Global, Regional and Country Trends in Underweight and Stunting as Indicators of Nutrition and Health of Populations

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Abstract
Stunting and wasting provide indicators of different nutritional deficiency problems, the causes of which are well established. Underweight based on weight-for-age cannot distinguish between these two and is therefore not useful to target programs and has limited value for tracking progress. Stunting reduces later school attainment and income as adults and increases the risk of obesity and noncommunicable diseases in later life. Globally, the estimated number of stunted children is decreasing, but is not on track to meet the goal of 100 million by 2025 (165 million), and there has been little change in the number of children suffering from wasting since 2004. Stunting and wasting provide excellent indicators of inequity. For example, from 1990 to 2010, the number of stunted children in Asia declined from 188.7 to 98.4 million, while in sub-Saharan Africa there was essentially no change in prevalence, and the number of stunted children increased from 45.7 to 55.8 million. Recent global development movements are recognizing the need for robust measures of trends in nutritional status of children, particularly during the critical first years of life. Such measures are needed to track progress and improve accountability, and should be aspirational to mobilize sufficient investment in nutrition.

Undernutrition as an Indicator of the Nutrition and Health of Populations
Healthy growth occurs as a result of adequate dietary intake, care-giving, including feeding practices, and a low burden of infectious disease [1]. Insufficient food intake to meet protein and energy needs leads to acute malnutrition (wasting, low weight-for-height), the severity of which will depend on the duration
and size of the deficit. Wasting is usually associated with chronic or acute periods of food insecurity and exacerbated by infectious disease [2]. Linear growth faltering or stunting (low height-for-age) is the result of insufficient quality of diet (in micronutrients and/or macronutrients), the interplay between gut health, immune function and exposure to infectious disease [3], and occurs even in regions and households with apparent food security.

Wasted children are highly susceptible to disease and the risk of mortality increases substantially with the severity of the problem. The risk of dying among severely wasted children is 8–9 times higher than that of children with adequate weight [1]. Stunted children are also 4–5 times more likely to die from infectious diseases before their 5th birthday than children of adequate height. The total estimated number of stunted children (165 million in 2011) is almost an order of magnitude higher than the estimated number of severely wasted children (19 million in 2011) [4]. The actual number of child deaths due to stunting and associated complications is therefore higher than that due to wasting [1].

Stunting in the first 2–3 years of life results in lasting height deficits during adulthood with potential associated risks for women during childbearing years ultimately leading to intergenerational impacts on health and development [5]. Growth in the first 2 years of life is consistently associated with irreversible cognitive, motor and behavior development. In a number of settings, the effect size for poor cognitive scores among moderately to severely stunted children (height-for-age age z score <−2) compared to nonstunted children (z score >−1) was estimated to be moderate to high (0.4–1.05 standard deviation, SD) [6]. Malnutrition and neglect cause visible impairment to normal brain development (fig. 1) [7]. Interventions to improve nutrition and child growth during this early period translate into higher educational attainment [8] and improved human capital as adults [9].

In addition, there is ample evidence that healthy growth during the first 2 years of life will reduce the incidence of noncommunicable diseases in later life [10]. On the other hand, rapid weight gain without adequate length gain in early life may increase the risk of later obesity and cardiovascular disease risk factors [11]. The extent to which rapid infant growth represents a risk may depend on whether it occurs in the context of recovery from earlier growth restriction and results in normalization of bodyweight and length, or whether excess growth is predominantly ponderal with constrained linear gain, thus leading to excess weight-for-height [12]. Stunting can be an independent condition, or be present together with wasting. Stunting can even occur in the presence of overweight and obesity; the concept of stunted obesity reflects a true double burden of malnutrition [13, 14]. The risk of micronutrient deficiencies is elevated in all malnutrition conditions [12, 15, 16].
The inclusion of a nutrition indicator (weight-for-age) as a measure of progress for the Millennium Development Goals (MDGs) did much to position nutrition within the development agenda. Although vital for positioning, this indicator does little to provide clarity on the nature of the nutrition problems that must be addressed, the likely consequences, or specificity on the type of interventions that can be effective to address this. Wasting continues to be a vital indicator to target feeding programs and to assess progress towards its elimination in regions and countries. The World Health Assembly (WHA) has now endorsed a target of reducing and maintaining wasting at <5% globally by 2025 [17]. The importance of assessing linear growth is also well recognized, and the WHA targets include a 40% reduction in the prevalence of stunting by 2025.

With the increasing number of overweight adults and children even in developing countries, our measures of healthy growth should encompass not only height and insufficient weight, but also risk of excess weight; the WHA targets for 2025 call for no increase in childhood overweight by 2025. Healthy linear growth can be defined in comparison to 2006 WHO growth reference [3] and assessed using height and age at a population level. Healthy growth in weight, however, would require accurate assessment of changes in lean and fat body mass. While BMI is appropriate to identify adults at risk of disease, it may not be as useful in children because of their changing body shape [18, 19].
more, maturation pattern differs between genders and different ethnic groups [20], which adds to the problem of using BMI in children.

In research or clinical settings, a number of direct and proxy measures of body composition exist including underwater weighing (densitometry), multi-frequency bioelectrical impedance analysis, magnetic resonance imaging, and skinfold thickness. All of these require extensive training and/or costly equipment and are not appropriate for large-scale surveys in resource-poor environments. Waist circumference is now used extensively as a surrogate marker of visceral obesity in adults but is less well validated for children. A recent study of children 8–18 years of age has shown that after adjusting for age and sex, waist circumference-to-height ratio was a better predictor of variance in percent body fat (80%) than waist circumference alone (72%) or BMI (68%), with the sum of 2 skinfold thicknesses providing only a slightly better estimate (84%) [21]. Further research is needed to refine the measures of excess weight in children feasible for use in large population-based surveys.

**Tracking Global and Regional Progress on Nutrition**

Since the acceptance of the MDGs, the prevalence of undernutrition (low weight-for-age) has been tracked globally. According to the 2010 MDG report, the prevalence of underweight decreased at global level from 31 to 26% from 1990 to 2008; a rate of reduction which is not on track to reach the MDG of halving the number of underweight children by 2015 [22]. Inequities between urban and rural areas in most regions and variation in the extent of progress across regions are clearly identifiable using this indicator. For example, the ratio of underweight in rural compared to urban areas ranges from 1.2 in South East Asia for 4.8 in Eastern Asia. In Asia and Latin America, the ratio has increased (i.e. increased disparity between urban and rural areas), while in Africa there has been little change since 1990.

Recognizing the complexity of collecting and analyzing quality data, UNICEF, WHO and the World Bank have come together to harmonize data and statistical methods used to derive prevalence estimates of malnutrition in children and have updated prevalence estimates from 1990 to 2011 [4]. This includes reanalyzing (when possible) or adjusting prevalence estimates using the WHO 2006 reference standard and a standardized methodology for adjusting for variation in age across surveys and a single model to assess trends over time and region. Trends in child nutrition were also recently published by the Nutrition Impact Model Study Group [23]. This methodology permits taking into consideration the full range of nutritional deficiencies from mild to severe and allows for non-
linear trends over time. Although the 2 methods result in slightly different prevalence estimates, the general conclusions with regard to trends across regions and over time are similar.

An updated summary of nutritional status of children globally using data from both reviews has recently been published as part of the updated Lancet Nutrition Series [24]. The data show that globally, the estimated number of stunted children is decreasing (fig. 2), but is not on track to meet the goal of 100 million by 2025. While substantial progress has been achieved in Asia, the prevalence of stunting is still high (over 25% in 2010), with almost 60% of all stunted children living in Asia. If current trends continue however, by 2025 the absolute number of stunted children in Africa will exceed that of Asia due to the very slow decline in prevalence in that region. From 1990 to 2010, the number of stunted children in Asia almost halved from 188.7 to 98.4 million, while in sub-Saharan Africa there was essentially no change in prevalence and the number of stunted children actually increased over the same period from 45.7 to 55.8 million.

There has been very little change in the absolute number of children suffering from severe wasting (weight-for-height z score < −3) since 2004, estimated at 3% or 19 million children globally. A total of 52 million children (8%) are estimated to suffer from moderate or severe wasting (weight-for-height z score < −2). On the contrary, there has been substantial increase in the number of overweight children, from 35.3 to 41.2 million, globally. The prevalence and number of overweight children has increased in Asia and Africa, and only in Latin America and the Caribbean has there been no substantial increase over the past years. The prevalence of overweight and obesity among children in the LAC region however is high and has increased substantially over the past decades.

**Fig. 2.** Percentage of stunted children <5 years of age globally and by region in 2005, 2010 and estimated number in 2025 [24].
Nutritional Indicators as Measures of Inequity and Implications for Program Design

Although Latin America contributes only small numbers to the global burden, stunting is highly prevalent in some parts of the region and provides a powerful indicator of inequity within countries and across the region. For example, in Mexico, by 2006, wasting and underweight have ceased to be public health problems (<5%) even among the rural and indigenous populations [25] (fig. 3). Using these indicators, one might claim victory in combating undernutrition in this country. That conclusion however, would be very different using stunting. At a national level, the prevalence has declined substantially from 26.9% in 1988 to 13.6% in 2012. National level data however, hide enormous variation within the country reflective of substantial inequity. In figure 4, the prevalence of stunting among the most and least disadvantaged populations is contrasted. Among the most vulnerable populations living in poverty, in rural areas, particularly the rural south and among indigenous populations, the prevalence ranges from 20 to 34%. On the contrary, among those least disadvantaged, the prevalence ranges from 7 to 10%. This variation is not apparent in Mexico for indicators of weight; no substantial difference in the prevalence of wasting or overweight is evident among the different economic levels, urban versus rural populations with only small differences in the prevalence of overweight by region of the country (highest in the north).
The data in Mexico provide clear priorities for the targeting of programs to address nutritional problems. Public health interventions are no longer needed in Mexico to address wasting. Efforts to improve linear growth and prevent stunting can be successfully targeted to those most at risk using economic criteria (lowest quintile) or region of residence, particularly the rural southern region. Social protection programs such as Mexico’s Oportunidades that are effectively targeted to the poor are therefore extremely well positioned as platforms for inclusion of nutrition actions. On the contrary, efforts to address excess weight are needed across all income groups and regions.

In countries with a higher burden of malnutrition, targeted approaches to reach those most at risk may be more costly than population-based programs. For example, a recent national survey in Pakistan reported a national prevalence of 43% stunting and 16.8% wasting. Although differences exist within diverse groups in the country, the magnitude of those differences is much less striking than that observed in Mexico. For example, in urban areas of Pakistan, 36% of children are stunted and 13.9% wasted, while in rural areas, 45.9% are stunted and 18% wasted. Among the 7 provinces in the country, the prevalence of stunting ranges from 60 to 80%. For the purposes of decision making, such surveys should go beyond prevalence of specific health and nutrition outcomes and should assess the trends in determinants of poor nutrition such as breast and complementary feeding patterns, hygiene and sanitation that might increase the risk of infectious disease as well as program participation.
Conclusions

Recent global development movements are recognizing a clear need for indicators that can provide robust measures of trends in nutritional status of children, particularly during the critical first years of life. Such measures are needed by societies investing in nutrition to track progress and improve accountability and should be aspirational to mobilize sufficient investment in nutrition. At the same time, indicators of nutrition should be easy to understand and based on measurements that are feasible in population surveys. This can be done only by tracking problems of undernutrition, specifically stunting and wasting, and overweight. Recent global development goals call for tracking of all three indicators, but further investments in regular data collection will be required in many countries in order to achieve this.

Disclosure Statement

The authors declare that no financial or other conflict of interest exists in relation to the content of the chapter.

References
