishment among the population' or 'prevalence of undernourishment'.

The first part of the chapter questions whether these two indicators are indeed measurable and reliable, and how they relate to each other, while the second takes a closer look at the first of the two indicators and considers how weight-for-age combines the effects of two distinct dimensions of child growth: growth in body stature with age, and fluctuations in body proportions. Each of these dimensions has its own indicator, namely the number of children with a height too low for their age, and the proportion of children with a weight below what would be expected for their height. Although the chapter focuses on the merits of these indicators for monitoring purposes, their relationship with indicators for other development targets and background conditions over time is an important issue. The monitoring of MDG targets should be combined with interpreting national trends appropriately, including attributing changes to likely explanatory factors such as the impact of different policies, economic opportunities or constraints, and natural or manmade changes or disasters. This chapter takes a first step towards developing new reporting tools to allow a better analysis of the 'prevalence of underweight' indicator.

Underweight vs. undernourishment: Measurement issues

The hunger-related target of MDG-1 is being monitored using two indicators. The first is derived from anthropometric surveys among children under five and the second is based on statistics about food availability for human consumption. The chapter starts with information on the relationship between the two indicators. This is followed by a brief overview of the procedure used to estimate the prevalence of undernourishment among the population and an assessment of the reliability of the prevalence of undernutrition using the results of successive anthropometric surveys that were undertaken over a relatively short period of time in the same country. Information is presented on the degree of stability of

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[2] The cut-off point used internationally is –2 Z-scores below the reference population median.

[3] A 'prevalence rate' (in %) describes the percentage of people in a given area who are suffering from a condition at a particular time. In epidemiology, this rate is distinguished from the 'incidence rate', which is the percentage of people in a given area who become ill in a certain period (e.g. one year). The monitoring of MDG-1 relies on prevalence percentages and not on incidence rates.

the results at a national level and the within-country distribution of undernutrition prevalence.

The relationship between underweight and undernourishment

The two indicators – prevalence of underweight and prevalence of undernourishment – are generally seen to allow a monitoring of trends concerning the occurrence of hunger. As they measure different aspects of nutrition (children's weight versus household per capita food consumption), the two indicators cannot be expected to give identical results. However, a positive correlation between the two is expected, with a decrease in the prevalence of undernourishment accompanying a decrease in the prevalence of underweight in children, and vice versa.

Figure 11.1 shows the patterns of change in underweight and undernourishment in Sri Lanka.[4] Between 1990 and 2002 there was a continuous decline in the prevalence of underweight among children and the prevalence of undernourishment in the general population. The two trend lines are similar in terms of slope but differ in level because the upper line refers to a percentage of children and the lower line to a percentage of the population.

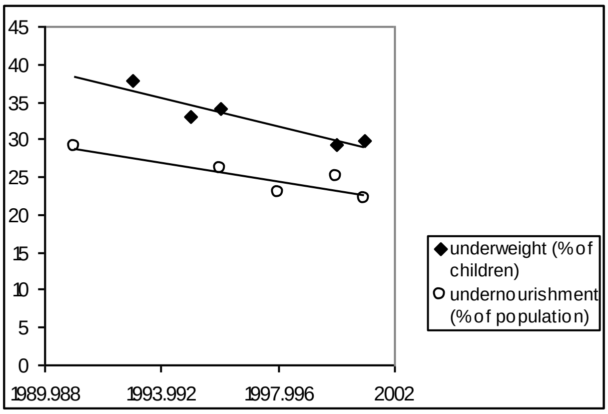

Figure 11.1 Trends in prevalence of underweight and undernourishment in Sri Lanka, 1990-2002

Source: FAO (1999-2005), WHO (2006a)

[4] The example given is of an Asian country, because production estimates for the staple food are probably more reliable there than in Sub-Saharan Africa. In Sri Lanka the staple food is rice. As most rice is commercially traded, it can be better estimated than production estimates for home-grown/consumed food crops such as cassava in SSA (see below).

However, a more systematic analysis of the combined data available at a national level on prevalence rates of underweight and national prevalence rates of undernourishment reveals that the clear positive relationship shown for Sri Lanka is exceptional. Figure 11.2 shows the results of comparing the changes in prevalence rates of underweight and undernourishment for 27 African countries.[5] For most countries, these changes were noted over a five to ten year period. If there had been a strong positive correlation between the two indicators, Figure 11.2 would show a concentration of data points on or near a line running from the bottom left to the upper right quadrants. However, the results reveal a wide scattering of data, indicating that the relationship between change in underweight and that in undernourishment is only weak. The changes in prevalence of underweight and undernourishment for eight countries surprisingly run in opposite directions (data points in the upper left and lower right quadrants). For individual countries, the direction and degree of change of the two MDG-1 indicators on hunger are far from similar and show poor correlation (P=0.175, Fisher's Exact test). This casts doubt on the suitability and reliability of at least one, if not both, indicators. Although it is true that underweight is not only caused by inadequate food consumption but also by inadequate healthcare and caring practices, it is unlikely that the influence of such factors can fully explain the poor association between undernourishment and underweight.

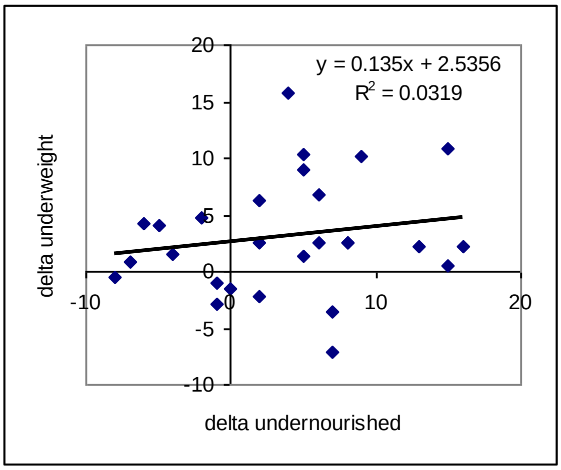

Figure 11.2 Changes over time in prevalence (%) of underweight and prevalence (%) of undernourishment in 27 African countries (see Appendix 1 for national data)

[5] The full data set on which Figure 11.2 is based is given in Appendix 1.

The prevalence of undernourishment

Methodology to estimate the prevalence of hunger on the basis of food availability and consumption has been developed by the FAO and consists of three main components: an estimate of the national availability of food for human consumption; an estimate of the within-country distribution of food consumption; and the setting of a minimum level of food energy requirements (in kcal).[6]

The method is in principle well designed but also complex and highly demanding of data. One of the greatest problems is that the data required are either poorly estimated or not available at all. For this reason, this method has frequently been criticized over the years (see, for example, Svedberg 1991, 1999, 2000). Without discussing all the steps in detail and the data required to arrive at an estimate of the prevalence of undernourishment, one exception is made that relates to the first step in the procedure. This is the estimation of a country's average per capita food consumption based on the food balance sheet, which is constructed following a so-called accounting method that makes estimates based on food production (marketed and subsistence), food imports and changes in stocks. All forms of non-food utilization are then subtracted from the total quantity of food available. This includes the usage of food for animal feed and as seed, food losses during transport and processing, and food exports. The balance of all these is considered to represent food availability for consumption by the population of the country concerned at retail level. The food balance approach leads to an indirect estimate of actual aggregate food consumption and does not account for any food losses between retail and household levels, nor within households.

Table 11.1 shows the difficulties that can be encountered when constructing a food balance sheet and gives figures on the production and consumption of cassava in various African countries that were selected for their relatively high levels of cassava production and consumption. The table shows that between 0% and 45% of national cassava production in the eight countries selected is reportedly used as feed, with estimates of waste varying between 5% and 35%. The resulting percentages available for human consumption in these countries vary from 45% in Uganda to 95% in Zambia. The percentages used can be seen to be rounded figures (with a precision of 5 to 10%). This reflects their very character: the percentages are generally only rough 'guesstimates'. This means that, apart from errors in absolute estimates of root crop production, inaccuracies in the above estimates of food utilization for other purposes than human consumption have far-reaching consequences for national-level estimates of total energy consumption. In turn, errors in the estimates of total per capita food consumption strongly influence estimates of the prevalence of undernourish-

6 One kilocalorie (kcal) corresponds to 4.814 kiloJoules (kJ).

ment. These, and various other problems associated with the FAO methodology for estimating hunger in the form of undernourishment (e.g. assumptions about the distribution of national food supplies among the population utilizing information on income distribution, and assumptions underlying the definition of inadequate energy consumption), cast doubt on the reliability and usefulness of the undernourishment indicator when assessing progress in the MDG-1's hunger-related target.

Table 11.1 Estimates of food and non-food utilization of cassava in selected Sub-Saharan African countries, 1999-2001

	% of production used as feed	% of production lost (waste)	% of production available as food	Food energy contributed by cassava in kcal/capita/day
Angola	25	5	70	644
Congo (DRC)	5	5	90	872
Ghana	15	35	50	645
Mozambique	10	15	75	637
Nigeria	25	30	45	277
Togo	0	15	85	386
Uganda	45	10	45	295
Zambia	0	5	95	251

Source: FAO Food Balance Sheets (1999-2001)

The prevalence of underweight and of stunting among children

The main question here is to what extent information based on anthropometric surveys among young children provides reliable information on the actual prevalence rates of undernutrition, and therefore whether underweight prevalence can be considered an appropriate indicator in monitoring MDG-1. Unlike undernourishment, the measurement of underweight in children is relatively straightforward and involves collecting anthropometric information (age, sex and body weight) from a sample of children.

Apart from the obvious requirement that anthropometric measurements are made and collected correctly, the most important condition for estimating a national-level prevalence rate of underweight is the representativeness of the sample. An empirical approach to assess the apparent representativeness of commonly used samples in nutrition surveys is the comparison of the results of two independent surveys in the same country or region that have been undertaken relatively close together. Surveys held at the same time in the same year are ideal. The following analysis uses the main determining factor of underweight, i.e. low height-for-age (stunting or chronic undernutrition), because it is generally held to be less affected by short-term fluctuations than low weight-for-height (see Box 11.1). In standard nutrition surveys, the age ranges covered are either children under five or children less than three years of age. Thus, when the time span between two surveys in the same area is no more than two

Box 11.1 Classifying growth in young children

When a child is not growing well, s/he lags behind in the development of body dimensions. The growth of a young child can thus be judged from the increase in his/her body weight and/or height over time. The resulting weight or height at any time is referred to as 'attained growth'. Given the child's age and sex, weight and height are converted into indices of attained growth: *weight-for-age* (WA) and *height-for-age* (HA) respectively. Body proportions are captured by a third index: *weight-for-height* (WH). When working out each of these indices, the growing child's attained weight or height is compared with the expected values in a population dataset that is recommended for international reference purposes. On the basis of studies among a reference population in an environment where undernutrition has not been a public-health problem, experts have established tables and curves to describe the recommended distribution of growth values for reference purposes. The World Health Organization has established reference data for international use.[7] Some countries use reference data based on their own research or borrowed from other sources.

WA is a composite index that combines the effects of two different biological processes: growth in body stature (measured by HA) and fluctuations in body 'fill' (measured by WH). A child can, therefore, be underweight because s/he is either too short for his/her age or too thin for his/her height or a combination of both. WA alone cannot distinguish between the two processes and needs to be complemented by information on its components (HA and WH). Body stature[8] at a given age is the result of the accumulation of linear growth since the child was conceived and a measure of long-term body growth. A below-normal value of HA indicates chronic undernutrition (*stunting*); this is the result of prolonged food deprivation and/or disease or illness. The other dimension of child growth is represented by WH. A below-normal index indicates acute undernutrition (*wasting*) and is attributed to concurrent or recent episodes of food deprivation and/or illness.

[7] In 1983, the World Health Organization adopted international reference values for weight-for-age, height-for-age and weight-for-height (WHO 1983) based on anthropometric data collected in the United States by the National Centre for Health Statistics (NCHS). In 2006 the WHO published new growth standards for international use (WHO 2006b; WHO 2007).

[8] The method of measuring the body stature of a child depends on its ability to stand. For children under 2 years of age, stature is measured with the child lying down. The resulting measurement is referred to as 'body length'. Children over two are measured standing upright and the result is referred to as 'height'. The effects of gravity make the latter measurement about 1 cm less than the former. There are separate reference tables for length and height. The term 'height' is used in this chapter to denote length and height.

or three years apart, part of the targeted population segment is represented in both surveys. It is partially for this reason that, in particular for the anthropometric height-for-age indicator, differences between successive surveys are expected to be relatively modest. Only over longer periods of time are significant changes and, hopefully, a reduction in undernutrition prevalence rates expected to occur.

Figure 11.3 shows the stunting prevalences for twelve Asian countries. The time span between the successive surveys is at most three years and for most countries only one or two years. Results confirm the expectation of, at most, moderate changes in stunting prevalence between the two successive surveys. The biggest difference is observed for Yemen with a difference in prevalence between the two surveys of approximately ten percentage points. The information presented in Figure 11.3 supports using anthropometry for monitoring undernutrition. It is also important to note that for some of the Asian countries

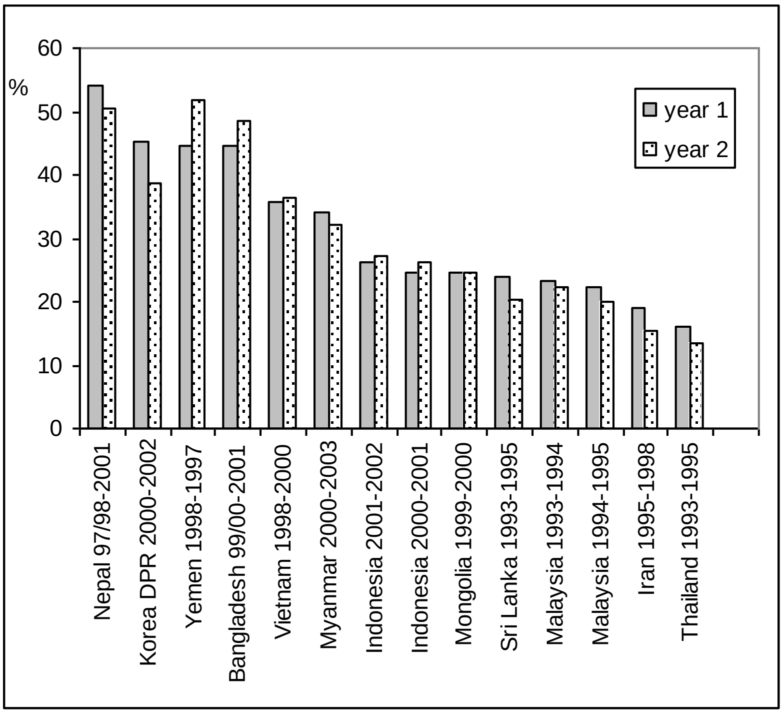

Figure 11.3 Prevalence rates of chronic undernutrition (low height-for-age) between two successive surveys in 12 Asian countries (year 1 = earlier year, year 2 = later year)

Source: DHS (2007), WHO (2006a) (see Appendix 2)

Note: Prevalence rates of low height-for-age were not available for Malaysia and Indonesia and the rates shown are for weight-for-age.

the sample sizes were quite large (see Appendix 2), therefore increasing the likelihood that the sample estimates would be close to the true population values for the respective countries.

Figure 11.4 provides a comparable analysis for nineteen African countries. The results concerning stunting in most of these countries were of a similar magnitude, although the differences were larger than in the Asian survey for several countries. The results support using the anthropometric indicator to assess undernutrition but in comparison with Asian countries, data reliability is probably somewhat weaker and careful use of the information is required. One of the reasons for the large differences between some of the surveys could be that sample sizes in nutrition surveys in Sub-Saharan Africa are smaller than sample sizes in similar surveys in Asia (Appendices 2 and 3).

The present assessment of the reliability of the results of anthropometric surveys by comparing two successive surveys should be considered an explorative exercise. When two successive surveys yield markedly different results, this could be caused either by a real change in nutritional conditions or by poor and/or non-representative sampling frames. Similarly, when two successive surveys give a similar anthropometric outcome, this is not proof that

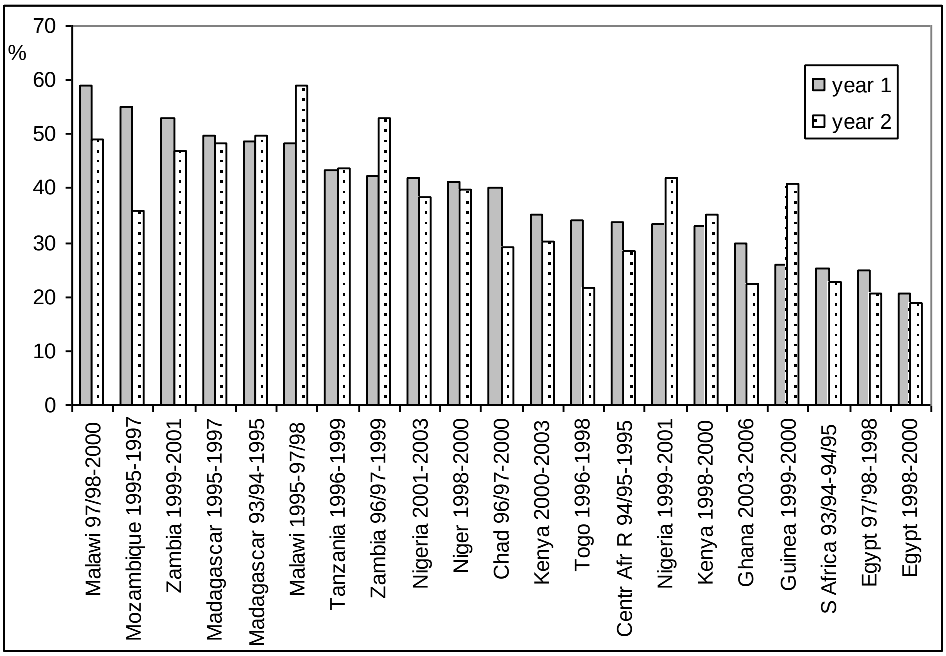

Figure 11.4 Prevalence rates of chronic undernutrition (low height-for-age) between two successive surveys in 19 African countries

Source: DHS (2007), WHO (2006a) (see Appendix 3) representative sampling has occurred. Yet when for a large number of countries, such as those presented in Figures 11.3 and 11.4, two successive surveys give similar results, this adds to the credibility of the results.

For a large number of Sub-Saharan African countries, the within-country distribution of stunting was analyzed. Figure 11.5 provides results from three successive anthropometric surveys at province or district level for Ghana and Malawi. The two figures illustrate the strengths and limitations of the currently available anthropometric data on undernutrition.

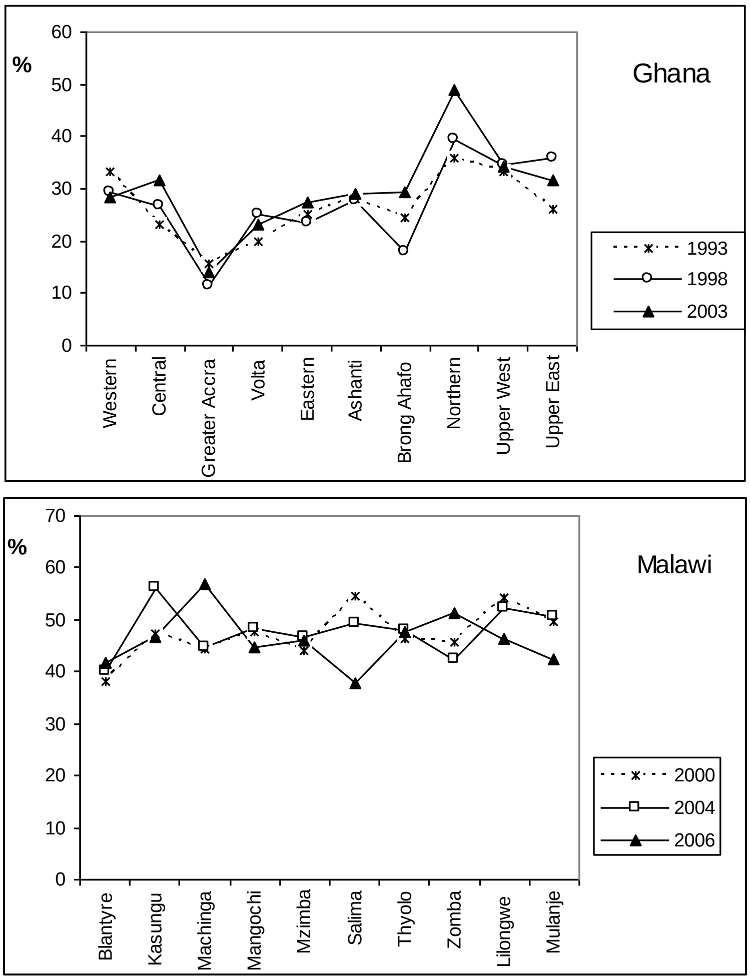

Figure 11.5 Within-country distribution of low height-for-age in children in successive surveys in Ghana (1993, 1998, 2003) and Malawi (2000, 2004, 2006)

Source: DHS (2007)

Figure 11.5 reveals a stable pattern of undernutrition for Ghana over a period of ten years that is prevalent in the country's various districts, while undernutrition prevalence in Ghana is highest in the northern part of the country and lowest in the Greater Accra region. The pattern of within-country undernutrition in Malawi is less clear. Whether these differences reflect true changes in nutritional conditions or are caused by a non-representativeness of the samples cannot be determined and further information is needed for a meaningful interpretation of the results.

The indicator of underweight prevalence has a good degree of reliability when it comes to monitoring MDG-1 on halving hunger and undernutrition. Data requirements are limited but caution should be exercised in interpreting the data with respect to the representativeness of the results at disaggregated levels, or when sample sizes are relatively small. The undernourishment indicator derived from food availability and distribution is data demanding, subject to wide margins of error and appears to be less suitable for monitoring progress towards achieving MDG-1's target of halving hunger between 1990 and 2015.

The indicator of underweight dissected

As height-for-age indicates the long term process of growth, perhaps prevalence of stunting would be a better indicator for monitoring MDG-1 than the prevalence of underweight. The reason is that the wasting component, which is implicit in underweight, might dilute or partially mask the effects of stunting. To investigate this hypothesis, the indicator of underweight now comes under the microscope for dissection.

Weight-for-age and its components

As mentioned in Box 11.1, weight-for-age (WA) is the composite result of weight-for-height (WH) and height-for-age (HA). The following schematic notation[9] illustrates the logic of this interconnection:

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[9] In fact, the anthropometric indices are not obtained by a simple arithmetical division of W by A (or H) and of H by A, respectively, but by a much more complex procedure involving the expression of an observed W or H in terms of its position compared to reference values. The resulting anthropometric indices are expressed as Z-score values: WAZ, WHZ and HAZ. The above notation is just for illustrative purposes. The true WAZ is not simply obtained by multiplying WHZ and HAZ but is calculated in its own right. A Z-score value indicates how far a child's observed value is above or below the median value of the international reference data for children of the same age (in the case of WA and HA) or height (in the case of WH). The distance of the observed value from the median reference value is expressed in terms of standard deviation units of the same reference population. The result has no measurement

$$W/A \approx W/H * H/A$$

For a group or sample of children, the frequency of individual results is expressed in terms of prevalence percentages: (i) the prevalence of underweight (i.e. children with a below-normal weight for their age), (ii) the prevalence of stunting (i.e. children with a height below normal for their age), and (iii) the prevalence of wasting (i.e. children with a below-normal weight for their height). The latter two partly overlap and some children are both wasted and stunted. Waterlow (1973) proposed a two-way cross-classification of the dichotomy according to WH and the dichotomy according to HA.

Table 11.2a shows prevalence percentages for Kenya's recent Demographic and Health Survey (DHS). In this example, 30.8% of the under-fives were stunted and 5.7% were wasted, but there was an overlap of 1.8% (wasted and stunted) such that the prevalence of children with normal height-for-age and normal weight-for-height was 65.3%. The much higher prevalence of stunting compared to the prevalence of wasting is a normal finding in nutrition surveys:

Table 11.2a Example of Waterlow's anthropometric classification of children

Waterlow's classification		
Anthropometric category	Wasted (WHZ<-2.0)	Non-wasted (WHZ>=-2.0)
Non-stunted (HAZ>=-2.0)	**Wasted, non-stunted**: 190 (3.9%)	**'Normal'**:* 3190 (65.3%)
Stunted (HAZ<-2.0)	**Wasted + stunted**: 88 (1.8%)	**Stunted, non-wasted**: 1417 (29.0%)

Source of prevalence data: Kenya Demographic and Health Survey (2003) (Measure DHS+ 2004).
Notes: The nationally representative sample survey covered 4885 under-fives from 400 sample points (clusters) in rural and urban areas of Kenya. To obtain the numbers in the above table, cases were weighted using the sampling weights in the SPPS data file to correct for any differences in sampling probabilities.
The anthropometric categories are defined by combinations of HAZ and WHZ above or below Z = -2. The figures refer to the number of children in that category and the percentage of all children is shown in brackets.
Formatting: The shading is an indication of the severity of the condition: light shading is for either wasted or stunted, and darker shading is for both wasted and stunted.
* This group may include children with values above the normal range (Z-scores>+2.0), which may represent overweight or abnormal height. When the term 'normal' is used in this chapter, it should be understood as meaning 'not sub-normal'. In Waterlow's classification, 'normal' means neither wasted nor stunted.

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units, as it is obtained as cm/cm or as kg/kg. According to statistical theory, the 'range of normal variation' of Z-score values is between -2.0 and +2.0.

the former is the accumulated result of a chronic process or trend, while the latter can be seen as the result of variation in this trend. Under non-emergency conditions, the prevalence of wasting is generally of a much smaller magnitude than the prevalence of stunting.

The mean Z-score values for the four categories are shown in Table 11.2b. The mean HAZ of the two categories in each row of Table 11.2a can be verified, and although not exactly the same, they are quite close. In the same vein, the mean WHZ of the two categories in each column of Table 11.2a are almost the same. Interestingly, the mean WAZ in Table 11.2b can be seen to exhibit three instead of two levels: normal children (-0.4), those with only one failure (around -2) and those with a double failure (-3.6). This is consistent with the intensity of the shading shown in Table 11.2a.

Table 11.2b Mean Z-score values of Waterlow's four nutritional status categories

	mean HAZ	mean WHZ	mean WAZ
Normal	-0.56	-0.03	-0.40
Wasted, non-stunted	0.05	-2.65	-2.10
Stunted, non-wasted	-2.90	-0.12	-1.85
Wasted and stunted	-3.08	-2.53	-3.64

Waterlow's classification invites questions it cannot answer about underweight children. Are all the wasted children underweight? Are all the stunted children underweight? And can there be underweight children who are not wasted or stunted? A more refined classification of undernutrition has recently been proposed by Peter Svedberg (2000), who extended Waterlow's classification with a third dichotomy based on WAZ. He proposed six different combinations of the three anthropometric indicators, which he labelled A to F. Nandy *et al*. (2005) applied this classification to survey data from India and rediscovered[10] one combination that Svedberg did not mention (and which they labelled group Y).[11] There are, therefore, seven possible categories based on the combinations of the three indicators (see Table 11.3).[12] For ease of reference,

[10] In fact, this classification was given in WHO (1983).

[11] This is the combination of being (slightly) underweight but not wasted (although almost) and not stunted (although almost).

[12] Cross-tabulating three dichotomies produces eight (=2*2*2) combinations. A theoretical eighth combination ("wasted and stunted, but not underweight": WS) is empty, as the anthropometric values that should give rise to that possibility cannot

group labels are proposed here that are abbreviations of the category descriptions. This has the added advantage that the number of digits in a label indicates whether one is dealing with a single, double or triple failure.

Svedberg further proposed combining the prevalences of the various possible combinations of wasting and/or stunting and/or underweight into one 'composite index of anthropometric failure' (CIAF), which is equal to 100% minus the prevalence of the group without failure (i.e. 100% minus Svedberg's group A, labelled N in this chapter). The CIAF is always a higher figure than each of the prevalences of wasting, stunting or underweight.

A new Anthro Table for Svedberg's classification of anthropometric failure

Svedberg's classification is essentially an extension of Waterlow's classification, so we propose building a table in analogy with Table 11.2a but with the more refined classification in seven categories. This disaggregation implies that the mean HAZ and WHZ are no longer similar for groups within the same row or column. Therefore the result of each of the seven categories in Table 11.4 is given at the cross-section of its own row and column.

The following analysis has again been done with the data set from Kenya's 2003 Demographic and Health Survey (Measure DHS+, 2004). The total number of underweight children (see the figures in bold) was 985 (20.1%) and the total non-underweight was 3,900 (79.9%). Table 11.4 is the Anthro Table that represents the frequency distribution of the seven anthropometric categories in its two-way (bivariate) layout.

The columns are arranged from low to high mean WHZ values and the rows from high to low mean HAZ values, as in a two-way graph.[13] The mean WHZ values are shown at the top of the columns and the mean HAZ values at the left of the rows. Categories that are on the same diagonal (W and S; WU and SU) have almost the same mean WAZ values. Their average is shown in the the lower right margins of Table 11.4; they should be read diagonally, as indicated by the oblique dashes. The mean WAZ values of the seven categories can be seen to follow a gradient perpendicular to the diagonal shown: highest (-0.3) for N and lowest (-3.6) for WSU. This elegant property of the Anthro Table is explained by the strong interrelationship between the three anthropometric indices discussed earlier. We propose calling a table with this special layout an

co-exist, at least not with the standard cut-off values of -2. As the cut-off values of WHZ and HAZ are relaxed, while keeping WAZ at -2.0, a point may be reached where group U becomes impossible and a new group WS will appear.

13 Admittedly, the distances between the mean Z-scores of the rows and columns are not constant. In this respect, the Anthro Table is a schematic visualization and not a precise graph.

Table 11.3 Svedberg's (2000) classification of children by categories of anthropometric normality/failure, expanded by Nandy *et al*. (2005)

Group name (Svedberg, expanded by Nandy *et al*.)	New proposed group label (this paper)	Description	Wasting	Stunting	Under-weight
A	N	**No failure**: Children whose height and weight are above the age-specific minimal norm (i.e. above –2 Z-scores) and are not suffering from any anthropometric failure	No	No	No
B	W	**Wasting only:** Children with acceptable weight and height-for-their age but who have sub-normal weight-for-height	Yes	No	No
C	WU	**Wasting and underweight**: Children with acceptable height but whose weight-for-age and weight-for-height are too low	Yes	No	Yes
D	WSU	**Wasting, stunting and underweight**: Children who are suffering from anthropometric failure in all three measurements	Yes	Yes	Yes
E	SU	**Stunting and underweight**: Children with low weight-for-age and low height-for-age but with acceptable weight-for-height	No	Yes	Yes
F	S	**Stunting only**: Children with low height-for-age but who have an acceptable weight, both for their age and their (short) height	No	Yes	No
Y	U	**Underweight only**: Children who are only underweight	No	No	Yes
Impossible	Impos-sible	**Wasting and stunting, but not underweight**:	Yes	Yes	No

Table 11.4 Anthro Table of children and prevalence % by anthropometric category

Waterlow categories			← wasted			non-wasted →				
	Svedberg/ Nandy's categories		WU	WSU	W	U	SU	N	S	
		mean WHZ	-2.8	-2.5	-2.4	-1.6	-0.8	0.0	0.5	
		mean HAZ								mean WAZ ↓
non-stunted →	W	1.4			69 1.4%					
	N	-0.5						3048 62.4%		
	WU	-0.7	**121** **2.5%**							
	U	-1.6				**142** **2.9%**				-0.3
← stunted	S	-2.6							783 16%	
	WSU	-3.1		**88** **1.8%**						-1.2
	SU	-3.2					**634** **13%**			
				mean WAZ →		-3.6		-2.6		-2.2
								← underweight		non-underweight →

Source of prevalence data: Kenya Demographic and Health Survey (2003) (Measure DHS+ 2004).
Legend: The anthropometric categories are defined by combinations of HAZ, WAZ and WHZ above or below Z=-2. (For the meaning of the abbreviations, see Table 3.) Entries are arranged according to the category's mean HAZ by mean WHZ values, as indicated in the margins.
Formatting: The shading indicates the four categories of Waterlow's classification: light shading is for either wasted or stunted (disregarding underweight) and darker shading for both wasted and stunted (and inherently underweight). Numbers and prevalence percentages of children who are underweight (only or in any combination) are in bold. The broken dashed line separates the combinations with normal weight-for-age from the combinations with underweight. As such, this line suggests combinations of WHZ and HAZ that have the same WAZ of -2. Underweight increases if one moves through the table from the upper right to the lower left-hand corner in a direction more or less perpendicular to the broken dashed line.

Anthro Table. In such a table it is possible to indicate schematically where the dividing line between underweight and normal weight would run if it were a graph (i.e. at WAZ=-2.0). This line runs diagonally through the Anthro Table (see the line with broken dashes that runs from the upper left to the lower right corner of Table 11.4).

The 88 children in the WSU category (with the darkest shading) in Table 11.4 are the same as the 88 children labelled 'wasted + stunted' in Waterlow's classification (Table 11.2a). This is because any child who is both wasted and stunted is also necessarily underweight (see Footnote 12). However, the reverse is not true: a child who is neither wasted nor stunted does not necessarily have a normal WA. In fact, the cut-off line for underweight (see the line with broken dashes) passes through the quadrant of Waterlow's 'normal' children and carves out a small percentage of children (here 2.9%) who are 'underweight only' (U). The average WAZ value of the U category is somewhat higher than the WAZ values of the WU and SU categories but lower than for N, which is consistent with its position in the Anthro Table.

In Table 11.4 it can be seen how the usual three (one-dimensional) indicators for undernutrition are related to Svedberg's CIAF (see above). Its prevalence in this example from Kenya is 100-62.4 = 37.6%. The indicator underweight (WAZ<-2.0; here: 20.2% of the children) unfortunately 'misses' the 16% of the children belonging to category S and the 1.4% belonging to category W, but has the merit of including 2.9% of the children (U) that are missed in Waterlow's classification. The combination of the wasting and stunting indicators (here: 34.7% of the children) misses category U but does include W among the wasted and S among the stunted. The stunting indicator (HAZ<-2.0; here: 30.8%) also misses the U category (2.9%) and is 'taunted' with the 1.8% of the children who are not only stunted but also wasted. The wasting indicator (WHZ<-2.0; here: 5.7%) misses the U category (2.9%) and includes the 1.8% of the children who are not only wasted but also stunted.

If the CIAF were considered the best indicator of the true prevalence of child undernutrition because it includes all forms of anthropometric failure (here 37.6%), Waterlow's classification would be a good second (here 34.7%), followed by stunting (here 30.8%), underweight (here 20.2%) and lastly wasting (here 5.7%). If the intention is to have the highest prevalence figure by not missing categories, their relative measure of success can indeed be judged from the above ranking order. However, this judgement in a way is not fair: wasting as an indicator of acute conditions is by its very nature usually a much more modest percentage than stunting. In this survey in Kenya, the prevalence of underweight is lower than the prevalence of stunting because the prevalence of wasting is relatively low.

A better criterion to judge the appropriateness of an indicator for monitoring purposes is how it reacts to change. One could say that using a composite index like the CIAF or the combination of wasting and stunting (or underweight for that matter) as an indicator would be more acceptable as wasting and stunting behave more similarly in terms of response to causal factors or of association with outcomes concerning health and performance. On the other hand, the more wasting and stunting behave differently, the more reason there would be to promote either of them in their own right as an overall indicator. Since stunting as a measure of chronic conditions is considered to be a better indicator of poverty and of the effect of sustainable actions to alleviate poverty, current consensus goes in the direction of promoting stunting as the preferred indicator for monitoring the progress of MDG-1 (SCN 2008).

Using the Anthro Table to investigate other factors

To address the above question, the differences in the seven anthropometric categories were investigated in terms of their score or performance on related factors, such as (i) possible causes or (ii) possible outcomes. A way of studying the association of child growth with another factor is to indicate the value of that factor for each of the seven anthropometric categories. Nandy *et al*. (2005) analyzed data from India and have provided graphs in which the X axis has the seven anthropometric categories arranged according to the number of anthropometric failures (N: none; S, U and W: one, SU and WU: two; WSU: three). The Y axis shows the average value of the factor investigated for the children in each category.

A similar analysis was done for this chapter using the DHS Kenya 2003 data set. In addition to a one-dimensional layout of the seven categories (as in the graphs by Nandy *et al*.), the two-dimensional character of the seven anthropometric categories is accounted for by presenting the results of the association analysis in the form of an Anthro Table.

The following sections give the results of two applications of the Anthro Table in investigating the association of anthropometric failure with other variables, i.e. poverty (as an example of a possible cause) and diarrhoea (as an example of a possible consequence).

Anthropometric failure and poverty

A factor that is one of the basic causes of undernutrition was analyzed. The Kenya DHS 2003 data set contains a wealth index factor Z-score for each child based on a number of household goods and assets. The mean of the wealth index scores is close to zero since the index is standardized for households to produce Z-scores (Rutstein & Johnson 2004). The Kenya DHS 2003 data set has a categorical variable derived from the wealth index, which divides the population approximately in quintiles (20% bands of the frequency distribution of ordered values). The quintiles are labelled from 'poorest' to 'richest' but these terms have to be understood in relative terms. Figure 11.6 gives the results of the prevalence of the anthropometric categories by wealth quintile.[14] The frequencies in which the different anthropometric categories occur differ according to wealth quintile: there is more undernutrition with increasing poverty.

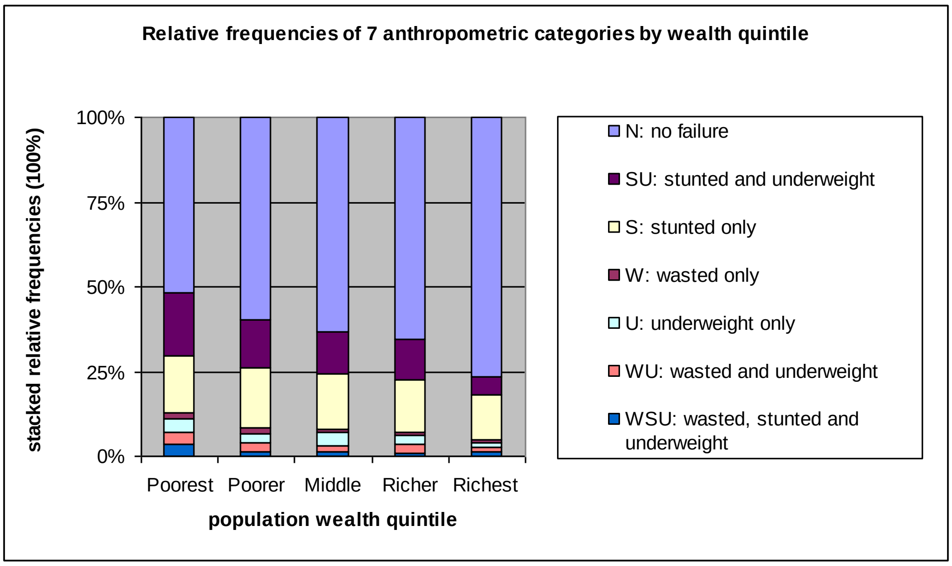

Figure 11.6 Relative frequencies of the seven anthropometric categories by population quintile based on the Kenyan 2003 household wealth index

Source: Kenya DHS (2003) (Measure DHS+ 2004)

To gain further insight into the pattern of frequencies in Figure 11.6, the results of the poorest (first bar) were contrasted to those of the richest, which served as a reference group (fifth bar). The results are shown in a one-dimensional arrangement according to Svedberg and Nandy in Table 11.5 and in a two-dimensional arrangement as an Anthro Table in Table 11.6. The prevalence percentages in the column of 'non-N' represent Svedberg's Composite Index of Anthropometric Failure (CIAF): 24% among the richest group (indicated by Q5). Among the richest households, therefore, almost 1 in 4 under-fives are undernourished.

The prevalence of all individual anthropometric failure categories as well as the CIAF are higher among the poorest (indicated by Q1), at the expense of a

[14] The data were analyzed using SPSS software version 15.0.

lower prevalence in their N category. In the following analysis, for each of the two selected quintile classes the prevalence percentages are divided by the prevalence in the corresponding N category, which is used as the referent group. The ratio of two prevalences gives a measure known as 'odds'.[15] The odds of composite anthropometric failure among the richest households are 0.307: for every one undernourished child, more than three are well nourished. In the poorest quintile, the CIAF prevalence is 48% (almost 1 in 2), which gives an odds of almost 1:1 (0.926).

The contrast in risk between the poorest and the richest is given by the Odds Ratio (OR) which is the ratio of the odds among the poorest and the odds among the richest. For the six failure categories combined (CIAF), the OR is 3.0 (almost 1:1 divided by almost 1:3). In other words, the odds of being undernourished among the poorest is three times the odds among the richest. The ORs for the individual failure categories range between 1.92 for S and 4.90 for SU.

SPSS has a module for multinomial logistic regression analysis,[16] which allows an investigation of the influence of covariates. Children's age had virtually no influence but their place of residence (urban/rural) did affect the odds of anthropometric failure. After correcting for type of residence (see the bottom row of Table 11.5), the influence of poverty on anthropometric outcomes became more pronounced, except for the WSU category. Among the poorest, the odds of the CIAF categories combined are almost fourfold compared to the richest quintile.

Table 11.5 shows that ORs are generally higher as one moves from single to double anthropometric failure, although the OR of WSU is not as high as its triple failure would lead one to expect compared to the double failure categories. The effect of poverty is surprisingly strong (OR=6.5) for children in the single failure category U (who are underweight but not [yet] wasted or stunted). Note that these children are classified as 'normal' according to Waterlow. They do not have the levels of stunting and/or wasting of the SU and WSU categories but the effect of poverty is at least as strong.

While the prevalence percentages of the seven categories are shown in Figure 11.6 and in Table 11.5 in a one-dimensional layout, Table 11.6 shows

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[15] Odds are a ratio of probabilities: the odds in favour of an event are the quantity $p/(1-p)$, where p is the probability of the event.

[16] The dependent variable in this analysis (anthropometric failure category) is a nominal variable with more than two categories. Logistic regression allows the contribution of a risk factor or of a set of risk factors in terms of the natural logarithms of the odds ratio to be estimated. Applying the natural exponential function to the regression estimates gives the odds ratio.

Table 11.5 Poverty and anthropometric categories

		Total	WSU	SU	WU	U	S	W	non-N (CIAF)	N (no failure)
Number	Q1	1202	42	223	45	46	203	21	578	624
	Q5	841	10	47	12	10	109	10	198	643
Prevalence %	Q1	100%	3.5%	18.5%	3.7%	3.8%	16.8%	1.7%	48.1%	51.9%
	Q5	100%	1.2%	5.6%	1.4%	1.2%	12.9%	1.2%	23.5%	76.5%
Odds	Q1		0.067	0.357	0.071	0.073	0.324	0.033	0.926	1.00
	Q5		0.016	0.073	0.018	0.015	0.169	0.016	0.307	1.00
Odds Ratio	Q1:Q5		4.29	4.90	3.87	4.78	1.92	2.05	3.01	1.00
Odds Ratio (corrected for residency)	Q1:Q5		3.60	5.77	5.74	6.49	2.53	2.74	3.80	1.00

Source: Kenya DHS (2003) (Measure DHS+ 2004).
Legend: W, WU, U, S, WSU, SU = anthropometric failure categories according to Svedberg and Nandy: combinations of wasting (W) and/or stunting (S) and/or underweight (U). N = category with no such anthropometric failure (see Table 11.3). Non-N = total of the six anthropometric failure categories.
Q1 = poorest household quintile; Q5 = richest household quintile
Odds = prevalence of children in the anthropometric failure category divided by the prevalence of children in the no-failure category N
Odds ratio (OR) = odds among children in Q1 divided by the odds among children in Q5. Using the multinomial logistic regression module of SPSS, a corrected OR was estimated with type of residence as a covariate.

the results of risk analysis in the same two-dimensional layout as in Table 11.4 according to Svedberg and Nandy's classification, with shading according to Waterlow's classification. This presentation by way of an Anthro Table allows a differential inspection of wasting, stunting and underweight in terms of the strength of their association with poverty. The various anthropometric values are indicated in the margins (cf Table 11.4), while the ORs of Q1 compared to Q5 are given in the body of the table. Starting from the referent category N, mean WHZ can be seen to follow a decreasing gradient from right to left, mean HAZ from top to bottom and mean WAZ from the upper right to the lower left-hand corner of the table. There are three trajectories for inspecting the OR tendencies while moving from the referent group N to the anthropometrically worse WSU group: (i) through the upper left quadrant, i.e. passing through W and WU (the 'wasting wing'); (ii) through the lower right quadrant, i.e. passing through S and SU (the 'stunting wing'); and (iii) passing through the centre U (where both WHZ and HAZ are on the low side but are not yet below -2.0). Inspecting the results of Table 11.6 in this way shows that the 'wasting' and 'stunting wings' have similarly increasing OR gradients: from 1.0 for the

Table 11.6 Anthro Table of poverty-related odds ratios for Kenya, 2003

Waterlow categories			← wasted			non-wasted →				
	Svedberg/ Nandy's categories		WU	WSU	W	U	SU	N	S	
		mean WHZ	-2.8	-2.5	-2.4	-1.6	-0.8	0.0	0.5	
		mean HAZ								
non-stunted ↑	W	1.4			2.74					
non-stunted ↑	N	-0.5						1.00		mean WAZ ↓
non-stunted ↑	WU	-0.7	**5.74**							
non-stunted ↑	U	-1.6				**6.49**				-0.3
← stunted	S	-2.6							2.53	
← stunted	WSU	-3.1		**3.60**						-1.2
← stunted	SU	-3.2					**5.77**			
				mean WAZ →		-3.6		-2.6		-2.2

non-underweight →

← underweight

Source of data: Subset of the Kenya Demographic and Health Survey 2003 (Measure DHS+ 2004), cases weighted: 1202 under-fives belonging to the lowest population quintile of the household wealth index (Q1: the 'poorest') compared to 841 children in the highest quintile (Q5: the 'richest').
For legend and formatting, see Table 11.4. For the abbreviations W, N, WU, U, S, WSU and SU, see Table 11.3. Odds ratio = odds among the children from the poorest household quintile divided by the odds among the children from the richest household quintile, corrected for urban/rural residency. Odds = proportion of children with a particular anthropometric failure divided by the proportion of children in the no-failure category N.

referent group through 2.5-2.7 for the single failure categories to 5.7-5.8 for the double failure categories. This is surprising because higher odds ratios on the stunting side, in line with the accepted theory that stunting is more strongly associated with poverty than wasting, might have been expected. A second result (mentioned above) is that the U category (the combination of moderate thinness and moderate shortness) is more strongly affected by poverty (6.5) than the double failure categories UW and SU (5.7), even if it has slightly more favourable WAZ values (-2.3 compared to -2.5). The third curious result is that the OR of the anthropometrically most unfavourable WSU category is nowhere near the highest of all.

The multiplicity of failures (single, double or triple) is not necessarily a good guide and this investigation has tried to disentangle the effects of stunting, wasting and underweight. However, the WSU category is of no help in the differential analysis of these effects because it is a combination of all three anthropometric failures. The overall picture is that poverty tends to drive children out of the 'no anthropometric failure' category in the direction of underweight in general. Being underweight is then not only due to stunting (SU) but for some children it is rather due to wasting (WU) and, for other children, to moderate underweight (U). Thus the conclusion of the differential inspection of Table 11.6 is that the data do not support the view that stunting was a better indicator than underweight in Kenya in 2003. Finally it is appropriate to mention that the situation in the referent group was not ideal. Even in the relatively wealthiest quintile, a sizeable proportion of under-fives (24%) suffered from anthropometric failure of various kinds.

Anthropometric failure and diarrhoea

The second application of the Anthro Table investigated in this study concerned the relationship between anthropometric status and recent episodes of diarrhoea (namely in the two weeks before the interview). Binary logistic regression analysis was used to generate a model of the occurrence of diarrhoea as a function of the child's anthropometric category.[17] As the child's age influences the result, this was included in the model as a continuous variable. The data were analyzed using SPSS software version 15.0. The output of the logistic regression is the set of odds ratios of having diarrhoea. The odds ratio is a measure of risk and expresses how many times the odds of having diarrhoea in one group is more than the odds of diarrhoea occurring in the referent group N. For instance, of the 3045 children in the referent group N, 448 had diarrhoea; the odds being 448/(3045-448)=0.17 or one child with diarrhoea for every six without diarrhoea. Of the 68 children who were wasted only, 19 had diarrhoea so the odds were 19/(68-19)=0.38 or one with diarrhoea for almost three without diarrhoea. The odds ratio (not corrected for age) was 0.38/0.17=2.25 for the W category.

[17] Because the dependent variable (diarrhoea) is a yes/no variable, binary logistic regression was used here. To represent the independent variable (anthropometric category), a yes/no variable was created for each of the six categories of anthropometric failure and for the N category (no failure). The latter was used as the referent group for the odds ratio, which in this analysis is a measure of the risk of diarrhoea.

After correction for age in the logistic model, the age-adjusted result was 1.80. In other words: wasted children were almost twice as likely to have had diarrhoea as those without anthropometric failure. Table 11.7 presents the odds ratios of diarrhoea for the seven anthropometric categories.

The inclusion of underweight in this classification is useful as it shows the dynamics within three of the four categories of Waterlow's classification: compare WU to W, U to N and SU to S. The OR's for the latter two pairs show what would be expected: a gradual increase in the odds of diarrhoea going from upper right to lower left in Table 11.7, i.e. with increasing undernutrition. However, being wasted without or with underweight (W or WU) increases the odds of diarrhoea almost twofold. It is doubled again when wasting occurs with (severe) stunting (WSU). Moderate stunting in itself (S) increases the odds of diarrhoea less (1.4 times). Moderate underweight alone (U) hardly raises the odds of diarrhoea, less so than the comparison of its mean WAZ values with those of W and S might predict.

It can be concluded that the association with diarrhoea is stronger for moderate wasting than for moderate stunting (i.e. when comparing single failure categories) but that differential effect is not evident among the double failure categories. The U category behaves differently from the previous poverty analysis: the risk of diarrhoea is only slightly increased. Judging by the mean WAZ of SU and WU, there may be a threshold effect, such that a doubling of the OR may occur somewhere at a WAZ around -3.

The value of the Anthro Table

Anthropometry is the method of choice for monitoring the attainment of the hunger-related target of MDG-1. The indicator prevalence of underweight is a combination of wasting and/or stunting (although some children are underweight without being wasted or stunted). It is important to look into the 'black box' of weight-for-age as the three anthropometric indices are closely intertwined. A combined analysis is possible and useful. A schematic table (Anthro Table) visualizes results according to the two-dimensional cross-classification of wasting by stunting, while also showing underweight. In this way it con serves essential information about all three anthropometric indices. It can be used both to visualize the frequency distribution of children and to analyze relationships with other variables. In particular it allows a differential diagnosis of wasting versus stunting. This Anthro Table was tested using examples of wealth and health data from DHS Kenya (2003) and the examples analyzed illustrate how the seven anthropometric categories allow a more refined analysis than Waterlow's classification by carving out the interesting U category from the 'normal' children and distinguishing single from double anthropometric failures (WU versus W and SU versus S). It can thus be seen that poverty had a striking effect on the U category, while that category was close to normal in terms of the occurrence of diarrhoea. The U category is useful to study the general gradient with underweight (from N to WSU) and to glimpse possible threshold effects. The multiplicity of anthropometric failures *per* se is not a

Table 11.7 Anthro Table of the risk of diarrhoea (Odds Ratio) in Kenya (2003) in the previous two weeks by anthropometric status category

Waterlow categories		← wasted			non-wasted →				
Svedberg/ Nandy's categories		WU	WSU	W	U	SU	N	S	
	mean WHZ	-2.8	-2.5	-2.4	-1.6	-0.8	0.0	0.5	
	mean HAZ								mean WAZ ↓
non-stunted → W	1.4			1.80					
non-stunted → N	-0.5						1.00		
non-stunted → WU	-0.7	**1.79**							
non-stunted → U	-1.6				**1.24**				-0.3
← stunted S	-2.6							1.38	
← stunted WSU	-3.1		**4.38**						-1.2
← stunted SU	-3.2					**1.97**			
			mean WAZ →		-3.6		-2.6		-2.2
						← underweight			non-underweight →

Source: Kenya DHS (2003) (Measure DHS+ 2004)

Legend: The anthropometric categories are defined by combinations of HAZ, WAZ and WHZ above or below Z=-2 (for the meaning of the abbreviations, see Table 11.3). Entries are arranged according to the category's mean HAZ by WAZ values as indicated in the margins. For the number of children in the survey and prevalence percentages, see Table 11.4. The odds of diarrhoea in each anthropometric group are expressed as a ratio of the odds in group N (the referent group). These quotients are known as the odds ratio (OR). The ORs of underweight children (only or in any combination) are shown in bold. Light shading is used for underweight or stunting, while dark shading is used for the combination of underweight and stunting.

good criterion for predicting risk because the order between W, U and S or between WU and SU cannot be decided, nor can the possibly special character of the U category (in the middle of the table but constrained in Z-score values).

Although the processes of wasting and stunting are considered to occur with a time lag (wasting preceding stunting), the growth outcomes are apparently more entangled in reality than has so far been realized and they tend to go hand in hand. Waterlow's 1975 classification was based on the assumption that wasting and stunting are different processes and need to be distinguished by adding the measurement of height to weight and by calculating the two indices (HAZ and WHZ) in addition to WAZ. Since the early 1990s there has been growing recognition that a child's weight and height growth go in spurts (Lampl *et al*. 1992). Results of a seasonality study in Kenya (Niemeijer et al, 1991; Hoorweg *et al*. 1995) found such spurts even at group level. The Svedberg & Nandy classification and the Anthro Table take these growth dynamics into account. The present study of the association with related factors suggests that the processes of wasting and stunting are intertwined and difficult to separate.

Conclusion

When monitoring MDG-1, the indicator of underweight prevalence among under-fives has a number of advantages over the undernourishment indicator. However, it needs to be classified according to three anthropometric indicators simultaneously to shed light on the issue of underweight versus stunting when analyzing long-term trends. The Anthro Table is a useful tool and adds value to a one-dimensional analysis. The analyses above confirm the reliability of underweight as a sound overall value of growth performance in children. The measurement of height in addition to weight remains a useful recommendation but should not replace the prevalence of underweight by that of stunting in monitoring the attainment of the hunger-related target of MDG-1. It allows a better understanding of the reasons for a particular underweight prevalence or trend, and this, in turn, is important in evaluating and designing policies and programmes. Svedberg's (2000) classification, which was amended by Nandy *et al*. (2005), is a fruitful inroad into deeper analysis with the specially constructed Anthro Table presented in this chapter.

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Appendix 1

Data for Figure 11.2: Percentages underweight and undernourishment in two subsequent surveys (with time spans of 5-10 years) for 27 SSA countries

	Underweight [1]			Undernourished [2]			
	year 1	year 2	delta under-weight	year 1	year 2	delta under-nourished	year 1-year 2
Cameroon	15.1	22.2	-7.1	32	25	7	1991-1999
Chad	38.8	28	10.8	49	34	15	1996-2000
Eritrea	43.7	39.6	4.1	68	73	-5	1996-2001
Ethiopia	47.7	47.2	0.5	57	42	15	1996-2000
Kenya	22.5	21.1	1.4	42	37	5	1995-2000
Rwanda	28.6	24.3	4.3	34	40	-6	1991-1999
Uganda	25.5	22.9	2.6	25	19	6	1996-2000
Tanzania	28.9	29.4	-0.5	35	43	-8	1991-2000
Angola	40.6	30.5	10.1	49	40	9	1996-2001
Botswana	17.2	12.5	4.7	22	24	-2	1996-2000
Lesotho	15.8	18	-2.2	27	25	2	1991-2000
Madagascar	40.9	40	0.9	33	40	-7	1991-1996
Malawi	27.6	25.4	2.2	49	33	16	1991-2000
Namibia	26.2	24	2.2	20	7	13	1991-2000
Zambia	25.2	28.1	-2.9	48	49	-1	1991-2001
Zimbabwe	15.5	13	2.5	46	38	8	1995-1999
Benin	29.2	22.9	6.3	17	15	2	1996-2001
Burkina Faso	32.7	34.3	-1.6	23	23	0	1991-1999
Côte d'Ivoire	23.8	21.2	2.6	17	15	2	1995-1999
Gambia	26.2	17.2	9	32	27	5	1996-2000
Guinea	29.1	32.7	-3.6	35	28	7	1996-2000
Mali	40	33.2	6.8	27	21	6	1996-2000
Mauritania	47.6	31.8	15.8	14	10	4	1991-2000
Niger	42.6	40.1	2.5	42	34	8	1991-2000
Nigeria	35.3	25	10.3	13	8	5	1991-2000
Senegal	21.6	22.7	-1.1	23	24	-1	1991-2000
Sierra Leone	28.7	27.2	1.5	46	50	-4	1991-2000

1) Percentage of children below 5 years with weight-for-age < median -2sd of WHO/NCHS reference, source WHO (2006a).

2) Estimated proportion of population below minimum level of dietary energy consumption, FAO (1999-2005).

Appendix 2

Data for Figure 11.3: Prevalence rates of low height-for-age (<median -2sd using WHO/NCHS reference) in children below 5 years

	year 1 (%)	year 2 (%)	Period	N year 1	N year 2
Nepal	54.2	50.5	97/98-2001	17241	6409
Korea DPR	45.2	38.6	2000-2002	4175	5232
Yemen	44.6	51.7	1996-1997	3833	7501
Bangladesh	44.6	48.5	99/00-2001	5421	71931
Vietnam	35.9	36.5	1998-2000	12919	94469
Myanmar	34.2	32.2	2000-2003	8081	5390
Indonesia [1)]	26.1	27.3	2001-2002	11693	74537
Indonesia [1)]	24.6	26.1	2000-2001	70602	11693
Mongolia	24.6	24.6	1999-2000	4037	5784
Sri Lanka	23.8	20.4	1993-1995	3067	2782
Malaysia [1)]	23.3	22.4	1993-1994	313246	317551
Malaysia [1)]	22.4	20.1	1994-1995	317551	344736
Iran	18.9	15.4	1995-1998	11139	2536
Thailand	16.0	13.4	1993-1995	11748	4178

[1)] Prevalence rates of low weight-for-age instead of low height-for-age are given for Indonesia and Malaysia.
Note: Survey pairs arranged in order of prevalence in year 1.
Source: DHS (2007), WHO (2006a)

Appendix 3

Data for Figure 11.4: Prevalence rates of low height-for-age (<median -2sd using WHO/NCHS reference) in children under 5 years of age

	year 1 (%)	year 2 (%)	Period	N year 1	N year 2
Malawi	59.1	49.0	97/98-2000	6309	9322
Mozambique	55.0	35.9	1995-1997	4586	2837
Zambia	53.0	46.8	1999-2001	1095000	5784
Madagascar	49.8	48.3	1995-1997	5049	3080
Madagascar	48.6	49.8	93/94-1995	3131	5049
Malawi	48.3	59.1	1995-97/98	3654	6309
Tanzania	43.4	43.8	1996-1999	5344	2821
Zambia	42.4	53.0	96/97-1999	5443	1095000
Nigeria	42.0	38.3	2001-2003	4954	4789
Niger	41.1	39.7	1998-2000	4022	4616
Chad	40.1	29.1	96/97-2000	5664	5043
Kenya	35.2	30.3	2000-2003	5917	5306
Togo	34.0	21.7	1996-1998	3761	3260
Central Afr. Rep.	33.6	28.4	94/95-1995	2310	2225
Nigeria	33.5	42.0	1999-2001	8617	4954
Kenya	33.0	35.3	1998-2000	4413	5917
Ghana	29.9	22.4	2003-2006	3183	3166
Guinea	26.1	40.9	1999-2000	2939	1457
South Africa	25.4	22.8	93/94-94/95	3689	9807
Egypt	24.9	20.6	97/98-1998	3328	3997
Egypt	20.6	18.7	1998-2000	3997	10193

Note: Survey pairs arranged in order of prevalence in year 1.
Source: DHS (2007), WHO (2006a), Unicef (2007)

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