Malnutrition, Poverty, and Economic Growth

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This paper examines the use of nutrition and health indicators for assessment of well-being and deprivation in the developing world, arguing that child anthropometric indicators provide a reliable, interesting, and readily available data source for comparison of absolute deprivation across populations and countries. Indicators of child malnutrition shortfall—especially height for age and weight for age—can therefore be used to supplement statistics on income/consumption poverty in poor countries. A major drawback of child anthropometric indicators is their lack of coverage of the adult population. The paper also presents novel analyses of the association between economic growth and the incidence of stunting (low height for age) using data on spells of change. A very small but statistically significant association between changes in income and changes in stunting is found, confirming previous results based on other methodologies that economic growth is insufficient to reduce malnutrition and that direct nutrition and health interventions are required.

JEL-codes: I1, I3, O1

Key words: Nutrition, poverty, stunting, welfare indicators
1. INTRODUCTION

Improved nutrition and health is a key priority in international development. Better health and nutrition is both an end in itself and a means to escape income poverty. Child malnutrition and ill health is of utmost concern since deprivation in early childhood often causes irreversible damage to physical and mental health, reduces learning at school, and leads to lower incomes as adult (ACC/SCN and IFPRI, 2002). It is therefore appropriate that several of the Millennium Development Goals adopted by the United Nations reflect on child malnutrition, including the goal to halve by 2015 the number of people living in hunger, and the goal to reduce child mortality by two-thirds.

There is growing interest in health and nutrition indicators, also by economists. Development researchers and practitioners increasingly define and conceptualize poverty in multidimensional terms, with health and nutrition among the most important dimensions. Measurement of health and nutrition status is an important topic in its own rights. However, indicators of health and nutrition outcomes, if chosen wisely, can also contribute to comparisons of well-being and deprivation more widely. In particular, child malnutrition indicators can help overcome some of the weaknesses that have been documented with comparisons of income/consumption poverty, such as the intractable problem of ensuring accurate monetary conversions.

This paper aims to contribute to the literature on international welfare comparison through health and nutrition indicators, pursuing two main arguments. The first argument is that indicators of anthropometric shortfall–especially low height and low weight relative to age–are uniquely suited for assessing absolute deprivation in developing countries: Anthropometric indicators are relatively precise, readily available for most countries, reflect the preferences and concerns of many poor people, intuitive, easy to use for advocacy, and consistent over time and across subgroups. Anthropometric indicators are therefore well suited to complement measures of income/consumption poverty, especially for cross-country, subgroup, and long run comparisons. Anthropometric indicators do not measure the same thing as measures of monetary poverty and should not replace such measures.

The second argument, based on analysis of spells of change, is that the association between economic growth and chronic child malnutrition, although statistically significant, is very small and much lower than the elasticity of growth on poverty. Direct interventions aimed at reducing infant malnutrition are therefore required.

The next section briefly surveys the weaknesses of international welfare comparisons based on monetary comparisons. This is followed by an overview of available non-monetary health and nutrition indicators in Section 3. Section 4 contrasts some of the pros and cons of anthropometrics versus
income/consumption poverty, while Section 5 presents the analysis of the growth elasticity of malnutrition. Section 6 concludes.

2. PROBLEMS OF MONETARY POVERTY COMPARISONS

In order to measure and compare progress (or lack of it) towards alleviating poverty, the World Bank and other agencies routinely collect and disseminate data on the number of persons living in poverty in a large number of countries. Analysis and measurement of absolute poverty is usually based on household expenditure or income obtained from nationally representative household surveys. Households whose per capita expenditure or income fall below the poverty line are said to be poor. This definition supports consistent tracking of poverty over time provided comparable surveys are available and the poverty line is kept fixed in real terms.

Comparing poverty between countries and even regions of a country is much harder. Most international comparisons are based upon the World Bank’s $1/day poverty line. This is defined as $1.08 per household member per day using 1993 Purchasing Power Parity (PPP) exchange rates, establishing an internationally comparable and intuitive poverty line (Chen and Ravallion, 2001). Although the resulting poverty estimates are cited widely, the methodological foundations are not as firm as one could desire. In an influential article, Deaton (2001) explains why.

According to Deaton (2001), one set of problems with the current global poverty counts stems from the difficulty of defining a poverty line that is consistent across countries. PPP rates used for conversion were never designed to compare poverty, and the basket of goods used to establish PPP measures is not necessarily relevant to the consumption choices of the poor. Moreover, PPP estimates are frequently revised, causing huge swings in poverty estimates unreflected in living conditions faced by the poor. A second set of issues relates to the underlying surveys used to assess households’ incomes and expenditures. Factors such as survey design, recall period used when inquiring households about expenditure items, methods of price deflation, the omission of public goods, and the choice between using expenditures or income all have a troubling influence on poverty estimates. In a number of countries, there are large and growing discrepancies between national accounts-based and survey-based estimates of average household consumption, the cause of which is not well understood (Ravallion, 2001a). A third weakness is the inability to measure the intra-household distribution of consumption and poverty. A household with average expenditures above the poverty line may well have individual members consuming below it, and vice versa, something that the usual household income and expenditure surveys (and the poverty estimates these give rise to) are unable to get at. Given that a large number of households consume near the poverty line and that
the intra-household distribution likely differs significantly between countries, the share of individuals consuming less than the poverty line may not be well captured by the standard household-level measures.¹

Comparisons of income/consumption poverty at the sub-national level suffer from parallel methodological weaknesses. Many developing countries are characterized by substantial regional variation in the consumption profiles of the poor and in the relative prices faced by poor consumers. In those circumstances, a national food poverty line based on some notion of the food consumption vector of the “average” poor household may be insufficiently specific to locally-relevant notions of poverty (for example because the food poverty line is priced using locally irrelevant food items). However, allowing regional variation in food poverty lines based on observed inter-regional differences in the food consumption vector of the poor may not be consistent because it runs the risk of admitting higher-value food items into the bundle in regions of higher welfare (Tarp and others, 2002).

These considerations highlight the theoretical and practical difficulties of ensuring that poverty lines accurately represent similar levels of welfare across regions and countries and that the ensuing regional and international poverty comparisons are reliable. It is therefore appropriate for economists to take a closer look at non-monetary indicators of well-being and deprivation. A case can be made that anthropometric indicators of low height for age and low weight for age are among the best suited to this end among all the available health and nutrition indicators.

3. INDICATORS OF HEALTH AND NUTRITION

Indicators of health and nutrition are attractive for a number of reasons: they add value in themselves, chiefly by reflecting the health and nutrition status of the population; they can help overcome some the known weaknesses of monetary welfare indicators; and they are consistent with prevailing multidimensional definitions of poverty.

Poor people themselves express an overriding concern with health issues. Recent compilations of participatory poverty assessments have documented how central health is to poor people, and how often ill health and income poverty reinforce one another in a vicious circle (Narayan et al., 2000; WHO and World Bank, 2002). Quantitative studies have also found such a link. Deaton (2001: 145) notes that “Those of us who have been exposed to field experience have been impressed by the prominence of health concerns in what people tell you about their poverty. Income, housing, and jobs tend to predominate when health is normal, but if someone gets sick, is hit by a car, or has a friend or a relative who has been raped or murdered, income poverty recedes into the background in people’s perceptions”.

¹ See also the interesting discussion of Deaton’s article by Ravallion (2001b) and Srinivasan (2001).
A variety of indicators is available to describe various aspects of the food security-nutrition-health nexus, either nutritional inputs (food availability) or nutrition-health outcomes (anthropometric indicators, national health statistics on mortality and longevity). The available indicators are surveyed in the following, assessing their usefulness for cross-country welfare comparison.

**Anthropometric indicators of child health and nutrition**

In the field of public health, there is a tradition going back to the 1950s for measuring the state of child nutrition and health using indicators based on the height, weight, age, and sex of the child (de Onis, 2000). When a child does not receive sufficient and adequate food relative to need, is ill, or both its body weight will be temporarily reduced. If the situation causing low weight is rectified, the child’s growth will catch up. However, if the episodes of nutritional deprivation and/or disease are repeated or prolonged, the result will be growth failure, short height. This is called *stunting* or chronic malnutrition. Stunting is a biological adaptation to inadequate food, frequent episodes of disease, or both during the first few years of life. Stunting is associated with greater mortality risk. Survivors face irreversible slower growth and smaller adult body size (Payne and Lipton, 1994). Thus, stunting reflects the cumulative impact of inadequate nutrition, prolonged illness, or both—children that are often sick do not eat much and do not grow tall. An authoritative source on human biological growth states, “The health of a population is most accurately reflected in the rate of growth of its children” (Eveleth and Tanner, 1991).

Low weight relative to height is often referred to as temporary malnutrition or *wasting*. Low weight-for-age, also called *underweight*, can be due to either wasting or stunting. Body weight fluctuates quite a bit, for example in response to variation in weather and food availability, whereas height has more power to pinpoint the chronically deprived. Although there is some controversy about which anthropometric indicator best predicts mortality risk (Pelletier, 1994), stunting is usually regarded as the best indicator of children’s long-run health status and well-being (de Onis et al, 2000).\(^2\) Height is a powerful clinical indicator: most malnourished children seem normal to their parents and others until their size is compared with what is expected for their age (Shrimpton, 2002). This idea has been formalized in the concept of height-for-age z-score, which is found by comparing an individual child’s height to the height distribution of a well-nourished reference population of the same age and sex. Children falling below the median by two standard deviations are said to be stunted.

\(^2\) Regression analyses of wasting typically yield results that are less significant and reliable as compared to analyses of stunting. Arguably, this is because children’s weight exhibits more random short-term fluctuation than their height.
Stunted children suffer from elevated mortality risk, slower mental development, begin school later, and perform less well in school, even in mild to moderate cases (Jukes et al, 2002). Stunting often starts in the fetal stage and accumulates through the first few years of life; at this point stunting becomes irreversible. Because of the synergy between nutrition and disease (both chronic and contagious), child malnutrition increases mortality risk by up to 8 times and may ultimately account for around half of all child deaths (Pelletier, 1994). Childhood malnutrition can be a catalyst for poverty later in life as it leads to inferior capacity for physical work, reduced work productivity, lower wages, less resilience to social, economic, and natural shocks, and increased reproductive and maternal health risks (Gopalan, 1992; de Onis et al, 2000; Haddad, 2002; Dasgupta, 1993 and 1997).

Although the role of genetic factors for adult human height is still not entirely resolved, there is no evidence to suggest that the growth potential of pre-school children varies across ethnic groups. For example, studies of African and Asian children from upper-class backgrounds have found that they experience a speed of growth that is almost identical to the speed of growth of US and UK children (Gopalan, 1992). Based on the conclusion that growth potential of pre-school children does not differ across ethnic groups, the WHO (1995) recommends the use of a single global reference population for calculating child anthropometric statistics. The use of a global reference population has previously been debated, but appears by now almost universally accepted by international experts in the field, especially for height (Eveleth and Tanner, 1991; Gopalan, 1992; Alderman, 2000). This consensus has facilitated a systematic collection of standardized anthropometric data on a global basis based on the National Center for Health Statistics/WHO reference population, and a sizeable database of comparable anthropometric data is now available, making it possible to consistently track indicators over time and across countries and perform cross-country studies as in Section 5 below. Stunting data report the incidence of rather severe growth failure—height for age below -2 standard deviations; this cut off point is somewhat arbitrary given that children suffering mild to moderate deprivation also experience elevated mortality risk (Pelletier, 1994; Martorell and Ho, 1984).

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1 Several comprehensive surveys of the evidence reach this conclusion, including Svedberg (2000: Ch 12), de Onis (2000), Dasgupta (1993: p.83), and Gopalan (1992). This should not be confused with the discussion about possible genetic components in final adult stature of individuals and populations.

4 For weight, there is concern that the US reference population may be too obese relative to optimal nutrition. That concern does not arise for height, since children can never exceed their genetic potential for height (Gopalan, 1992).

5 See de Onis et al (2000) and www.who.int/nutgrowthdb. The WHO data (on incidence of low height-for-age and low weight-for-age) are also included in the World Bank’s World Development Indicators. All these data are based on nationally representative surveys benchmarked against an identical reference population.
Assessing international deprivation based on children’s anthropometric shortfall is consistent with definitions of absolute poverty, which invariably evolve around the inability to command resources sufficient for fulfilling basic needs. The most basic of needs for any child is to obtain the nutrition adequate for normal growth and absence of preventable illnesses. Malnutrition is an acute deprivation of the most basic of needs, and stunting data reflect the cumulative impact of such deprivation. Many cultures embody norms according to which parents, relatives, and society at large have to protect and care for children, an idea that has been enshrined in various human rights declarations, including the 1989 Convention on the Rights of the Child (Haddad, 2002; Eide 2002). There are hence compelling ethical underpinnings of adopting a greater focus on child anthropometric shortfall.

Summing up, indicators of nutritional shortfall directly measure, without the need for complicating monetary conversions, the extent to which a society is able to fulfill the most basic and urgent needs of its citizens. As a concept, the proportion of children who experience malnutrition is intuitive and easy to understand, and it therefore has excellent powers for advocacy.

**Anthropometric indicators of adult health**

Work by Bogin (2001) and others suggests that genetic differences in growth potential are small, whether for children or adults. Final adult stature of a population can therefore be used as an indicator of health and well-being. Adult height has been used by economic historians to study improvements in well-being over the very long run (Steckel, 1995; Steckel and Nicholas, 1991; Fogel, 1994). The rapid increase in height for each successive generation of immigrant populations, and the historical gains in height in all of the developed countries over the last few centuries (in Japan, decades) are also suggestive that the average height of a population is largely determined by nutrition and health (Floud, 1992).

More recently, Body Mass Index (BMI) has become a popular indicator of adult health. BMI is defined as weight (in kilogram) relative to squared height (measured in meters). BMI below and above the norm is a good predictor of current morbidity and mortality risk of adults. Yet BMI does not capture growth retardation as a biological adaptation to inadequate nutrition early in life: a short person can have a normal BMI yet still suffer the inhibiting consequences of stunting, including reduced work productivity. Other measures, for example based upon arm circumference, are also sometimes used but these are not internationally reported and therefore not good for comparisons.

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6 Final height reflects upon the accumulated health and nutritional deprivation during fetal development, infancy, childhood and adolescence, and as such is not a very good indicator of current health and nutrition.  
7 Average final height of Japanese rose by 4.3 cm for males and 2.7 cm for females from 1957-1977 (Gopalan, 1992).
Nutritional availability

Estimates of food and calorie availability at the household level are often used to discuss the global incidence of hunger. Two competing estimates of calorie availability shortfall are available: The FAO model and household surveys. The FAO uses a model to estimate the share of undernourished in a country based on three parameters: national per-capita availability of calories, the distribution of calories across households (assumed to be lognormal), and a norm for the critical minimum intake of calories.\(^8\) Household expenditure surveys can also be used to assess calorie availability at the household level; in this case, each food item consumed is converted into calories using standard tables of calorie content. The focus on calories is somewhat arbitrary given that deficiencies in protein, iodine, iron, vitamins, and other micronutrients also can cause severe health implications, even where energy consumption is sufficient. Moreover, and perhaps worse, calorie shortfalls are inherently problematic to estimate because calorie needs differ across individuals according to age, gender, body size, body composition, health status, and physical activity as well as over time for any given individual in ways that are hard to quantify (Srinivasan, 1992). Moreover, measures of food availability are unable to shed light on the intra-household distribution of food, care, and health in the same way as household-level expenditure surveys are uninformative about the intra-household distribution of expenditure and poverty. In contrast, anthropometric indicators provide evidence of nutritional shortfall net of needs at the level of the individual, and therefore circumvent the two intractable problems of establishing individual nutritional requirements and measuring or modeling the intra-household resource distribution.

National health statistics

Statistics on infant and child mortality and life expectancy assess the health of a country’s population and are indicative of important aspects of well-being. These measures are intuitive, easy to use, and widely available. They are, however, often available only with a considerable lag and may not always be nationally representative in poor countries.

As indicators of global deprivation, mortality and longevity measures suffer from some shortcomings. First, not all deprived people die from their deprivation; arguably, non-fatal deprivation should also count. Secondly, mortality and longevity statistics are defined only for an entire population

\(^8\) Svedberg (1999 and 2000) criticizes the assumptions and data underlying the FAO method.
and—unlike anthropometrics—cannot be used to assess individuals at risk. Finally, although the data quality of national health statistics is hard to assess in each case, they are known to be of mixed quality, and sometimes based on small samples and outdated figures (Svedberg, 2000). Similar remarks can be made about the UNDP’s Human Development Index (HDI) and other composite indicators based on national health and education statistics. In contrast, anthropometric indicators collected through household surveys are subject to standardized methodologies and sampling techniques designed to ensure national representativeness.

**Summing up**

For all of the reasons argued above, indicators of anthropometric shortfall seem to be reliable and attractive tools for comparing levels of absolute deprivation across sub-groups, regions, and countries. Which anthropometric indicator is preferable? Choice of anthropometric measure can have a large impact on results given that the correlation between wasting and stunting is low (Victora, 1992). One could make the point that stunting best captures permanent and cumulative deprivation, is less prone to short-term variability than measures based on weight for height, and therefore better measures well-being or deprivation. However, Svedberg (2000) proposes using a composite anthropometric index, namely the proportion of children that are either stunted, wasted, or underweight. The rationale is that the anthropometric measures each capture a distinct aspect of childhood deprivation, and the total universe of deprived children therefore includes all who are either stunted, wasted, or underweight. This composite index has yet to be applied in the literature, let alone reported by international organizations. However, one of the existing measures—namely low weight-for-age (underweight)—captures both temporary and chronic nutritional shortfall and therefore comes close to the composite index proposed by Svedberg. Haddad and others (2003) study income-malnutrition links using underweight.

Data on stunting and underweight are easily available. Statistics on the incidence of stunting and underweight for children below 60 months are reported in the *World Development Indicator.* For international

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9 Yet there is a reverse argument. Those individuals who have perished due to malnutrition can obviously not be included in surveys, and hence are not counted in the anthropometric statistics. One can say that statistics on stunting suffer from a sample selection problem in that the lower tail is missing due to death. Statistics on income/consumption poverty suffer from exactly the same phenomenon. In principle, precise information on (country-specific) mortality risk at each degree of stunting should make it possible to correct for this problem. In practice, however, it is probably a better idea to supplement the numbers on stunting with data on infant- and child mortality.

10 The incidence of low height for age is often larger than the incidence of underweight; this is puzzling given that a short child presumably also weights less. Perhaps obesity in the reference population drives up the reference standard deviation of weight for age.
comparison, the choice between stunting and underweight may not matter much since the cross-country correlation between low height-for-age and low weight-for-age is around 0.9.

4. COMPARING ANTHROPOMETRIC INDICATORS WITH MEASURES OF INCOME/CONSUMPTION POVERTY

Indicators of anthropometric shortfall have many similarities with standard measures of poverty headcount. Both are concerned with the lower tail of the distribution, measuring shortfall (in income/consumption and in nutrition, respectively) relative to a given norm. Moreover, both measures fail to account for those who have died and therefore left the population under study, despite the fact that both the income poor and the malnourished experience elevated mortality risk. This section briefly discusses the pros and cons of using income/consumption poverty and anthropometrics to assess deprivation.

Benefits of anthropometric indicators relative to income/consumption poverty

The focus of economists on income poverty defined at the household level can sometimes cause public goods to be pushed to the backstage. There are robust links from publicly provided goods such as sanitation, clean water, health care, disease control, traffic safety, absence of crime and violence, and other elements of a "healthy environment" to public health and welfare outcomes. The expenditure aggregates used to assess poverty could in principle be augmented with an imputed value of consumption of certain public goods such as subsidized education and health. For other public goods, including roads, policing, and public administration no such imputation would appear to be feasible. Indicators of anthropometric shortfall implicitly capture aspects of the quality of public goods, specifically how these translate into deprivation of pre-school children. Moreover, measures of child malnutrition are available at the level of individuals, making it possible to assess intra-household differences in deprivation, for example along gender lines.

Anthropometric indicators can be measured with a reasonable degree of accuracy. To compute anthropometric indicators, one needs to collect data on height, weight, age, and gender. Bairagi (1986) claims that z-scores can be measured with a margin of error of a few percentage-points, even under field conditions. The major sources of measurement error (which can produce bias in the reported share of the population below the cut-off) stem from poor training of the enumerators and from errors in child age, which is sometimes difficult for parents to remember (Alderman, 2000). For the smallest children, even a few months error in reported age leads to a sizable error in the z-scores. There is also some imprecision from measuring the height of babies, which has to be done lying rather than standing.
Potential limitations of anthropometric indicators

Failure to cover adult health and nutrition is an obvious drawback of child anthropometrics that needs to be acknowledged openly. However, since the growth deprivation of pre-schoolers is irreversible, and therefore determining the lifetime health endowment of individuals, perhaps the lack of adult coverage is a drawback one can live with in many circumstances.

Economists conceptualize poverty as a state households move in and out of. Stunting, in contrast, is not a state children easily escape from: growth shortfalls in infancy are reversible only for children up to a certain age after which they become irreversible (certainly after teenagers leave the adolescent growth spurt). This needs to be kept in mind when using anthropometric data to assess the impact of policy. Two types of anthropometric data can be used, longitudinal and cross-sectional. Longitudinal data on individual children are used for example for targeting nutritional assistance and relief effort in times of famine and natural disaster (Micklewright and Ismail, 2001). The effect to which economic growth and interventions can reduce malnutrition of individual children depends on the age of these children and the biological mechanisms governing catch-up growth. It is likely that weight (wasting) responds faster than height (stunting). The other type of data, standardized population cross-section surveys of children below 60 months, are used for anthropometric comparisons across countries and over time for entire populations. Examination of change in malnutrition over time for countries in Section V shows substantial movement in under-five stunting rates over fairly short time periods of sometimes even a few years. The median annual change in stunting in the examined spells is 0.6 percentage-points, but changes of 1-2 percentage-points per year are not uncommon. This suggests population average stunting rates can potentially be a useful indicator of socio-economic progress in the short, medium, and long term.

Some may comment that measuring deprivation based on indicators of anthropometric shortfall amounts to confusing the cause (poverty) with its effect (malnutrition and ill health). Needless to say, income/consumption poverty and child malnutrition measure distinct things and should never be confused. However, many studies have suggested that income poverty and under-nutrition are closely intertwined in a vicious circle of low income leading to inappropriate nutrition, which if persistent reinforces present and future poverty due to lower labor productivity, inhibited learning, and other pathways (Deolalikar, 1988; Subramaniam and Deaton, 1996; Ravallion, 1997b; Dasgupta 1997). The notion of a vicious circle of poverty, under-nutrition, and ill health adds to the appeal of anthropometric deprivation indicators.
Correlations between child malnutrition and income poverty

Although many details differ, indicators of income poverty and stunting do not tell fundamentally different stories. Table 1 shows the distribution across continents of world headcount poverty based on the $1/day and $2/day poverty lines as well as the number of stunted children. By all measures, the bulk of global poverty and deprivation is found in Asia; around 69-74 percent of the poor and deprived live in Asia, 20-26 percent are in Sub-Saharan Africa, and the rest in the Americas.

Looking instead at the regional incidence of poverty and stunting, there is a reversal of rank. Stunting data show larger deprivation in South Asia than in Sub-Saharan Africa (43.7 against 35.2 percent), whereas international poverty comparisons suggest that the incidence of $1/day poverty is worse in Africa (48 percent) than it is in South Asia (40 percent). For $2/day poverty, however, the pattern resembles that for stunting, with lower poverty in Africa (78 percent) as compared to South Asia (84 percent) (Chen and Ravallion, 2001). Income poverty and child malnutrition correlate to a fair degree at the country level. The cross-country correlation between $1/day poverty and stunting is 0.62.¹¹

5. THE GROWTH ELASTICITY OF STUNTING

The preceding parts of this article argued that child malnutrition is important, that measures of chronic malnutrition such as stunting or underweight are preferable for many purposes, including as non-income indicators of deprivation. The aim of this section is to estimate the association between economic growth and malnutrition, focusing on stunting. For policy formulation and analysis, it is often important to know how much economic growth in itself is associated directly or indirectly with improved outcomes, since this can help decide whether and how much direct health and nutrition interventions are required over and above policies designed to stimulate growth. Candidates for nutritional interventions include supplementary feeding, fortification, improving health knowledge, community based nutrition programs, and so on.

Previous research has followed three distinct avenues. One line of research deals with the income elasticity of household demand for calories—arguing that calories constitute an important input to the health production function, and using cross-sections of households (see for example Behrman, Foster, and Rosenzweig, 1997 and Bouis and Haddad, 1992). The second strand of literature carries out cross-country regressions of nutrition indicators on per capita income (Smith and Haddad, 2000a and 2000b; Steckel, 1995; Svedberg, 2000). A third approach analyzes the income (or expenditure)-nutrition relationship

¹¹ I took the average, for each country, of the available stunting data from the 1990s from the World Bank’s World Development Indicators (electronic edition, 2001), and correlated it with the latest data available on PPP $1/day headcount (from the appendix of World Bank, 2002).
in cross-sectional household survey data. A prominent example of this is Haddad and others (2003) who estimate the expenditure elasticity of underweight using household survey data from 12 developing countries and compare the results to cross-country estimates (see also Micklewright and Ismail, 2001). These three approaches all provide valuable and important insights. Broadly speaking, the existing research finds (i) that income/expenditures matter for nutrition; but that (ii) the link from income to nutrition tends to be small and insufficient to dramatically reduce hunger in the medium run; and (iii) that results depend to a substantial extent on issues related to methodology and specification, for example whether income/expenditures is instrumented and which covariates are included alongside income in the regressions.

**Analysis of spells of change in nutrition**

A fourth and novel approach is explored in the remainder of this section. The idea is to look at *spells* of change in malnutrition, and associate these spells with economic growth. A spell is the change between any two years for which a given country has observations on both malnutrition and GNI. Malnutrition data are derived from surveys and the length of the spell is defined by the period between two consecutive surveys. Stunting is used in order to focus on chronic malnutrition, as argued above. Denoting by \( M_{i,t} \) the incidence of stunting in country \( i \) in year \( t \), a spell of malnutrition change is defined as \( (M_{i,t+1} - M_{i,t}) \), i.e. the percentage-point change in malnutrition between two years for which we have available nationally representative and comparable cross-sectional survey data on malnutrition incidence. The change in stunting incidence is regressed on the percentage change in GNI per capita, defined as \( \frac{(Y_{i,t+1} - Y_{i,t})}{Y_{i,t}} \). This procedure—analyzing spells of change between comparable surveys—is inspired by an approach used to assess the association between economic growth and income/consumption poverty (Ravallion, 1995 and 1997; Ravallion and Chen, 1997; Squire, 1993).

Constructing spells of change in the variables removes unobserved and omitted country fixed effects correlated with both the level of income and the level of malnutrition that could otherwise lead to biased estimates. However, while this difference-on-difference procedure removes fixed effects associated with the levels of income and malnutrition, it also has limitations. The approach does not determine causality and does not take account of the fact that multiple factors besides economic growth also influence stunting, including factors that may jointly determine economic growth and stunting. Therefore, this approach cannot distinguish between economic growth-malnutrition associations that are *direct* (through higher consumption) and *indirect* (e.g. through changes in public policies or investment). The approach it also mute on the lag

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12 Poverty headcounts can be matched with mean household consumption from the survey that generated the headcount, whereas in the stunting context one has to rely on an income measure from the national accounts. GNI per capita is used here in order to approximate income.
structure between income gains and nutritional improvements. Spells analysis merely estimates the size of the average association, providing an unbiased answer to the question of how much change in stunting on average is associated with an episode of economic growth or contraction.

Employing the World Bank’s World Development Indicators, a total of 166 spells of change in chronic malnutrition could be constructed (Table 2 gives an overview; countries with malnutrition below 2 percent were ignored). Each spell represents the difference between two nationally representative cross-sectional surveys of children aged 0-59 months. Table 3 shows the distribution of spells by sign for the entire sample. Forty-five spells are positive, recording increasing levels of stunting, 118 are negative and three are zero. The average spell is a 2.6 percentage-point fall in chronic malnutrition over the period of the spell, while the 25th and the 75th percentiles are -6.8 and 0.2, respectively. The average spell length is 4.7 years, and the average growth in GNI per capita associated with the spell is 27 percent. Data has purposively not been annualized, but refer to the entire period of the spell, which can last from 1 to 20 years.

Figure 1 shows a scatter plot of the data with a non-parametric regression line included. A negative relationship between growth and change in chronic malnutrition can be discerned (i.e. positive economic growth associated with malnutrition decline), although the slope of the curve does not seem steep.

OLS regressions were run using the spells data set. Outliers have been excluded based on a DFBETA criterion, and robust t-statistics are shown in parentheses. No weighting is used in the presented results; an alternative specification with observations weighted by the duration of the spell (giving more weight to spells of longer duration) were also attempted and yielded essentially identical results, available from the author upon request. In the first column in Table 4, malnutrition change is regressed on change in GNI per capita. The other columns show alternative specifications where controls have been added for initial period income inequality (available only for 134 of the spells) and beginning-of-spell malnutrition, respectively, and with outliers retained. Table 5 shows results when the model is run separately for each continent.

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14 STATA’s ksm command with unweighted smoothing was used to produce the figure.

15 The identification of outliers is based on a regression of change in malnutrition on the rate of economic growth. Observations are excluded if $|\text{DFBETA}| > 2N^{-1/2}$, resulting in the exclusion of 7 observations out of 166.

16 Except Europe, where only two observations are available.
All of these results confirm a highly significant association between economic growth and change in stunting incidence. This also holds when initial income inequality is controlled for (in the form of the gini measure, column 2); countries with high inequality experience slower reductions in malnutrition, ceteris paribus, significant at the 10% level. This finding reflects the fact that deprivation is harder to reduce in societies with a high degree of inequality because few of the gains from growth accrue to the poor. It parallels a similar finding in the literature on the growth-poverty relationship, namely that the growth elasticity of poverty is smaller in countries that are relatively more unequal and/or more poor (Heltberg, 2004); the difference, however, is that the growth elasticity of poverty is much larger than what we find here for malnutrition. The association between economic growth and malnutrition also remains significant when controlling for the incidence of stunting at the beginning of the spell (highly significant, see column 3), and for both inequality and initial malnutrition (column 4); in the latter case initial malnutrition remains significant while inequality does not, perhaps because the influence of the level of inequality is absorbed into pre-spell malnutrition. Including the seven identified outliers also does not alter the results much (column 5). Continent-specific regressions (Table 5) show broadly similar results with a significant growth-malnutrition association of the same order of magnitude in all of the regions (although the pre-spell level of stunting is significant only in two of the regions).

The estimates imply that a doubling of income on average is associated with a reduction in the incidence of child malnutrition by 5-7 percentage points. At the unweighted mean of the data (stunting incidence = 30 percent), this implies an elasticity of around -0.2. In other words, in an average country with 30 percent of children stunted, income growth of 10 percent per capita is on average associated with 2 percent stunting reduction, from 30 to 29.4 percent. In a country with 50 percent stunting, the elasticity of stunting with respect to economic growth is only around -0.12. The conclusion is that economic growth on average is slow in bringing about stunting reduction. This finding is broadly in line with the conclusions from much of the earlier research on the income-nutrition links.

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17 Interaction effects between economic growth and inequality were tried and proved insignificant.

18 1-2 outliers are excluded in each case. All of the regressions in Table 4 (except column 5) and Table 5 exclude the same 7 outliers as identified in footnote 15.

19 Haddad and others (2003) find somewhat larger income elasticities of underweight, in the level of -0.5, although varying according to data set and methodology. Their results are hard to compare with the results of this study since specification, data, and the nutritional measure in focus all differ. Moreover, there is no reason to expect cross-sectional and time series analysis to yield identical results. Since malnutrition responds with a time lag, cross-sectional analysis (as in Haddad and others, 2003, may better capture the long-run effects of income changes, while spells analysis conducted here concerns the short and medium term.
These results raise several questions. For example, it would be interesting to understand better the causality issues and the mechanisms through which different sources, patterns, and determinants of economic growth influence nutrition outcomes. Which are the mechanisms that link from growth in average income via more spending by households and governments on food, health care, sanitation, and clean water to improvements in child health and nutrition? Although the average growth episode is associated with modest nutrition improvement, there could well be circumstances (for example, low inequality) under which economic growth could promote greater nutrition improvements. Another issue is the lag structure. The spells approach implicitly estimates short or medium term associations. The long-term growth-nutrition relationship is likely to be larger (and embody two-way causality). Most important is the need to develop and evaluate cost-effective interventions against malnutrition. These issues could not be addressed within the scope of this article and are left for future research.

6. CONCLUSIONS

Indicators of anthropometric shortfall, in particular stunting and underweight, appear to possess many attractive properties for a measure of well-being and deprivation. Major advantages stem from the consistency conferred by avoiding monetary comparison, ability to assess intra-household resource distribution, and relatively good precision (dependent on survey quality). If one wants to know whether deprivation is worse in country/region A as compared to country/region B, measures of anthropometric shortfall provide important clues.

Novel analysis of spells of change in stunting demonstrated that episodes of economic growth are often associated with reduced child malnutrition. The association is statistically significant but quite small. The elasticity of stunting with respect to growth in per capita GNI is around -0.2 in a country with 30 percent stunting. For comparison, this is at the most one-tenth of the growth elasticity of income/consumption poverty. Halving stunting from a level of 30 percent through economic growth alone would require 3.7 percent real growth per capita per year for 25 years. This is much higher than the past growth performance of most developing countries. Cutting malnutrition to half in a country with 50 percent stunting requires 5.9 percent real per capita growth for 25 years. The conclusion is that supplementary interventions that aim directly at improving child health and nutrition are required.
REFERENCES


Pelletier, David L (1994) ”The Relationship Between Child Anthropometry And Mortality In Developing Countries: Implications For Policy, Programs, And Future Research”, The Journal of Nutrition 124(10), 2047S-2081S.


### Table 1: The world distribution of consumption poverty and stunting (in percent)

<table>
<thead>
<tr>
<th>Continent</th>
<th>Income below $1.08 a day</th>
<th>Income below $2.15 per day</th>
<th>Chronic Malnutrition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td>68.7</td>
<td>73.9</td>
<td>70.3</td>
</tr>
<tr>
<td>Africa</td>
<td>26.2</td>
<td>20.4</td>
<td>26.0</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>5.2</td>
<td>5.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Chen and Ravallion (2001); de Onis et al (2000).

### Table 2: Data set on spells of change in stunting

<table>
<thead>
<tr>
<th>Continent</th>
<th>Average change in stunting (%-age points)</th>
<th>Average growth rate in GNI per capita (%)</th>
<th>Average Gini coefficient of inequality</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>-0.50</td>
<td>27</td>
<td>47.13</td>
<td>45</td>
</tr>
<tr>
<td>Asia</td>
<td>-5.24</td>
<td>37</td>
<td>37.10</td>
<td>38</td>
</tr>
<tr>
<td>Middle East and North Africa</td>
<td>-2.49</td>
<td>29</td>
<td>34.17</td>
<td>20</td>
</tr>
<tr>
<td>Americas</td>
<td>-2.60</td>
<td>22</td>
<td>50.25</td>
<td>61</td>
</tr>
<tr>
<td>Europe</td>
<td>-3.60</td>
<td>-3</td>
<td>48.70</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>-2.63</td>
<td>27</td>
<td>44.50</td>
<td>166</td>
</tr>
</tbody>
</table>

Values are for spells of change between consecutive nationally representative surveys from which comparable malnutrition indicators can be construed. Values cover entire period of spells and are not annualized.

### Table 3: Change in stunting and in GNI per capita

<table>
<thead>
<tr>
<th>Change in GNI per capita</th>
<th>Change in stunting incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increased</td>
</tr>
<tr>
<td>Positive</td>
<td>35</td>
</tr>
<tr>
<td>No change</td>
<td>4</td>
</tr>
<tr>
<td>Negative</td>
<td>6</td>
</tr>
<tr>
<td>In total</td>
<td>45</td>
</tr>
</tbody>
</table>

Data refer to number of spells in the full sample

Source: Author’s calculation based on World Development Indicators.
### Table 4: Regression of spells of change in malnutrition
Dependent variable: percentage point change in stunting incidence

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth rate of GNI per capita</td>
<td>-6.849</td>
<td>-6.152</td>
<td>-6.079</td>
<td>-4.950</td>
<td>-5.342</td>
</tr>
<tr>
<td></td>
<td>(6.79)**</td>
<td>(4.71)**</td>
<td>(5.39)**</td>
<td>(3.59)**</td>
<td>(3.78)**</td>
</tr>
<tr>
<td>Gini index of income inequality</td>
<td>0.091</td>
<td>0.053</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.87)</td>
<td>(1.13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial incidence of stunting</td>
<td>-0.101</td>
<td>-0.097</td>
<td>-0.088</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.16)**</td>
<td>(3.71)**</td>
<td>(3.53)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-1.022</td>
<td>-5.232</td>
<td>1.949</td>
<td>-0.756</td>
<td>1.609</td>
</tr>
<tr>
<td></td>
<td>(1.98)*</td>
<td>(2.36)*</td>
<td>(2.31)*</td>
<td>(0.34)</td>
<td>(1.84)</td>
</tr>
<tr>
<td>Observations</td>
<td>159</td>
<td>134</td>
<td>159</td>
<td>134</td>
<td>166</td>
</tr>
<tr>
<td>Outliers included?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.12</td>
<td>0.11</td>
<td>0.19</td>
<td>0.17</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses. * significant at 5% level; ** significant at 1% level

Source: Author’s calculation based on World Development Indicators.

### Table 5: Regressions of spells of change in malnutrition by continent
Dependent variable: percentage point change in stunting incidence

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Africa</td>
<td>Asia</td>
<td>Americas</td>
<td>Middle East and North Africa</td>
</tr>
<tr>
<td>Growth rate of GNI per capita</td>
<td>-7.300</td>
<td>-6.319</td>
<td>-6.480</td>
<td>-5.092</td>
</tr>
<tr>
<td></td>
<td>(2.37)*</td>
<td>(2.58)*</td>
<td>(4.26)**</td>
<td>(2.06)</td>
</tr>
<tr>
<td>Initial incidence of stunting</td>
<td>-0.297</td>
<td>-0.075</td>
<td>-0.130</td>
<td>-0.080</td>
</tr>
<tr>
<td></td>
<td>(2.82)**</td>
<td>(1.42)</td>
<td>(3.43)**</td>
<td>(0.53)</td>
</tr>
<tr>
<td>Constant</td>
<td>11.194</td>
<td>0.363</td>
<td>1.702</td>
<td>0.599</td>
</tr>
<tr>
<td></td>
<td>(2.68)*</td>
<td>(0.15)</td>
<td>(1.89)</td>
<td>(0.15)</td>
</tr>
<tr>
<td>Observations</td>
<td>43</td>
<td>37</td>
<td>59</td>
<td>18</td>
</tr>
<tr>
<td>Outliers included?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.19</td>
<td>0.26</td>
<td>0.24</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Robust t-statistics in parentheses. * significant at 5% level; ** significant at 1% level

Source: Author’s calculation based on World Development Indicators.
Figure 1: Plots of stunting spells

Source: Author’s calculation based on World Development Indicators.