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Relationships between undernutrition prevalence among children and adults at national and subnational level

by

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Contents

Abstract

Anthropometric information on the prevalence of undernutrition in children, such as the prevalence of a low weight-for-age, is increasingly used as an indicator of poverty or food insecurity at the level of countries or regions within countries. However, little is known how, at this level, the nutritional status of children is related to the nutritional status of other age segments such as adolescents or adults. Without such information, the undernutrition prevalence among children cannot be interpreted as an overall indicator of poverty or food insecurity.

In the present study, utilizing in particular results from the Demographic and Health Studies, an analysis is made of the relationships between undernutrition prevalence rates among children and adults, both at the level of countries and at the level of smaller geographical subunits within countries (districts, provinces). At the level of countries, results reveal a strong positive relationship between undernutrition prevalence rates among children and adults. These results are in support of the concept that national undernutrition prevalence rates among children can be considered a proximate of overall nutritional conditions in a country.

At the level of smaller geographical units relationships are different. High levels of undernutrition among children may or may not be associated with high levels of undernutrition in adults. It is hypothesized that a combined high prevalence of undernutrition both among children and adults is in particular associated with insufficient household level access to food, while a combination of a high level of child undernutrition with an adequate or reasonable nutritional condition of adults points to non food factors, such as poor water and sanitation conditions and poor education, as major causes of undernutrition.

1. Introduction

Information both on absolute levels and on trends with respect to undernutrition prevalence in low income countries are considered of relevance for, at least, two reasons.

In the first place, malnutrition by itself is considered an unacceptable infringement of human well-being and human dignity, and its eradication is a development goal by itself. One of the Millennium Development Goals is to reduce between 1990 and 2015 the global prevalence of hunger by 50% (World Bank, 2002). In the second place, the prevalence rate of undernutrition in children is one of the most widely used non-monetary indicators to characterize poverty and food security conditions in developing countries or regions (FAO, 2003; World Bank, 2004). Thus, where a significant and lasting decrease in undernutrition prevalence has been observed, it is generally considered a confirmation or at least strong indication of an overall reduction in poverty and an improvement in the food security situation. And vice versa, where over a certain period of time an increase in undernutrition is being observed, it is considered an indication of overall deteriorating conditions with respect to general human well-being.

In line with this role of nutrition data in poverty and food security assessment, over past decades the collection of representative data on undernutrition prevalence in children, generally the under fives, has become common practice in most developing countries, and for many countries the first reliable nationally representative estimates date back to the 1980s or even before (WHO, 2004).

While thus for young children a rather complete database on undernutrition prevalence is available, the question can be asked whether observed undernutrition prevalence rates in children, and trends over time, are similar for other age groups, such as older children, adolescents, adults, or the elderly. In fact, with undernutrition being considered a strong indicator of poverty and food insecurity, at least a positive correlation is expected to exist between undernutrition prevalence rates among different age groups. Yet, studies which report on the relationships between undernutrition prevalence among different age groups are limited, and until recently broad community or country wide assessments of undernutrition prevalence, covering various age groups, were not or hardly available.

For one specific segment of the population however, namely women of reproductive age, past years have seen a rapid increase in data availability. The main source of these data are the so-called Demographic and Health Surveys, which have been implemented and are still being implemented in a large number of developing countries, and in which nationally representative data are being collected on fertility, family planning, and maternal and child health (DHS, 2004). Since the early 1990s is in most of these surveys the collection of anthropometric data in children and adult women included.

With information now being available, for a large number of developing countries, on undernutrition prevalence both in children and in one group of adults, women of reproductive age, the question can in principle be addressed whether prevalence rates in these two different age segments are well correlated or whether there are major differences or anomalies.

In the present study, a systematic analysis is being made of the relationships between undernutrition in children and adult women, utilizing national and subnational data from developing countries in Africa, Latin America, and Asia. In principle, a positive correlation is expected to exist between the undernutrition prevalence rates in these two population groups, as poverty is considered the underlying cause of both undernutrition in children and in adults. However, it is also anticipated that the strength of the relationship between undernutrition prevalence rates in these two age groups may vary between countries, or between regions within countries. It is hypothesized that information on patterns of undernutrition, as these occur among different age groups within a population, can give further direction in the identification of direct or indirect causative factors of undernutrition, whether in children, in adults, or both. Where undernutrition prevalence rates in children and adults run closely parallel, the same factors are probably affecting the nutritional status of both age segments. Where the relationship is much weaker, factors responsible for undernutrition in children are probably different from factors which cause a poor nutritional status in adults.

2. Methods

The main source of data for the present study are the Demographic and Health Surveys (DHS, 2004). These surveys started in the 1980s and provide for a large number of developing countries nationally representative data on fertility, family planning, and maternal and child health. Since the early 1990s in the majority of the DHS-surveys anthropometric information is being collected both in children and in adults. In many countries two or more survey rounds have been implemented, and where this is the case the most recent data have been used for the present study. Only for an analysis on trends results from two surveys from one country have been used.

With respect to children, the prevalence rate of children with low weight-for-age has been selected as indicator of undernutrition, using the cut-off point of the median of the reference population minus two standard deviations (M-2sd). This indicator is generally considered to reflect the combined effects of both chronic and acute undernutrition (WHO, 1995). The surveyed age group is either 0-3 years or 0-5 years. Differences between these two age brackets in prevalence rates of undernutrition, expressed in percentage children with low weight-for-age, are generally small, generally less than 5 percent. Thus, for example for Benin DHS reports a 23.8 percent prevalence of low weight-for-age among children 0-3 years and a 22.9 percent prevalence among children 0-5 years, a difference of 3.8% (DHS-Benin, 2002).

With respect to women, the DHS-surveys provide information on undernutrition prevalence in women of reproductive age, and the covered age group is generally 18-45 years. In some surveys the surveyed age group is slightly different, but no attempts have been made to correct for these (small) differences in age brackets. The indicator used for quantifying undernutrition prevalence in adult women is the percentage of women with a Body Mass Index (weight in kg divided by square height in meters) below 18.5.

For the analysis of the relationships between undernutrition in children and adults at national level, for a few countries use was made of other sources than DHS. This was in particular the case for some countries from South and Southeast Asia, as DHS surveys which include anthropometry both on children and adults are less widely available for this region (Annex I provides the complete listing of surveys which have been consulted for the present study).

The analysis of the relationships between undernutrition in children and in adults at subnational level was also mainly based on data reported in the DHS studies, as in these reports undernutrition prevalence rates are generally also reported at the level of districts, provinces, or other subnational geographical units. In principle, only those geographical units have been considered for which the sample sizes for both children and adults were 200 or more. Provinces or districts in which smaller samples were surveyed were either excluded from the analysis or combined in order to arrive at a sample size of at least 200. For two countries, Chad and Kazakhstan, DHS-reports did not provide a subregional breakdown. Here, a breakdown of national level data was realized by using results on undernutrition prevalence rates in urban and rural areas. For the subnational analysis, the only data which were not from DHS are those for Vietnam.

Data from those countries, where more than one survey reports on anthropometry in both children and adults, have been used for an analysis of trends over time, with the change over time in undernutrition prevalence being expressed as the percentage point difference between the prevalence rates at time-point one and time point two. A positive figure denotes a decrease in undernutrition prevalence and a negative figure denotes an increase in undernutrition prevalence. Thus, when for a hypothetical country undernutrition prevalence was, for example, 32% in 1994 and 27% in 1999, the resulting change over time is 32-27=5%. It may be noted that the time intervals between the two surveys are generally in the order of magnitude of 5 years (mean 4 years and 11 months, see Annex II).

The analysis of the relationships between undernutrition prevalence rates among children and adult women was performed with simple OLS for regression analysis and with F-tests for analysis of variance, using SAS-software. In all analyses ‘% low WFA’ stands for percentage of children with low weight-for-age and ‘% low BMI’ stands for percentage of adult women with low Body Mass Index.

3. Results

National level data on undernutrition prevalence in children and adult women

Figure 1 shows for 56 countries (30 from Africa, 18 from Asia, and 8 from Latin America) the relationship between the national means for undernutrition prevalence in adult women (% of women with BMI<18.5) and children (% of children 0-3 years with weight for age below median –2sd). For those countries where DHS surveys cover children up to 5 years the undernutrition prevalence rates were recalculated for the 0-3 years age group.

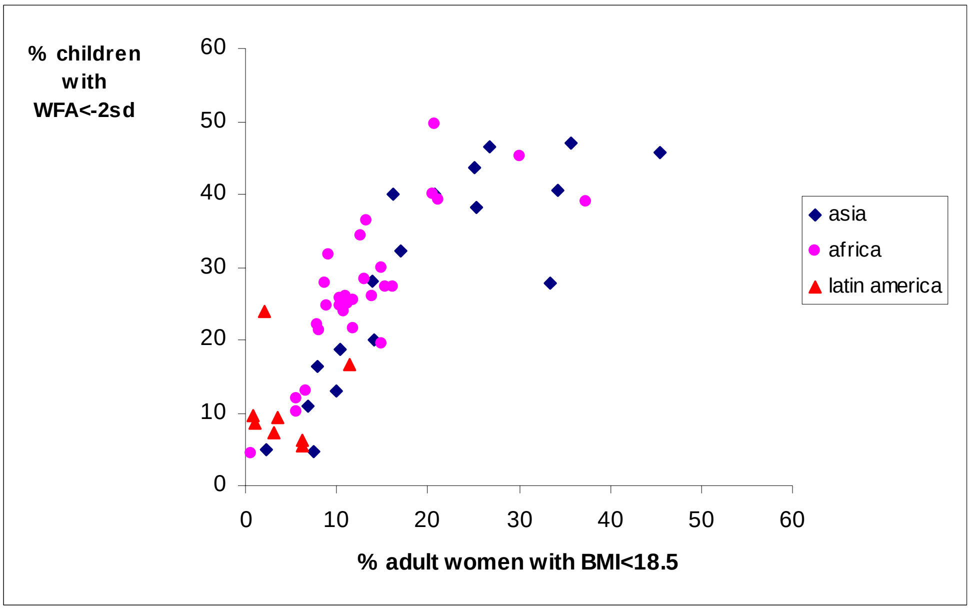

Figure 1 Relationship between undernutrition in adult women and undernutrition in children 0-3 years. Source: see Annex 1

The relationship has been investigated quantitatively by applying a quadratic OLS regression analysis (%lowWFA= A0 + A1 (%lowBMI) + A2 $(\%lowBMI)^2$). The analysis has been done for all countries together, and also for countries from the three developing regions separately. Results are summarized in Table 1. For all 56 countries combined, the parameters A1 and A2 are highly significant, and the r-square result is high (0.74). Results for countries from Asia and Africa separately are rather similar, with again highly significant parameters ($P \leq 0.0005$), and r-square results of the same order of magnitude (0.84 and 0.72). Only for the countries in Latin America, there is no significantly positive relationship between undernutrition in children and undernutrition in adults. In these countries overall levels of undernutrition are relatively low, while also the number of countries for which data are available is small. For all equations, except the one for Latin America, the intercept is non-significant.

With respect to individual data points, figure 1 shows that for some countries the relationship between the undernutrition prevalence rates among women and children deviates rather strongly from the general pattern. Among these are for example the data points for Guatemala, Niger and Sri Lanka, represented by the data points (2%, 23.9%), (20.7%, 49.6%)

and (33.4%, 27.8%), reflecting the undernutrition prevalence rates among women and children in these three countries (see Annex 1).

For Guatemala a very low level of undernutrition among adult women is associated with a high level of undernutrition among children. It may be noted that for Guatemala the high prevalence of children with low weight-for-age is at least partially the result of the fact that Guatemalan children are on average very short, also in comparison with other Latin American countries. With respect to Niger, the undernutrition prevalence rate among children of almost 50% appears to be exceptionally high. However the year in which the survey was done, 1998, was probably in terms of nutrition a very unfavorable year, as indicated by the fact that also the prevalence of wasting (low weight-for-height) was very high in 1998 (20.7%). In two other surveys, one in 1992 and one in 2001 the reported undernutrition prevalence rates among children were considerably lower (36.6.% in 1992 and 40.4% in 2000) (DHS-Niger, 1992; MICS-Niger, 2000). Yet, for the present study, the 1998 results have been used as this is the only dataset which reports both on children and adults. Finally, in Sri Lanka the prevalence rate of child undernutrition appears to be considerably lower than what might be expected on the basis of the prevalence rate of undernutrition among adult women. The moderate level of child malnutrition in Sri Lanka, at least in comparison with nearby countries such as India and Bangladesh, has often been attributed to Sri Lanka's major efforts over past decades to reduce malnutrition rates among children (Wijekoon *et al*., 1995).

Table 1. Regression analysis between undernutrition prevalence in children and undernutrition prevalence in adult women at national level.

	N	A0	P	A1	P	A2	P	R2
All countries	56	2.43	0.3137	2.26	< 0.0001	-0.031	< 0.0001	0.74
Asia	18	-5.15	0.3076	2.71	< 0.0001	-0.037	0.0034	0.84
Africa	30	0.83	0.8351	2.70	< 0.0001	-0.043	0.0014	0.72
L America	8	16.03	0.0419	-2.93	0.2993	0.253	0.2678	0.24

Regression: %lowWFA= A0 + A1 (%lowBMI) + A2 (%lowBMI)2 ; %lowWFA=percentage children with weight-for-age below median-2sd; %lowBMI=percentage adult women with Body Mass Index<18.5; Source: see Annex I.

Subnational level data on undernutrition prevalence in children and adult women

Results on the relationships between undernutrition prevalence in children and adult women at the level of districts, provinces, or other subnational geographical units are graphically represented in figure 2 (a, b, c and d). Figure 2a gives the combined result for 289 geographical units in 56 countries for which subnational data are available, and figures 2b, 2c and 2d give the results for countries from Africa, Asia and Latin America separately. At this subnational level, data points appear to be more widely scattered in comparison with the data presented in figure 1. This is both the case when plotting all data points for the three developing regions in one diagram (figure 2a) or when plotting data points separately for Africa, Asia and Latin America (figures 2b, 2c and 2d).

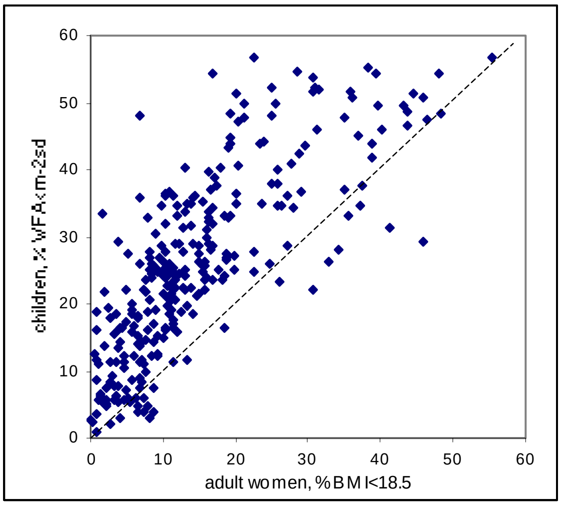

Figure 2a All developing regions

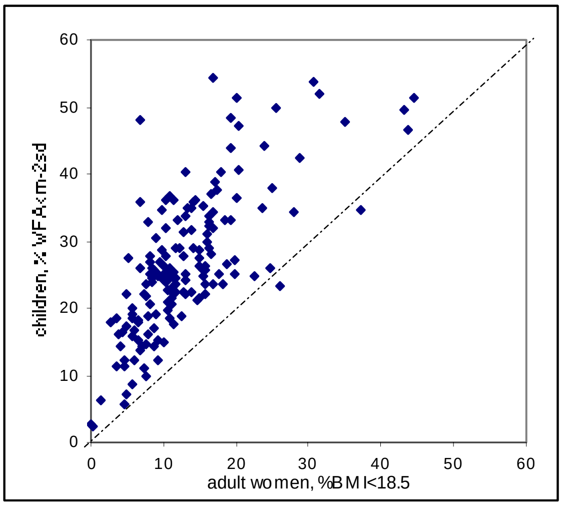

Figure 2b Africa

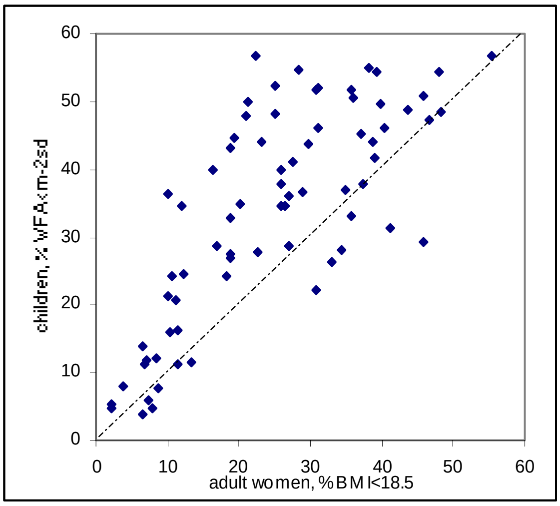

Figure 2c Asia

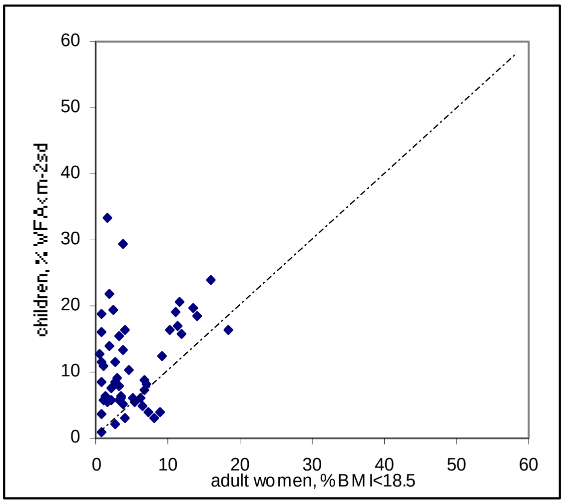

Figure 2d Latin America

Figure 2. Relationships between undernutrition prevalence among children (0-3 or 0-5 years) and adult women at the level of subnational geographical units. Source: see Annex I.

More remarkably, figure 2 reveals that data points are in particular located in the upper left parts of the diagrams. This implies, among other things, that intermediate and high levels of child malnutrition are associated with widely varying levels of undernutrition among adult women. It also implies that high levels of undernutrition among adult women are almost invariably associated with high levels of child malnutrition. This pattern in the relationship between undernutrition among children and adults holds true for each of the three developing regions, and has been articulated by adding the 45º lines in figures 2a, 2b, 2c and 2d.

The relationships between undernutrition in children and adults at subnational level have been estimated with the same quadratic regression formula as used for estimating these relationships with national level data. Table 2 shows that, again, both for all geographical subunits from the three developing regions together, and separately for the geographical subunits from countries in Asia and Africa, most parameters of the relationships between undernutrition in children and adults are highly significant (p<0.0001). However, the r-square results are now considerably lower (0.65, 0.65, and 0,56), which reflect the fact that datapoints are more widely scattered. For Latin America there is no significant relationship between undernutrition in children and undernutrition in adults.

Table 2. Regression analysis between undernutrition prevalence in children and undernutrition prevalence in adult women at subnational level.

	N	A0	P	A1	P	A2	P	R2
All	289	6.10	<0.0001	1.80	<0.0001	-0.020	<0.0001	0.65
Asia	73	-0.93	0.8033	2.22	<0.0001	-0.026	0.0001	0.65
Africa	164	8.51	<0.0001	1.74	<0.0001	-0.020	0.0002	0.56
L America	52	11.83	<0.0001	-0.84	0.2461	0.085	0.0604	0.15

Regression: %lowWFA= A0 + A1 (%lowBMI) + A2 (%lowBMI)2 ;%lowWFA=percentage children (0-3 or 0-5 years) with weight-for-age below median-2sd; %lowBMI=percentage adult women with Body Mass Index<18.5; Source: see Annex I.

For a further characterization of the distribution of the undernutrition prevalence rates in children and adult women, the 289 geographical units for which data are available have been divided into tertiles. This has been done in two ways, either on the basis of prevalence of a low Body Mass Index among adult women (% low BMI) or on the basis of the prevalence of low weight-for-age among children (% low WFA). Subsequently, for the tertiles based on the '% low BMI' ranking, the mean and standard deviation of the prevalence of '% low WFA' was calculated, while for the tertiles based on the '% low WFA' ranking, the mean and standard deviation of '% low BMI' was calculated (Table 3).

Table 3. Standard deviation of undernutrition prevalence in children at different levels (tertiles) of under-nutrition prevalence in adult women, and standard deviation of undernutrition prevalence of adult women at different levels (tertiles) of undernutrition prevalence in children

% Low BMI[1)] Tertile	% Low WFA[2)] Mean	Sd [3)]	% Low WFA Tertile	% Low BMI Mean	Sd
1 (n=96)	13.6	8.7 *	1 (n=96)	5.7	3.6 *
2 (n=97)	24.1	7.0 * #	2 (n=97)	13.3	6.8 *
3 (n=96)	39.2	10.0 #	3 (n=96)	24.4	11.6 *

1) %lowBMI= percentage adult women with Body Mass Index<18.5; 2) %lowWFA=percentage children (0-3 or 0-5 years) with weight-for-age below median-2sd; 3) Standard deviations with similar symbols (* or #) have significantly different F-values (P<0005). All prevalence rates as reported at the level of subnational geographical units. Source: see Annex I.

Table 3 shows that for each of the three '% low BMI' tertiles, the standard deviation for the '% low WFA' results are in the same order of magnitude, and the result for the lowest tertile (sd=8.7) is not significantly different from the result for the highest tertile (sd=10.0). Results for the three '% low WFA' tertiles, however, are very different as here the standard deviation for the

'% low BMI' result increases strongly and significantly when going from the lowest to the highest tertile (from 3.6 to 11.6).

This pattern in the variances of prevalence rates of undernutrition among respectively children and adult women confirms the visual observation that high levels of undernutrition in adult women are strongly associated with high levels of child undernutrition, but that relatively high levels of undernutrition in children are associated with a wide range of undernutrition prevalence rates in adult women. Thus, on the one hand there are provinces or districts where undernutrition rates are relatively high both in adult women and in children, but on the other hand there are also many regions where malnutrition in children is high, but where undernutrition in adults is relatively low. Districts or provinces where adult undernutrition is high but child malnutrition is low are almost non-existent.

Trends in undernutrition prevalence

For a further interpretation of the available information on the relationships between undernutrition prevalence among children and adults, it is also considered relevant to investigate how changes over time in undernutrition prevalence in children are related to changes over time in undernutrition prevalence in adults. In principle, also here a positive correlation is expected.

Results on these trends as they occur at the level of countries are presented in figure 3. The figure is divided into four quadrants (I, II, III, and IV), with datapoints in the quadrants II and III representing observations in which undernutrition prevalence rates in children and adult women are moving in the same direction, and datapoints in quadrants I and IV representing observations where undernutrition prevalence rates in children and adult women are moving in opposite direction. In principle it is expected that the majority of data points would be either in the second quadrant where undernutrition prevalence rates among children and adults both decrease, or in the third quadrant where undernutrition prevalence rates in children and adults both increase.

Figure 3 reveals that this expectation is not fully met. While indeed the larger number of data points are in the second and third quadrant, there are still a considerable number of observations in the first and fourth quadrant, indicating that undernutrition prevalence rates in children and adults move in different directions. Yet, the correlation coefficient between the changes in undernutrition prevalence in children and undernutrition prevalence in adult women is significantly positive (r^2=0.44, $p<0.0001$), confirming the expectation that changes in the undernutrition prevalence rates tend to be in the same direction for children and adult women.

It may be noted that the time intervals between surveys in the various countries on which the trend data are based are not very long (average 4 years and 11 months, range 3 to 8 years), which may partially explain the fact that the relationship between changes in undernutrition prevalence among children and adults are not too strong.

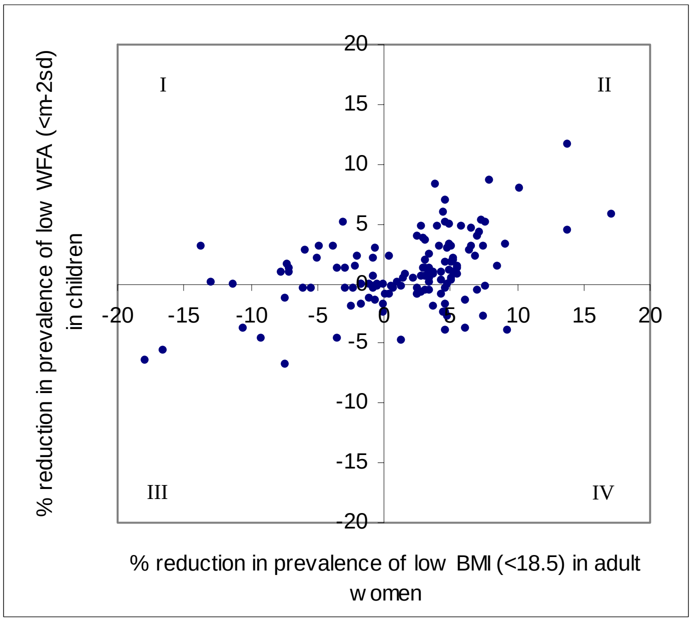

Figure 3. Relationship between changes in undernutrition prevalence among children (0-3 or 0-5 years) and undernutrition prevalence among adult women; positive changes are reductions in undernutrition prevalence, negative changes are increases in undernutrition prevalence. Source: see Annex II.

4. Discussion

The present study investigates, at national and subnational level, the relationships between undernutrition prevalence rates in children and in adults in low-income, often food-insecure developing countries. As poverty and food insecurity are likely to affect, at least to some extent, all age groups of a community, a possibly weak but positive relationship between undernutrition prevalence in various age segments (children, adults, elderly) is expected. In view of limitations as regards data availability, the present report addresses the relationships between undernutrition in children and adult women.

Results reveal that there is, at the level of countries, a strong and significantly positive relationship between undernutrition prevalence rates in children and adult women. This is the case for the combined dataset for countries from Africa, Asia and Latin America, and also for countries from Africa and Asia separately. Only, for Latin America, where overall prevalence rates of undernutrition are much lower, both in children and adults, there is no longer a positive relationship. Results are in support of the general concept that, at the level of countries, information on undernutrition prevalence in children can be considered a proximate of the overall nutritional and food security conditions in a country. In this respect it is also relevant to note that differences in undernutrition prevalence between adult males and adult females have been shown to be generally small (Nubé and van den Boom, 2003), and that therefore the level of undernutrition among adult women can be considered a proximate of undernutrition among all adults, males and females together.

When considering the results at the level of smaller geographical units within countries (provinces, districts) findings are different. First, the strengths of the relationships between undernutrition prevalence rates among children and among adult women, as analyzed by simple OLS, are weaker. In the second place, the distribution of data points appears to be asymmetrical. Results show that high levels of undernutrition in adult women are almost invariably associated with high levels of undernutrition in children. At the same time, however, relatively high levels of undernutrition in children are associated with a wide range of undernutrition levels in adult women. In other words, it is not uncommon to find a combination of a relatively low level of undernutrition among adult women and a rather high level of child malnutrition.

It is important to note that the present analysis is based on undernutrition prevalence data either at the level of countries or at the level of provinces or districts within countries, but not at the level of households. In recent years, a number of studies have been published which report on intrahousehold patterns with respect to nutritional status. These studies reveal that household members belonging to different age brackets may be differently affected by undernutrition. For example, already in 1985 the concept of family anthropometry was introduced by Dugdale, showing that households may reveal various patterns with respect to the relative prevalence rates of undernutrition among children and adults within households (Dugdale, 1985). These observations have been confirmed by several studies of more recent date (Bégin *et al*., 1992; Lindtjørn *et al*., 1997; Monteiro *et al*.,1997). The most detailed study which strongly relates to the present report is a study on the relationships between the nutritional status of mothers and their children in selected population groups in India, Ethiopia and Zimbabwe (James *et al.*, 1999) The study reports highly varying levels of malnutrition among children and mothers in the surveyed population groups in the various countries, and also widely varying correlation coefficients between nutritional status of mothers and their children.

Furthermore, it should be noted that in particular in more recent years an increasing number of studies, being undertaken among poor communities in developing countries, report on the coexistence of undernutrition and overnutrition, not only at the level of communities but also at the level of households (Doak *et al*., 2000; Florencio *et al*., 2001; Angeles-Agdeppa *et al*., 2003; Garrett and Ruel, 2003; Khor and Sharif, 2003).

With respect to the observed relationships between undernutrition among children and adult women, as presented in this study, it should be noted that results are partially determined by the choice of cut-off points below which individuals are classified as undernourished. For the present report the most commonly used cut-off points have been selected, which are for children below 3 or 5 years the mean of the reference population minus two standard deviations, and for adults a Body Mass Index of 18.5 (WHO, 1995). In particular with respect to adults the selection of the most appropriate cut-off point to discriminate between adequate and inadequate nutritional status remains subject of debate, and other cut-off points or methods to define undernutrition have been proposed (van der Sande *et al.*, 2001; Norgan, 1995). Clearly, when other cut-off points would be applied, the absolute levels of undernutrition prevalence will change. However, the overall patterns in the relationships between undernutrition among children and adults are unlikely to differ strongly from the presently reported results.

From a policy point of view, the most important question is what factors are responsible for the diverse patterns in undernutrition prevalence rates as observed among children and adults. When reviewing the various studies that have addressed the relationships between undernutrition in children and adults, a general concept emerges that overall food shortages on the one hand and poor conditions with respect to health and sanitation and with respect to education and child care on the other hand have different impacts on the nutritional conditions of respectively children and adults. Thus, in the study by James (1999) it is hypothesized that the combination of wasting among children and a low body mass index of the mother points to food insecurity, while the combination of wasting among children and normal body mass index of the mother points to a need for public health measures (water, sanitation) and maternal education. And in a study by Armar-Klemesu (2000) has the combined occurrence of overnutrition and undernutrition in one and the same household been attributed to factors other than absolute levels of household food availability (Armar-Klemesu *et al*., 2000).

The importance of the present study is that it is the first one in which a systematic analysis has been made on the relationships between undernutrition prevalence rates among children and adults, both at the level of countries and at the level of regions within countries (districts, provinces). In line with previous studies, it is hypothesized that in regions where poor anthropometric results are being observed in both children and adults, limited overall levels in household food supply are most likely to play an important role in the causation of undernutrition. Where problems of undernutrition in children are serious, but where adults appear to be, on average, in a relatively better nutritional condition, other factors than household level food shortages are likely to be responsible for the occurrence of undernutrition in children. Among these factors are for example frequent occurrence of infectious diseases, and associated poor water and sanitation conditions, poor quality of diets with deficiencies in micronutrients (vitamins, minerals), and insufficient opportunities for mothers or other caretakers to provide their children with adequate care (Stephensen, 1999).

In a more general context, the results of the present study are considered of relevance in evaluating anthropometric information for the assessment of poverty and food insecurity. While for the assessment of poverty, monetary indicators (incomes, expenditures) are most widely used, their limitations, in particular in developing countries, are well known and have been extensively discussed (Ravallion, 1995; McKay and Lawson, 2003). Thus, over past decades there have been continuing efforts to develop methods for the assessment of poverty which are less dependant on incomes or expenditures (Baulch and Masset, 2003). At the level of countries most authoritative in this area are probably the activities of UNDP who developed the so called Human Development Index (HDI), incorporating information on income, health and education into one composite indicator (UNDP, 2004). In addition, various other related indicators have been developed such as the Human Poverty Index (HPI) and the Gender related Development Index (GDI) (UNDP, 2004). While these indicators play an important role in assessing development and in monitoring progress in eradicating or reducing poverty, there remains the disadvantage that the constructed indices still depend on the, to some extent, arbitrary weighting of the contributing factors.

Another approach in circumventing the tedious task of collecting information on incomes or expenditure has been the development of asset indicators. The information required for such asset indicators is relatively easy to collect, and it has been shown to be a useful alternative to income or expenditure information (Sahn, 2003; Sahn and Stifel, 2003). Yet, also with respect to these asset indicators there are clearly methodological problems, for example with respect to the choice of assets to be included or, again, the possible weighing of its various components. It is interesting to note that in the study by Sahn (2003), anthropometric information on children has been selected as the indicator against which the validity of the asset indicator has been evaluated.

Probably partially in response to these problems with respect to the various indicators of human development and poverty, over recent years anthropometric information is increasingly being used and accepted as an indicator of overall human well being (Nubé *et al.*, 1998; Srinivasan, 2000; Nubé, 2001; Carter and Maluccio, 2003). In comparison with income or expenditure data there is no need for information on prices or on purchasing power, and also no need for inflation correction factors when analyzing trends over time. Another advantage is that anthropometric data are collected in individuals, and results are therefore directly available in the form of headcounts.

Results of the present study, which provide detailed information on the relationships between undernutrition among children and adults, are considered of relevance for further evaluating and proper usage of anthropometric information in the assessment of poverty and human well being.

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Annex I: Listing of surveys consulted

	Source	Year [1)]	Low BMI %	Low WFA %	Sample size adult women	Sample size children	Number of geogra-phical subunits
Africa							
Benin	a)	2001	10.7	23.8	5320	2683	7
Burkina Faso	a)	‘98/’99	13.3	36.4	3279	2530	5
Cameroon	a)	1998	7.9	22.2	1659	1920	2
Centr. Afr. Rep.	a)	‘94/’95	15.3	27.3	1921	2310	5
Chad	a)	‘96/’97	21.1	39.2	3546	3541	3
Comoros	a)	1996	10.3	25.8	730	921	2
Côte d’Ivoire	a)	‘98/’99	8.2	21.4	3012	1100	5
Egypt	a)	2000	0.6	4.5	13664	6235	3
Eritrea	a)	2000	37.3	39.0	7685	3080	5
Ethiopia	a)	2000	30.1	45.3	13447	6075	4
Gabon	a)	2000	6.6	13.0	2190	2014	5
Ghana	a)	1998	11.3	24.9	1945	1638	8
Guinea	a)	1999	11.8	25.4	3153	2821	5
Kenya	a)	1998	11.9	21.5	3106	4413	7
Madagascar	a)	1997	20.6	40.0	2604	3080	5
Malawi	a)	2000	8.8	27.8	11125	6071	12
Mali	a)	2001	12.6	34.2	10049	6261	7
Mauritania	a)	‘00/’01	13.0	28.4	6843	2226	5
Mozambique	a)	1997	10.9	26.1	3088	1706	7
Namibia	a)	1992	13.9	25.9	2580	2430	4
Niger	a)	1998	20.7	49.6	3324	4022	6
Nigeria	a)	1999	16.1	27.3	1972	1473	4
Rwanda	a)	2000	9.0	24.8	8968	3884	12
Senegal	a)	‘92/’93	15.0	19.5	2786	2469	4
South Africa	b) c)	’98; ‘94/’95	5.6	10.1	7717	5486	-
Tanzania	a)	1996	9.2	31.7	3629	3498	7
Togo	a)	1998	10.9	25.1	3034	3260	6
Uganda	a)	2000	10.4	24.7	5601	3585	4
Zambia	a)	‘01/’02	15.0	29.8	6591	3622	9
Zimbabwe	a)	1999	5.6	11.9	5590	1833	7
Asia							
Bangladesh	a)	99/00	45.4	45.7	4483	3300	6
Cambodja	a)	2000	20.7	40.1	6760	1892	9
China	b) d)	1991; 1992	7.8	16.4	2150	99175	-
India	a)	98/99	35.8	47.0	77119	24600	25
Indonesia	b) e)	1996; 1995	17.0	32.1	5817	5702	-
Jordan	a)	1997	2.3	4.9	2925	3266	3
Kazakhstan	a)	1999	7.4	4.6	2238	354	2
Kyrgyz Rep.	a)	1997	6.9	11.0	3518	1015	2
Lao	3)	2001	16.2	40.0	±3000	1347	-
Malaysia	b) f)	1996; 1995	14.1	20.1	15134	344736	-
Nepal	a)	2001	26.7	46.4	7784	3767	5
Pakistan	b) g)	‘90/’94;1996	25.3	38.2	n.i.	7368	-
Philippines	b) h)	1998	13.9	28.0	1557	15098	-
Sri Lanka	b) I)	1995	33.4	27.9	1344	1580	-
Turkmenistan	a)	2000	9.9	13.1	7316	1746	6
Uzbekistan	a)	1996	10.3	18.8	4038	989	4
Vietnam	b) h)	1998; 1997	34.3	40.6	4212	18690	3
Yemen	a)	1997	25.2	43.7	5479	4967	8

Annex I (continued)

	Source	Year [1)]	Low BMI %	Low WFA %	Sample size adult women	Sample size children	Number of geogra-phical subunits
Latin America							
Bolivia	a)	1998	0.9	9.5	2791	3244	5
Brasil	a)	1996	6.3	5.4	2951	2306	6
Colombia	a)	2000	3.2	7.2	3070	2498	5
Dom. Rep.	a)	1996	6.2	6.3	2492	2130	5
Guatemala	a)	'98/'99	2.0	23.9	2200	2150	4
Haiti	a)	2000	11.5	16.7	9090	3750	10
Nicaragua	a)	2001	3.5	9.3	11838	3711	13
Peru	a)	1996	1.1	8.6	9605	7958	4

Notes:

[1)] When two years separated by semicolon, the first year indicates year of data collection on adult women, the second year indicates year of data collection on children; when two years separated by slash then data collection spread over two years.

[2)] For Lao, Malaysia, Pakistan and Vietnam 0-5 years children, for all other countries 0-3 years children.

Sources:

a) DHS, 2004, , Demographic and Health Surveys, Measure DHS, Macro International Inc., Calverton, USA; internet: http://www.measuredhs.com ; accessed 26 September 2004.

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Annex II: Listing of countries used for analysis of trend

Country	Source	First survey	Second survey	Interval (yrs)
Bangladesh	DHS	1996/1997	1999/2000	3
Benin	DHS	1996	2001	5
Bolivia	DHS	1994	1998	4
Burkina Faso	DHS	1993	1998/1999	5.5
Colombia	DHS	1995	2000	5
Côte d'Ivoire	DHS	1994	1998	4
Eritrea	DHS	1995	2002	7
Ghana	DHS	1993	1998	5
Guatemala	DHS	1995	1998/1999	3.5
Haiti	DHS	1994/1995	2000	5
Kazakhstan	DHS	1995	1999	5.5
Kenya	DHS	1992	1998	6
Madagascar	DHS	1992	1997	5
Malawi	DHS	1992	2000	8
Mali	DHS	1995/1996	2001	5.5
Nepal	DHS	1996	2001	5
Niger	DHS	1992	1996	4
Tanzania	DHS	1992	1996	4
Uganda	DHS	1995	2000	5
Zambia	DHS	1992	1996	4
Zimbabwe	DHS	1994	1999	5

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