Chapter 5

Levels and Trends in Low Height-for-Age

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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, results 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 caused an estimated 14 percent to 17 percent of mortality in children under age five years in 2011, accounting for 1.0 million to 1.2 million 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 with the 2010 baseline (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. Stunting estimates are made at the regional level for all world regions by UNICEF, WHO, and World Bank (2012, 2014). This chapter presents a set of country-level estimates by the Nutrition Impact Model Study (NIMS) for 1985–2011 (Stevens and others 2012). The NIMS collaboration estimates trends in the complete distributions of child height-for-age by country, including stunting prevalence. Paciorek and others (2013) extend this body of work to separately estimate children's height-for-age distribution in urban and rural areas, by country and year. Separate estimates for urban and rural areas allow strategies that target children in each setting to be prioritized.

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 from nationally or regionally representative household surveys, including Demographic and Health Surveys and Multiple Indicator Cluster Surveys, as follows:

- We obtained these data as anonymized individual anthropometric measurements, if accessible, or as summary statistics from the WHO's Global Database on Child Growth and Malnutrition (de Onis and Blossner 2003), or from preliminary reports not yet included in the WHO's database.
- For data obtained as individual observations, we extracted information on urban or rural place of residence for each observation. We calculated height-for-age z-scores (HAZ) using the 2006 WHO child

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growth standards for each individual measurement (WHO 2006).
- For data obtained as summary statistics, we extracted the summary statistic for the entire population covered by each data source, usually at the national level, and, where possible, separately for urban and rural areas.
- In cases for which only summarized statistics were calculated using the 1977 National Center for Health Statistics reference, regression equations were developed to convert these estimates to the 2006 WHO child growth standards (Stevens and others 2012). Our final data set included measured heights of more than 7.7 million children under age five years.

Despite the extensive data search, there were gaps in data availability; an average of 4.5 data sources were available for each country over the 26 years in the study period. We therefore developed 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. Two statistical analyses were conducted:

- An analysis of HAZ distribution in 141 low- and middle-income countries (LMICs) for each year from 1985 to 2011
- An analysis of HAZ distribution in urban and rural areas in the same 141 LMICs for each year 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 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 both as a linear trend and as a smooth nonlinear trend. The estimates were informed by time-varying covariates that help predict HAZ, including maternal education, national income (natural logarithm of per capita gross domestic product [GDP] in inflation-adjusted U.S. dollars), proportion of the population in urban areas, and an aggregate metric of access to basic health care. Finally, the model accounted for the fact that data did not cover the entire country; data that did not cover the complete age range of 0–59 months may have more variation relative to the true levels than nationally representative data and data that covered the full range of ages. Estimates by sex were not made because little difference was found between male and female stunting prevalence (Stevens and others 2012).

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 (as defined by the 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, prevalence of stunting (HAZ below −2), and prevalence of severe stunting (HAZ below −3).

GLOBAL AND REGIONAL TRENDS

Global Trends

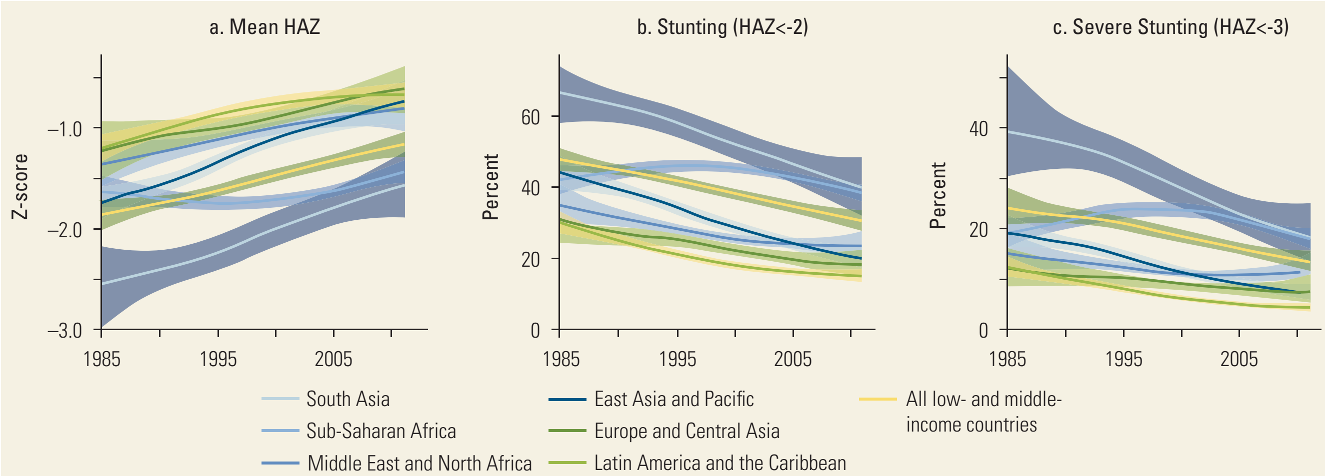
In LMICs the prevalence of stunting has declined and mean HAZ has improved since 1985. In 1985, 47.2 percent (95 percent uncertainty interval 44.0–50.3) of children under age five years were moderately or severely stunted; this rate improved to 29.9 percent (27.1–32.9) in 2011 (figure 5.1). Mean HAZ increased during the same period, from −1.86 (−2.01 to −1.72) to −1.16 (−1.29 to −1.04).

Despite large improvements, many children remain stunted. In 2011, 314 million (95 percent uncertainty interval 296 million to 331 million) children had HAZ below −1, a moderate improvement from 367 million (352 million 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.

Regional Trends

Although child height improved in LMICs as a whole, progress was less consistent at the regional level (figure 5.1). East Asia and Pacific and South Asia show the largest improvements in mean HAZ, increasing by about 0.4 per decade. Mean HAZ also increased to a lesser extent in Europe and Central Asia, the Middle East and North Africa, and Latin America and the Caribbean (increases of 0.20–0.23 per decade). However, children's height in Sub-Saharan Africa showed inconsistent progress. In Sub-Saharan Africa, stunting prevalence may

Figure 5.1 Trends in Mean Height-for-Age Z-Score and Stunting Prevalence, by Region, 1985–2011



Source: Stevens and others 2012.
Note: Shaded areas show the 95 percent uncertainty interval. HAZ = height-for-age z-scores.

have increased from 41.4 percent (95 percent uncertainty interval 37.3–45.6) in 1985 to more than 45 from 1995 to 1999; it subsequently decreased to 37.7 percent (35.3–40.2) by 2011.

In 1985, mean HAZ was higher and the prevalence of stunting was lower in urban areas than in rural areas in all regions (figure 5.2). Urban and rural mean HAZ and prevalence of stunting largely improved at the same pace; the urban-rural gaps in mean HAZ and prevalence of stunting were, in most cases, maintained during the period. Nevertheless, some improvements were observed. In Europe and Central Asia and the Middle East and North Africa, both the absolute and relative gaps in the prevalence of stunting decreased. In Europe and Central Asia, the gap between urban and rural prevalence of stunting fell from 15 percent in 1985 to 7 percent, the narrowest gap observed, in 2011.

The most impressive improvement in children's height occurred in China, followed by Vietnam, Bangladesh, India, Bhutan, Brazil, Nepal, 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 the Oceania region of East Asia and Pacific; 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 inequality in mean HAZ.

Improvement in mean HAZ at the national level can be divided into three components:

- Improvement in mean HAZ in rural children
- Improvement in mean HAZ in urban children
- Increases in the proportion of children in urban areas.

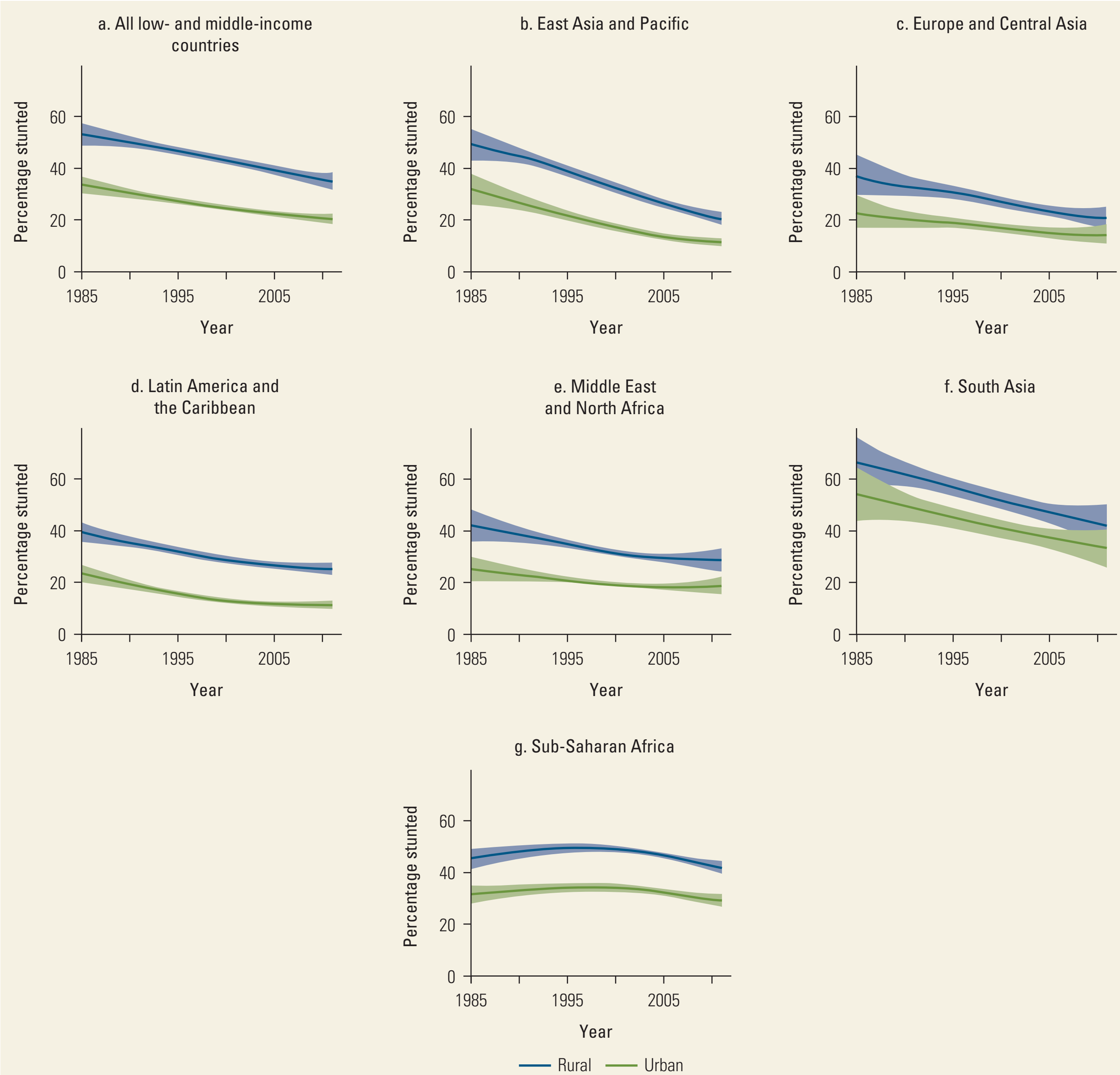
Figure 5.3 shows each component's contribution in each region. In East Asia and Pacific and in South Asia, both predominantly rural regions in 1985 (less than 30 percent urban) and in 2011 (less than 50 percent urban), improvements in rural HAZ contributed 68 percent or more of the overall improvement in HAZ. In contrast, in Latin America and the Caribbean, a predominantly urban region (66 percent urban in 1985, increasing to 78 percent urban by 2011), urban improvements contributed more than 70 percent of the overall improvement.

Height-for-Age in 2011

Despite large improvements in HAZ in most regions, only a few countries have mean HAZ and stunting prevalence that approach the ideal of a mean HAZ of at least zero and stunting prevalence of 2.3 percent (maps 5.1, 5.2, 5.3). Chile, Jamaica, and Kuwait have mean HAZ greater than 0 and a prevalence of stunting of less than 5 percent, as do urban areas of China.

The majority of stunted children still live in rural areas. These stunted children live mainly in South Asia (52 million [uncertainty interval 42 million to 62 million]) and Sub-Saharan Africa (37 million [35 million to 40 million]). In rural areas in Afghanistan,

Figure 5.2 Trends in Urban and Rural Prevalence of Stunting, by Region, 1985–2011



Source: Paciorek and others 2013.
Note: Shaded areas show the 95 percent uncertainty interval of the trend.

Burundi, Guatemala, Niger, Timor-Leste, and the Republic of Yemen, more than 50 percent of the children under age five years were stunted in 2011.

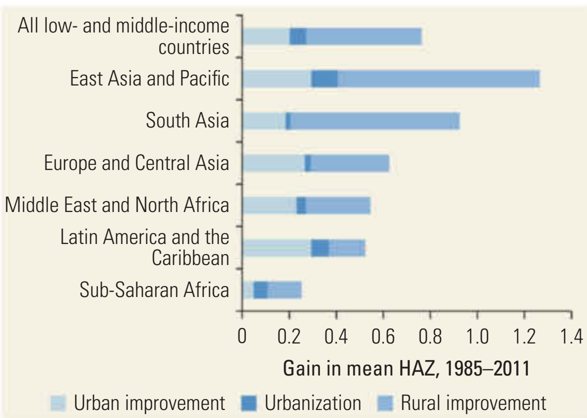
Nevertheless, as urbanization increases, a rising percentage of stunted children live in urban areas—from 23 percent in 1985 to 31 percent in 2011 (figure 5.4). In 2011, 18 million (uncertainty interval 14 million to 22 million) stunted children lived in urban South Asia and 15 million (14 million to 16 million) in urban Sub-Saharan Africa.

IMPLICATIONS FOR PRIORITY SETTING

Stunting has 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 mortality in children under age five years (WHO 2013). The Scaling-Up Nutrition initiative provides a catalyst for implementing 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 5.1).

Figure 5.3 Contributions of Urban Improvement, Urbanization, and Rural Improvement to Overall Improvements in Mean HAZ, 1985–2011



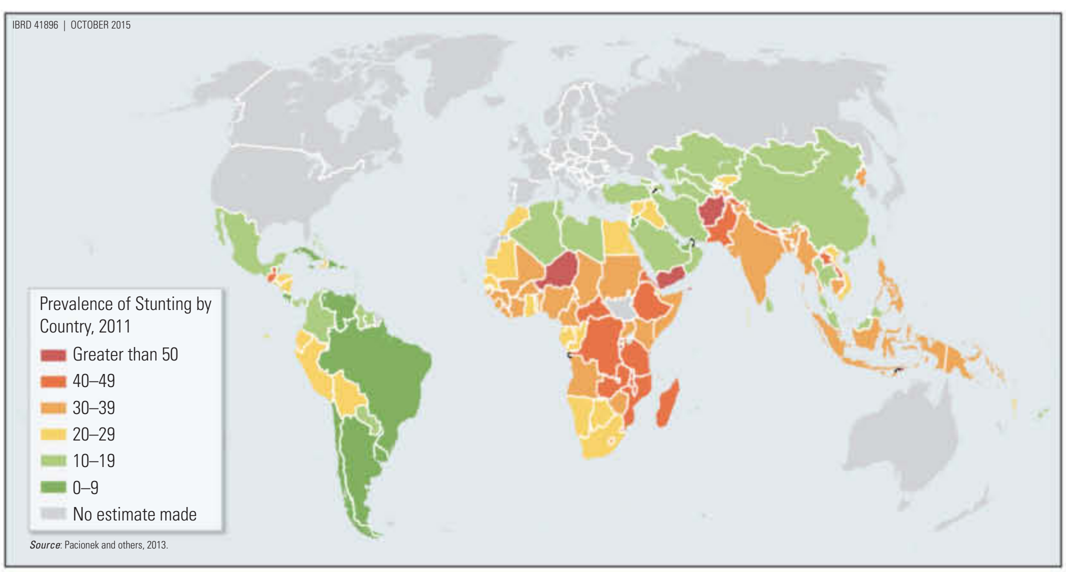
Source: Paciorek and others 2013.
Note: HAZ = height-for-age z-scores.

Stunting prevalence and mean HAZ have improved globally and in most regions, although progress has been uneven in Sub-Saharan Africa. Improvements in HAZ at the national level have generally not been accompanied by reductions in the gap between urban and rural stunting or between stunting in poorer and wealthier populations (Restrepo-Méndez and others 2014). South Asia and Sub-Saharan Africa, the regions with the highest rates of stunting and severe stunting, also have the highest rates of child mortality (UNICEF 2014; WHO 2013). Because children's nutrition, as measured by linear growth, is protective (Olofin and others 2013), it is important to prioritize programs that target these areas.

Children's linear growth is restricted when they do not receive sufficient nutrition (through nonexclusive breastfeeding or inappropriate complementary feeding) 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 (WHO 2014a). However, interventions such as nutrition education and diarrhea case management can mitigate low height-for-age (Bhutta and others 2008; Bhutta and others 2013).

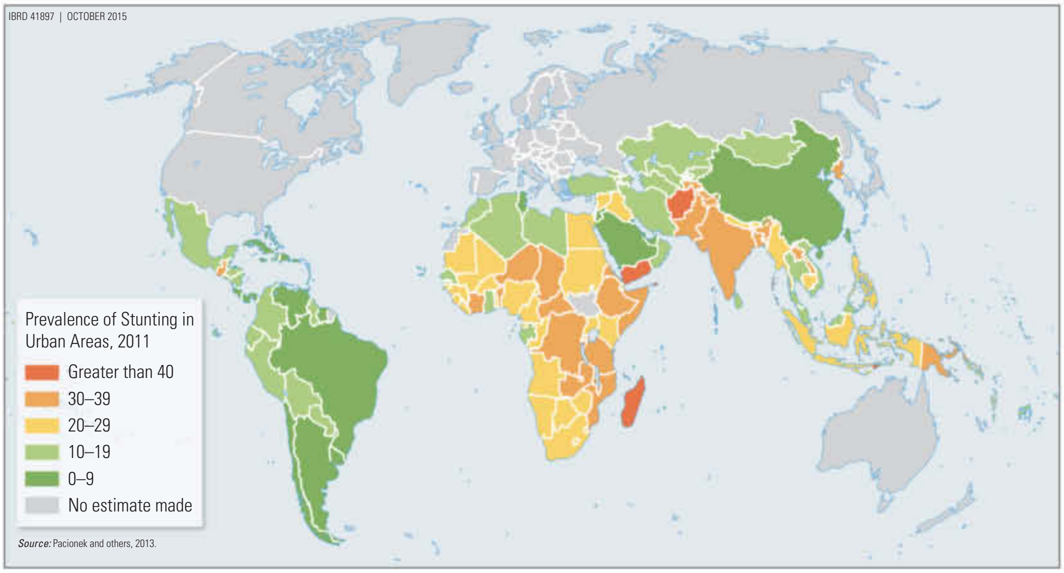
We previously found that reductions in stunting were consistent with a shift of the entire distribution of HAZ (Stevens and others 2012). This finding implies that, for the past two and a half decades, the primary

Map 5.1 Prevalence of Stunting by Country, 2011



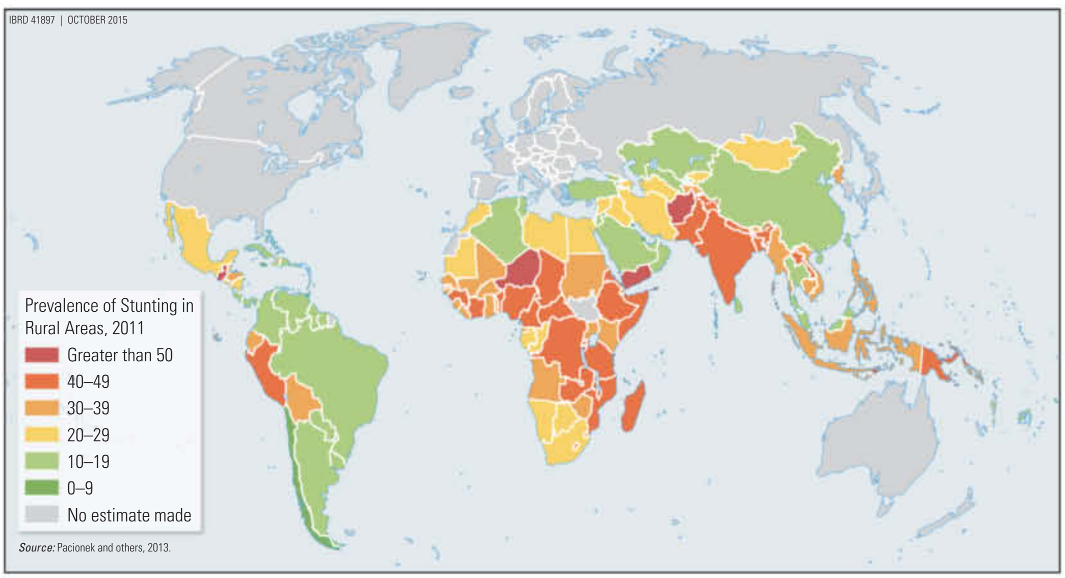
Source: Stevens and others 2012.

Map 5.2 Prevalence of Stunting by Country: Urban Areas, 2011



Source: Paciorek and others 2013.

Map 5.3 Prevalence of Stunting by Country: Rural Areas, 2011



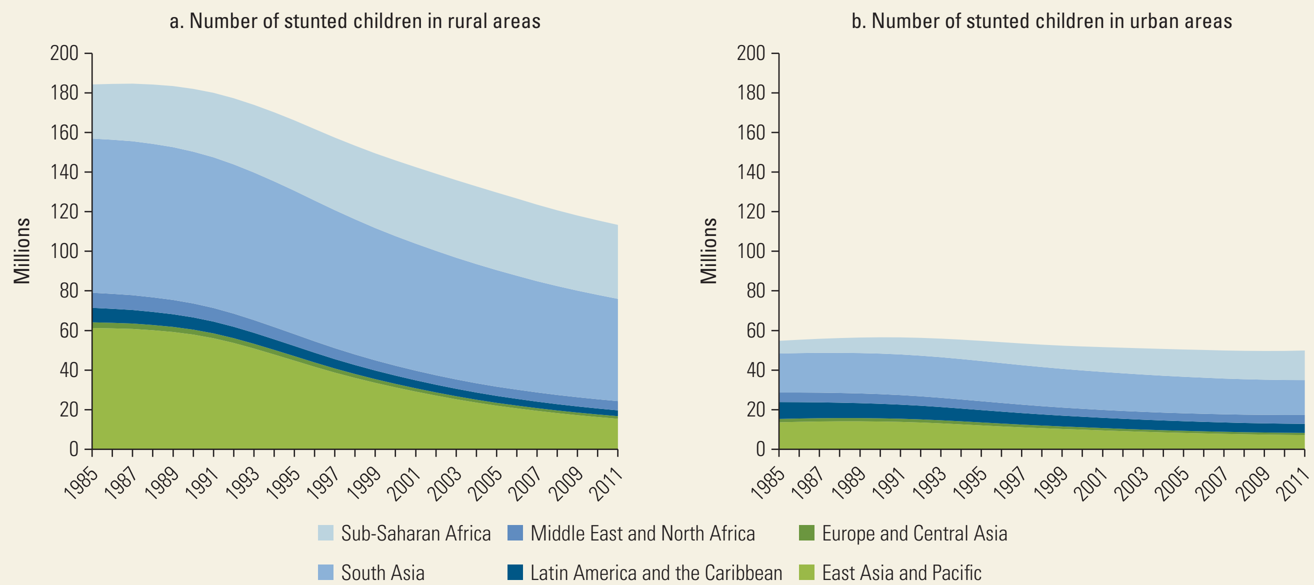
Source: Paciorek and others 2013.

mechanism for improvement has been population improvements rather than targeted interventions. These population improvements 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, evaluating potential interventions' expected benefits for rural children is appropriate.

Although the relative importance of various population 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 more equitable income distribution and increased investments in health care and nutrition programs (Anand and Ravallion 1993; Haddad and

Figure 5.4 Number of Stunted Children, by Region and Urban or Rural Residence, 1985–2011



Source: Paciorek and others 2013.

Box 5.1

Global Patterns in Wasting or 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 2013 was 7.7 percent (uncertainty interval 6.6 percent to 8.9 percent), and the global prevalence of severe wasting was 2.6 percent (uncertainty interval 2.1 percent to 3.2 percent) (UNICEF, WHO, and World Bank 2014). According to these estimates, the prevalence of wasting and severe wasting were highest in the World Bank regions (in decreasing order) of South Asia, Sub-Saharan Africa, and the Middle East and North Africa, with estimated regional prevalence of wasting ranging between 15 percent and 7 percent.

Of the 102 countries for which data on severe wasting from 2006 to 2012 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 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 before 2006) indicate a prevalence of wasting greater than 15 percent (WHO 2014b).

others 2003; Ravallion 1990; Smith and Haddad 2002; Subramanyam and others 2011).

- Macroeconomic shocks, structural adjustment, and trade policy reforms have been implicated in the worsening nutritional status in Sub-Saharan Africa in the 1980s and 1990s (Cooper Weil and others 1990; Pongou, Salomon, and Ezzati 2006). The adverse effects on nutrition were greatest in poorer households, especially in rural areas, transmitted through lower household earnings and assets, reduced food subsidies, and reduced health care use (Cooper Weil and others 1990; Pongou, Salomon, and Ezzati 2006).

In contrast, programs that improve income, nutrition, and health care among the poor generally also improve growth outcomes, especially in children of lower socioeconomic status (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 nutrition programs that support breastfeeding and appropriate complementary feeding. Conditional cash transfer programs, especially those linked to nutrition education and primary health care, offer the potential to help target and deliver these interventions (Bassett 2008).

CONCLUSIONS

Prioritizing improvements in HAZ in rural areas of high-burden countries 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 breastfeeding and complementary feeding using local foods; and offer case management of diarrhea and other infectious diseases (Bhutta and others 2013; Sanchez and Swaminathan 2005; WHO 2014a).

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 live in cities; these children are susceptible to economic shocks that affect food prices and may face different barriers to accessing adequate nutrition than rural children.

NOTES

World Bank Income Classifications as of July 2014 are as follows, based on estimates of gross national income (GNI) per capita for 2013:

- Low-income countries (LICs) = US$1,045 or less
- Middle-income countries (MICs) are subdivided:
  a) lower-middle-income = US$1,046 to US$4,125
  b) upper-middle-income (UMICs) = US$4,126 to US$12,745
- High-income countries (HICs) = US$12,746 or more.

The authors alone are responsible for the views expressed in this chapter and they do not necessarily represent the views, decisions, or policies of the institutions with which they are affiliated.

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