Abstract

Stunting prevalence is considered the best indicator of children’s nutritional status. This chapter presents urban, rural, and combined estimates of trends in children’s (<5 years) stunting in 141 developing countries. Between 1985 and 2011, the prevalence of stunting in developing countries declined from 47.5% (95% uncertainty interval 44.0-50.3) to 29.9% (27.1-32.9). In all regions, stunting prevalence was higher in rural areas, and in most regions, urban and rural stunting prevalence improved at a similar pace. In 2011, 88 of 170 million stunted children lived in rural South Asia and Sub-Saharan Africa, regions which also have the highest child mortality rates.

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Introduction

Children’s nutritional status influences their survival, cognitive development, and lifelong health (Adair and others 2013; Black and others 2013; Grantham-McGregor and others 2007; Olofin and others 2013). Inadequate nutrition, together with infections, result in restricted linear growth. Stunting, or low height-for-age, is an indicator of overall nutritional status (Black and others 2013; WHO 2013) and an important cause of morbidity and mortality in infants and children (Black and others 2013; Olofin and others 2013).

Stunting was estimated to cause 14 percent to 17 percent of mortality in children under age five years in 2011, accounting for 1.0 million to 1.2 million child deaths (Black and others 2013). The World Health Assembly endorsed the target of reducing the number of children with stunting by 40
percent by 2025, compared to the baseline of 2010 (World Health Assembly 2012). According to the World Health Organization (WHO), rates of stunting reduction need to be accelerated to meet this target (World Health Assembly 2012).

Country-level information on trends in child height-for-age is needed for priority setting, planning, and program evaluation. Estimates are made at the regional level for all world regions by the United Nations Children’s Fund (UNICEF), the WHO, and the World Bank (UNICEF, WHO, and World Bank 2012, 2013). This chapter presents a set of estimates by the Nutrition Impact Model Study (NIMS), which were made at the country level for 1985-2011 (Stevens and others 2012). The NIMS collaboration estimated trends in the complete distributions of child height-for-age by country, including stunting prevalence. This body of work was extended to separately estimate children’s height-for-age distribution in urban and rural areas, by country and year (Paciorek and others 2013). Separate estimates for urban and rural areas allow for prioritizing strategies that target children in each setting (UN 2011).

**Methods**

We present published estimates of the height-for-age distribution from the NIMS study (Paciorek and others 2013; Stevens and others 2012). We accessed population-representative data on the height of children under age five years; anonymized individual anthropometric measurements from nationally or regionally representative household surveys, including urban or rural residences; summary statistics from the WHO’s Global Database on Child Growth and Malnutrition (de Onis and Blossner, 2003); and summary statistics from preliminary reports not yet included in the WHO’s database. We also accessed summary statistics for the entire population covered by each data source, usually at the national level, and, where possible, separately for urban and rural areas. We calculated height-for-age Z-scores (HAZ), using the 2006 WHO child growth standards for each individual record, if available (World Health Organization, 2006). In cases where only summarized statistics calculated using the 1977 National Center for Health Statistics (NCHS) reference, we developed regression equations to convert these estimates to the 2006 WHO child growth standards (Stevens and others 2013).

We then used Bayesian hierarchical mixture models to estimate the complete distribution of childhood HAZ for each country and year, from which we calculated summary statistics such as mean HAZ and the prevalence of stunting. The inputs for our model were individual-level records and summary statistics. We carried out two statistical analyses:

- An analysis of HAZ distribution in 141 developing countries for each year from 1985 to 2011
- An analysis of HAZ distribution in urban and rural areas in the same 141 developing countries, from 1985 to 2011.

In the first model, estimates for each country-year were informed by data from that country-year itself, if available, and by data from other years in the same country and in other countries, especially those in the same region with data in similar time periods. This hierarchical model shares information to a greater degree where data are nonexistent or weakly informative (for example, because they have a small sample size), and to a lesser degree, in data-rich countries and regions. We modeled trends over time as a linear trend plus a smooth non-linear trend. The estimates are informed by time-varying covariates that help predict HAZ, including maternal education (Gakidou and others 2010), national income (natural logarithm of per capita gross domestic product in inflation-adjusted US$), proportion of the population in urban areas, and an aggregate metric of access to basic health care (Stevens 2012). Finally, the model accounted for the fact that data that
did not cover the entire country; data that did not cover the complete age range of 0 months to 59 months may have more variation relative to the true levels than nationally representative data and data that covered the full range of ages.

For the second analysis, the statistical model was extended to make separate estimates for urban and rural children. The urban-rural difference in HAZ distribution was allowed to vary by country and year. Both analyses were also carried out for children’s weight-for-age distribution, not reported here.

Public health professionals usually report the prevalence of stunting (defined by WHO as HAZ below -2) rather than other metrics, such as mean HAZ or the prevalence of severe stunting (HAZ below -3). In this chapter, we report mean HAZ, stunting (HAZ below -2), and severe stunting (HAZ below -3).

Global and Regional Trends
In developing countries, the prevalence of stunting has declined and mean HAZ has improved since 1985. In 1985, 47.2 percent (95 percent uncertainty interval 44.0 to 50.3) of children under age five years were moderately or severely stunted; this improved to 29.9% (27.1 to 32.9) in 2011 (figure __.1). Mean HAZ increased during the same period, from -1.86 (-2.01 to -1.72) in 1985 to -1.16 (-1.29 to -1.04). Despite large improvements, many children remain stunted. In 2011, 314 (296 to 331) million children had HAZ below -1, a moderate improvement from 367 (352 to 379) million in 1985. Of the children with HAZ below -1 in 2011, 46 percent had HAZ between -1 and -2, 31 percent had HAZ between -2 and -3, and 23 percent had HAZ below -3.

Although child height improved in developing countries as a whole, progress was less consistent at the regional level (figure __.1). East and Southeast Asia and South Asia showed the largest improvements in mean HAZ, increasing by about 0.4 per decade. Mean HAZ also increased by 0.30 (0.19 to 0.41) per decade in Southern and Tropical Latin America, where, by 2011, prevalence of stunting was 8.7 percent (6.1 to 11.8), the lowest of all developing regions. Mean HAZ also increased to a lesser extent in Andean and Central Latin America and Central Asia, as well as the Middle East and North Africa. However, children’s height in sub-Saharan Africa and Oceania (with large uncertainty) had inconsistent progress. In Sub-Saharan Africa, stunting prevalence may have increased from 41.4 percent (37.2 to 45.6) in 1985 to more than 45 percent from 1995-99; it subsequently decreased to 37.7 percent (35.3 percent to 40.2 percent). We estimated that mean HAZ may have decreased 0.07 (0.19 to -0.04) per decade from 1985 to 2000, and then increased 0.28 (0.15 to 0.40) per decade from 2000-11.

Figure __. 1. Trends in Mean Height-for-Age Z Score and Stunting Prevalence, by Region
In 1985, mean HAZ was higher and prevalence of stunting was lower in urban areas than in rural areas in all regions [figure 2]. Urban and rural mean HAZ and prevalence of stunting largely improved at the same pace, meaning that the urban-rural gap in HAZ was maintained during the period. The exceptions were South Asia, Central Asia/Middle East/North Africa, and Southern and Tropical Latin America, where rural HAZ improved at a greater pace than urban HAZ. The convergence of urban and rural HAZ was most marked in Southern and Tropical Latin America. In 2011, the prevalence of stunting in Southern and Tropical Latin America was 8.2 percent (5.6 to 11.3) in urban areas and 11.4 percent (8.2 to 15.6) in rural areas, a gap of only 3.2 percent (0.8 to 1.4 Percent).
The most impressive improvement in children’s height occurred in China, followed by four other South Asian countries, Viet Nam, Brazil, and Tunisia; in these countries, mean HAZ increased by 0.35-0.51 per decade. In most of these high-performing countries, the urban-rural gap in mean HAZ also declined; the exceptions are China, Vietnam, and with large uncertainty, Jamaica. HAZ may have deteriorated in 17 countries between 1985 and 2011, nearly all in Sub-Saharan Africa and Oceania; most had large uncertainties, with the exception of estimated declines in Côte d’Ivoire and Niger. Overall, the rate of improvement in mean HAZ was positively correlated with a reduction in urban-rural inequalities in mean HAZ.

Figure 2. Trends in Urban and Rural Prevalence of Stunting, by Region

Note: Shaded areas show the 95 percent uncertainty interval of the trend.

Improvement in mean HAZ at the national level may be divided into three components: improvement in mean HAZ in rural children, improvement in mean HAZ in urban children, and increases in the proportion of children in urban areas. Figure 3 shows each component’s contribution in each region. In East Asia and Pacific, and in South Asia, all predominantly rural regions in 1985 (less than 30 percent urban) and 2011 (less than 50 percent urban), increases in rural HAZ contributed >= 68 percent of the overall national increase in HAZ. In contrast, in Latin America and the Caribbean, predominantly urban regions (more than 60 percent urban in 1985, increasing to more than 70 percent urban by 2011), urban and rural improvements contributed in approximately equal measures to overall improvements.

Figure 3. Contributions of Urban Improvement to Mean HAZ, Urbanization and Rural Improvement in Mean HAZ to Overall Gains in Mean HAZ, 1985-2011

**Height-for-Age in 2011**

Despite large improvements in HAZ in most regions, only a few countries have mean HAZ and stunting prevalences that approach ideal of a mean HAZ of at least zero and stunting prevalence of 2.3 percent ([map 1], [map 2], [map 3]). Chile, Jamaica, and Kuwait have mean HAZ greater than 0 and a prevalence of stunting less than 5 percent, as do urban areas in China.

Although the world is increasingly urbanized, the majority of stunted children still live in rural areas. These stunted children live mainly in rural South Asia (51 [42 to 62] million) and rural Sub-Saharan Africa (37 [35 to 40] million). In rural Afghanistan, Burundi, Guatemala, Niger, Timor-Leste, and Yemen, more than half of the children under age five were stunted in 2011.

Nevertheless, as the developing world urbanizes, an increasing percentage of stunted children live in urban areas--from 23 percent in 1985 to 31 percent in 2011 ([figure 4]). In 2011, 18 (14 to 22) million stunted children lived in urban South Asia and 15 (14 to 16) million in urban Sub-Saharan Africa.
Figure __.4 Number of Stunted Children, by Region and Urban or Rural Residence, 1985-2011

Map __.1 Prevalence of Stunting by Country, 2011


Map __.2 Prevalence of Stunting by Country: Urban areas, 2011


Map __.3 Prevalence of Stunting by Country: Rural areas, 2011
Implications for Priority Setting

Recently, stunting had received increased attention as a primary indicator of children’s nutritional status. It has been included as one of three health status indicators by the Commission on Information and Accountability for Women’s and Children’s Health, together with maternal mortality ratios and under-five child mortality (WHO 2013). The Scaling-Up Nutrition (SUN) initiative provides a catalyst to implement effective nutrition interventions at the population level, and the WHO’s target to reduce the number of stunted children provides a goal (World Health Assembly 2012). Other anthropometric indicators, such as wasting and severe wasting, provide complementary information on acute nutritional situations (Box 1).

Box 1 Global Patterns in Low Weight-for-Height

Child wasting may be caused by acute illness, inappropriate feeding, or insufficient feeding. The World Health Assembly endorsed a target goal of reducing and maintaining childhood wasting to less than 5 percent by 2025 (World Health Assembly 2012). The global prevalence of wasting in 2012 was 7.8 percent (6.7 percent to 8.9 percent), and the global prevalence of severe wasting was 2.6 percent (2.1 percent to 3.2 percent) (UNICEF, WHO, and World Bank 2013). According to these joint estimates, the prevalence of wasting and severe wasting were highest in the World Bank regions of South Asia, Sub-Saharan Africa, and the Middle East & North Africa, with estimated regional prevalences ranging from 16 to 7 percent.

Of the 102 countries for which data on severe wasting from 2006-12 were available, 51 had at least one survey with a severe wasting prevalence of 2 percent or higher. Of the 110 countries reporting data on wasting in the same time period, 64 reported prevalence of wasting greater than 5 percent in at least one survey. In nine countries--Bangladesh, Benin, Chad, Djibouti, India, Niger, Papua New Guinea, South Sudan, and Timor-Leste--the most recent survey data (excluding data prior to 2006) indicate a prevalence of wasting greater than 15 percent (WHO 2014).
Stunting prevalence and mean HAZ have improved globally and in most regions, although progress has been uneven in Sub-Saharan Africa and, with large uncertainty, in Oceania. Most children who are stunted and severely stunted live in rural areas of South Asia and Sub-Saharan Africa, the regions with the highest rates of child mortality (UNICEF 2013; WHO 2013). Since children’s nutrition, as measured by linear growth, is protective (Olofin and others 2013), programs that target these areas should be prioritized.

Children’s linear growth is restricted when they do not receive sufficiently nutritious foods or when they lose nutrients during sickness. Both situations have a range of contributing factors. Food insufficiency, poor water and sanitation, and limited access to high-quality primary care are all associated with household and community poverty; all may lead to poor growth outcomes (UNICEF 1990). However, interventions such as nutrition education and diarrhea case management can mitigate low height-for-age (Bhutta and others 2008; Bhutta and others 2013).

We previously found that reductions in stunting were consistent with a shift of the entire distribution of height-for-age Z score (Stevens and others 2012). This finding implies that the past mechanism for improvement has been mainly through population improvements rather than targeted interventions. These population improvements can include enhanced health promotion, such as breastfeeding and complementary feeding; improved environmental and sanitary conditions; increased availability and affordability of nutritious foods; and improved income and education levels. Because the burden of stunting is still largely in rural areas, it is appropriate to evaluate potential interventions in terms of their expected benefits for rural children.

Although the relative importance of various macro forces is uncertain, several lessons have emerged from the research:

- Growth in national income seems to have a positive effect on child nutrition but may be insufficient, perhaps because improving nutritional status requires equitable income distribution and investments in health care, agriculture, and programs that improve access to food (Anand and Ravillion 1993; Haddad and others 2003; Ravallion 1990; Smith and Haddad 2002; Subramanyam and others 2011).

- Macroeconomic shocks, structural adjustment, and trade policy reforms have been implicated in worsening nutritional status in Sub-Saharan Africa in the 1980s and 1990s (Cooper and others 1990; Pongou, Salomen, and Ezzati 2006). Their adverse effects on nutrition were greatest in poorer households, especially in rural areas, mediated through lower household earnings and assets, reduced food subsidies, and reduced health care use 1990s (Cooper and others 1990; Pongou, Salomen, and Ezzati 2006). In contrast, programs that improve income, nutrition, and health care among the poor generally also improve growth outcomes, especially in lower-SES children (Bhutta and others 2013; Fernald, Gertler, and Neufeld 2008; Lagarde, Haines, and Palmer 2007; Rivera and others 2004).

These findings indicate that child nutrition is best improved through equitable economic growth, pro-poor primary care, and food programs. Conditional cash transfer programs, especially linked to nutrition education and primary health care, are promising ways to target and deliver these interventions (Bassett 2008).

Conclusions
Prioritizing the need to improve HAZ in rural areas is an essential component of initiatives to improve child health and nutrition. Achieving this goal may occur through policies that improve households’ economic status and food security; provide more equitable access to interventions and services, such as clean water and sanitation; encourage complementary feeding using local foods; and offer case management of diarrhea and other infectious diseases (Bhutta 2013; Sanchez and Swaminathan 2005).

A second essential component of improvement initiatives is the development and implementation of complementary policies and programs for children in urban settings. An increasing share of undernourished children lives in cities; these children are susceptible to environmental and economic shocks that affect food security and prices.
References


