

## Review Article

## Childhood stunting: a global perspective

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## Abstract

Childhood stunting is the best overall indicator of children's well-being and an accurate reflection of social inequalities. Stunting is the most prevalent form of child malnutrition with an estimated 161 million children worldwide in 2013 falling below  $-2$  SD from the length-for-age/height-for-age World Health Organization Child Growth Standards median. Many more millions suffer from some degree of growth faltering as the entire length-for-age/height-for-age  $z$ -score distribution is shifted to the left indicating that all children, and not only those falling below a specific cutoff, are affected. Despite global consensus on how to define and measure it, stunting often goes unrecognized in communities where short stature is the norm as linear growth is not routinely assessed in primary health care settings and it is difficult to visually recognize it. Growth faltering often begins *in utero* and continues for at least the first 2 years of post-natal life. Linear growth failure serves as a marker of multiple pathological disorders associated with increased morbidity and mortality, loss of physical growth potential, reduced neurodevelopmental and cognitive function and an elevated risk of chronic disease in adulthood. The severe irreversible physical and neurocognitive damage that accompanies stunted growth poses a major threat to human development. Increased awareness of stunting's magnitude and devastating consequences has resulted in its being identified as a major global health priority and the focus of international attention at the highest levels with global targets set for 2025 and beyond. The challenge is to prevent linear growth failure while keeping child overweight and obesity at bay.

**Keywords:** stunting, malnutrition, infant and child growth, child development, healthy growth.

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## Introduction

Linear growth is the best overall indicator of children's well-being and provides an accurate marker of inequalities in human development. This is tragically reflected in the millions of children worldwide who not only fail to achieve their linear growth potential because of suboptimal health conditions and inadequate nutrition and care; they also suffer the severe irreversible physical and cognitive damage that accompanies stunted growth.

Stunting often goes unrecognized in communities where short stature is so common that it is considered normal. The difficulty in visually identifying stunted children and the lack of routine assessment of linear growth in primary health care services explain why it has taken so long to recognize the magnitude of this hidden scourge. However, after many years of neglect,

stunting is now identified as a major global health priority and the focus of several high-profile initiatives like Scaling Up Nutrition, the Zero Hunger Challenge and the Nutrition for Growth Summit. Stunting is also at the heart of the six global nutrition targets for 2025 that the World Health Assembly adopted in 2012 (WHO 2012), and it has been proposed as a leading indicator for the post-2015 development agenda.

Increased international attention is the result of greater awareness of the significance of stunting as a major public health problem. First, it affects large numbers of children globally. Second, it has severe short-term and long-term health and functional consequences, including poor cognition and educational performance, low adult wages and lost productivity. Third, there is consensus regarding its definition and a robust standard to define normal human growth that is applicable everywhere. Fourth, there is agreement

on a critical window – from conception through the first 2 years of life – within which linear growth is most sensitive to environmentally modifiable factors related to feeding, infections and psychosocial care. Fifth, it is a cross-cutting problem calling for a multisectoral response. Action to reduce stunting requires improvements in food and nutrition security, education, WASH (water, sanitation and hygiene interventions), health, poverty reduction and the status of women.

Stunting results from a complex interaction of household, environmental, socioeconomic and cultural influences that are described in the World Health Organization (WHO) Conceptual Framework on Childhood Stunting (Stewart *et al.* 2013). Readers are referred to this framework for a comprehensive review of the contextual and causal factors that lead to stunted growth. This paper reviews the definition of stunting, how to measure it and the timing of growth faltering; describes worldwide patterns and recent trends; reviews the consequences of stunting for child survival, growth and cognitive development and long-term health; and discusses the WHO's global target for reducing stunting by 2025.

### Childhood growth faltering: a broader definition of stunting

Stunting is identified by assessing a child's length or height (recumbent length for children less than 2 years old and standing height for children age 2 years or older) and interpreting the measurements by comparing them with an acceptable set of standard values. There is international agreement that children are stunted if their length/height is below  $-2$  SDs from the WHO Child Growth Standards median for the

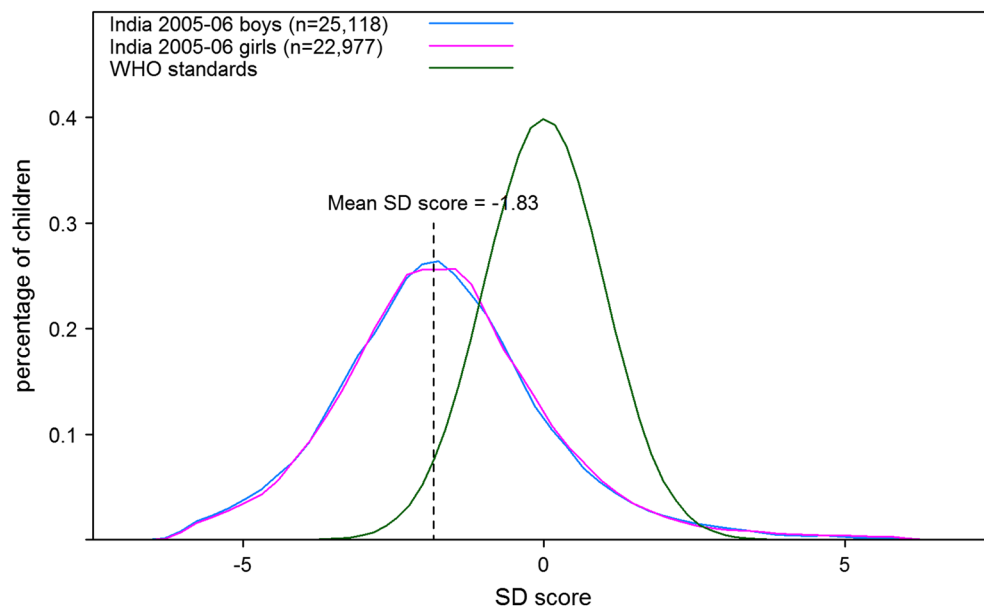
same age and sex (WHO 2008; de Onis *et al.* 2013). Similarly, children are considered severely stunted if their length/height is below  $-3$  SDs from the WHO Child Growth Standards median for the same age and sex.

The use of cut-off points is required to determine the limits of 'normality', and this practice is not unique to anthropometry but widely applied in clinical and laboratory tests. Nevertheless, it is important to bear in mind that in reality there are no two distinct populations – one stunted and the other growing adequately – but rather a gradation of growth faltering. That is, the risk of being stunted and suffering from its devastating consequences does not change dramatically simply by crossing the cut-off line; significant deterioration within the 'normal' range may also occur.

Fig. 1 shows, using the India National Family Health Survey 2005–2006 (International Institute for Population Sciences (IIPS) & Macro International 2007), that the entire length-for-age/height-for-age  $z$ -score distribution is shifted to the left (compared with the WHO Child Growth Standards), indicating that all children, and not only those falling below a specific cut-off, are affected by some degree of growth faltering. From a public health standpoint, it is important not to lose sight of this population perspective as height deficits are associated with large gaps in cognitive achievement. For example, Spears documented a height-achievement slope among Indian children (Spears 2012) using the India Human Development Survey, a representative sample of 40 000 households that matches anthropometric data to learning tests. Being one SD taller was associated with being 5 percentage points more likely to be able to write, a slope that falls to only 3.4 percentage points by controlling for a long list of contemporary and early life conditions (Spears 2012). Thus, there are developmental

#### Key messages

- Stunting is a scourge that has early beginnings and far-reaching consequences. Of the world's 161 million stunted children in 2013, about half lived in Asia and over one-third in Africa.
- Stunting often goes unrecognized in communities where short stature is the norm. Measuring length/height – not just weight – should be standard practice when assessing child growth.
- Stunting's impact on neurocognitive function has devastating consequences. Stunted children have stunted brains and live stunted lives, hampering the development of entire societies.
- Stunting is the result of a complex array of causal and contextual factors. Solutions will require multifaceted and transdisciplinary approaches.



**Fig. 1.** SD score distribution for length-for-age/height-for-age of Indian children compared with the World Health Organization (WHO) Child Growth Standards (India National Family Health Survey (NFHS-3) 2005–6).

consequences for all children and not just those falling below internationally agreed cut-off levels.

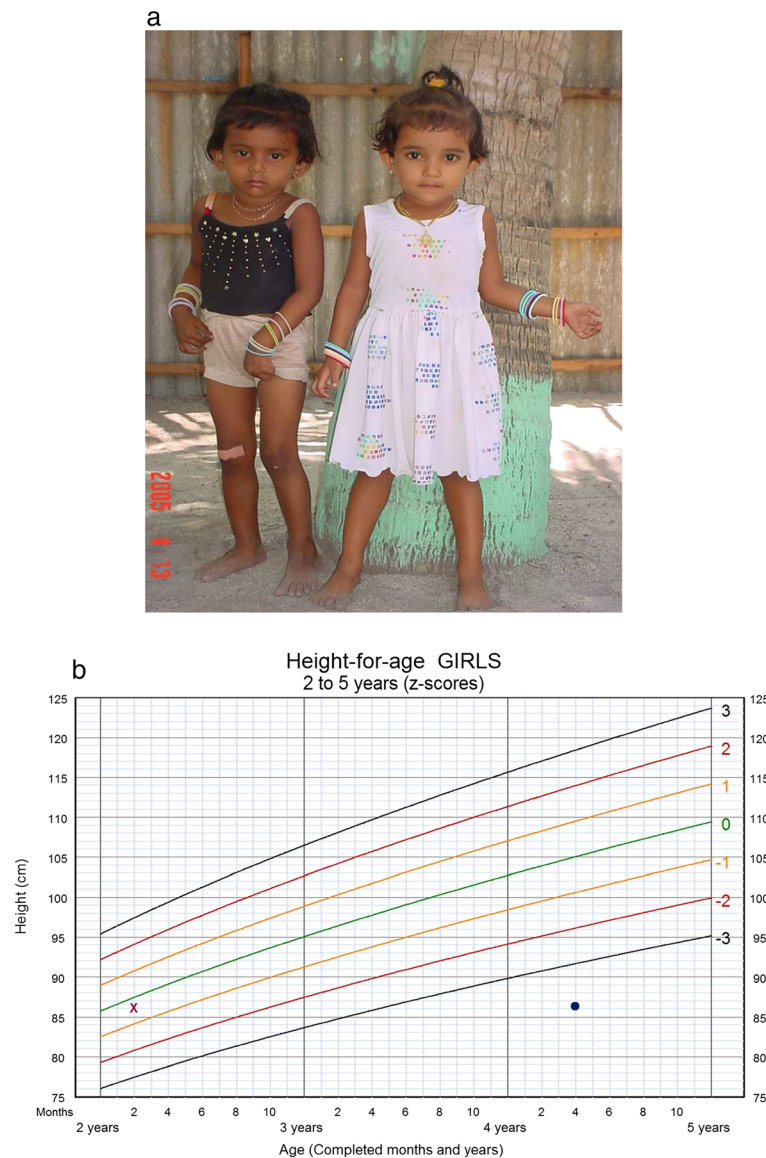
### Challenges in measuring childhood stunting: methods and community norms

Families and health workers often fail to recognize childhood stunting in communities where short stature is so common that it is considered normal. This is largely because linear growth is not routinely measured as part of community health programmes, in addition to lack of awareness of stunting's devastating health consequences. Assessment of linear growth is essential for determining whether a child is growing adequately or has a growth problem or tendency towards a growth problem that should be addressed. Fig. 2a provides the example of two girls from the Maldives of identical height (86 cm). While one of the girls, at 2 years and 2 months, is growing adequately, the other, who is 4 years and 4 months old, is severely stunted (Fig. 2b). It was impossible to distinguish which girl was stunted merely by observing them play and interact with each other. Awareness of their age difference triggered alarms, but it was only when

their heights were measured and compared with the WHO standards that the very severe stunted growth of one of the girls became evident. Measuring children's length (up to 24 months) or height (from 24 months onwards) should be standard practice.

Assessing linear growth is not difficult, but it requires adherence to key principles and attention to detail. The accuracy and reliability of length and height measurements are highly dependent on the robustness, precision, maintenance and calibration of the anthropometric equipment; the measurement techniques and the establishment of data quality procedures (de Onis *et al.* 2004a). Variability in length and height measurements can result from a variety of influences, including the setting where measurements are taken, the behaviour and cooperation of the child, the accuracy and precision of the instruments, the anthropometrist's technical capability and data recording methods. Appropriate training and adherence to standardized methods and procedures are thus essential to reduce measurement error and minimize bias (de Onis *et al.* 2004a).

Fig. 3 shows the correct positioning of a baby's feet and a health worker's hands for measuring recumbent length in children below 2 years of age. Measuring length in young infants is particularly delicate because of the



**Fig. 2.** (a) Two Maldivian girls below 5 years of age – which is the stunted one? (Photo taken in the Maldives. © WHO/Mercedes de Onis, 2005) (b) Height-for-age measurements of two Maldivian girls plotted relative to the World Health Organization Child Growth Standards.

gentle pressure on the knees required to straighten the legs. Various training materials are available for different levels of expertise. The WHO Training Course on Child Growth Assessment (WHO 2008) teaches the basic skills needed to measure the weight and length/height of children and to plot and interpret the measurements. Errors in plotting on charts are common, and even the most experienced professionals can inadvertently make them, yet correct plotting and interpretation of measurements are essential for identifying growth problems.

The interpretation of anthropometric measurements is heavily dependent on the growth standards used to compare and interpret values (de Onis *et al.* 2006a). Choice of a growth reference has received considerable attention (Dale *et al.* 2009; Isanaka *et al.* 2009; Saha *et al.* 2009; van Dijk & Innis 2009; Bois *et al.* 2010; Vesel *et al.* 2010; Kerac *et al.* 2011; Maalouf-Manasseh *et al.* 2011) to the point of becoming the subject of passionate debate. Since the release of the WHO Child Growth Standards (de Onis *et al.* 2006b; WHO 2006; WHO



**Fig. 3.** Measuring recumbent length in a child below 2 years of age – positioning of baby's feet and health worker's hands (Photo taken in Louboutigué village in the Sila Region, Chad. © UNICEF/NYHQ2011-2162/Patricia Esteve, 2011).

Multicentre Growth Reference Study Group 2006b; WHO 2007; WHO 2009), the prevailing international consensus is that, on average, children of all ethnic backgrounds have similar growth potential. Today, over 140 countries are using the robust methodology of the WHO standards, which accurately describe physiological growth and harmonize child growth assessment the world over (de Onis *et al.* 2012).

The WHO Child Growth Standards increased attention to stunting by revealing that it is a greater problem than previously believed (de Onis *et al.* 2006a). Based on the observation that children of well-off populations in developing countries experience similar growth patterns to those of healthy, well-nourished children in developed countries (Bhandari *et al.* 2002; Mohamed *et al.* 2004; Owusu *et al.* 2004; WHO Multicentre Growth Reference Study Group 2006a), the WHO Multicentre Growth Reference Study (MGRS) was conducted to develop normative standards based on an innovative prescriptive approach. The methodology and conduct of the MGRS is described elsewhere (de Onis *et al.* 2004b). A critical result of the study was the remarkable similarity in linear growth of the six MGRS populations (3% and 70% inter-individual and inter-site variability, respectively), demonstrating that, when health, environmental and care needs are met, human growth potential is universal to at least 5 years of age (WHO Multicentre Growth Reference Study Group 2006a). Beyond time and borders, the

WHO standards stand as a symbol of children's right to achieve their genetic growth potential.

The similarity in growth across human populations in early life has been recently reinforced by evidence from the multi-country study Intergrowth-21st. Using methods and a prescriptive approach similar to those in the MGRS, the eight study sites of Intergrowth-21st showed that fetal growth and newborn length are similar across diverse geographical settings when mothers' nutritional and health needs are met and environmental constraints on growth are few (Villar *et al.* 2014a). Furthermore, the Intergrowth-21st study, implemented several years after completion of the MGRS, reported strikingly similar findings: the mean birth length for term newborns in Intergrowth-21st was 49.4 cm (SD 1.9) compared with 49.5 cm (SD 1.9) in the MGRS (Villar *et al.* 2014a). These results provided the conceptual frame for developing matching international standards for fetal growth, newborn size according to gestational age and preterm post-natal growth (Papageorghiou *et al.* 2014; Villar *et al.* 2014b; Villar *et al.* 2015).

### The timing of growth faltering

Stunting often begins *in utero* and continues for at least the first 2 years of post-natal life. The India National Family Health Survey 2005–2006 presented in Fig. 1 illustrates a typical pattern. At birth, stunting rates in this national sample are already estimated to be around 20% indicating the process of growth failure started prenatally. Thereafter, rates increase sharply, reaching 58% in the 18–23 month age range (International Institute for Population Sciences (IIPS) and Macro International 2007). This characteristic pattern of stunting in early childhood has established the period from conception to the second birthday (the first 1000 days) as the critical window during which failure to grow is part of an active process of becoming stunted (Victora *et al.* 2010).

Prenatally, the introduction of the WHO standards made it clear that intrauterine growth faltering is a greater problem than previously believed based on the prior National Center for Health Statistics references (de Onis *et al.* 2006a). The proportion of growth

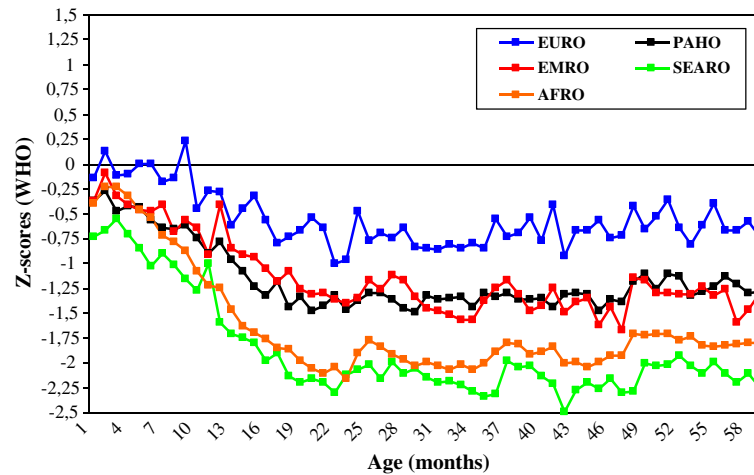
failure that occurs prior to compared with after birth is still not fully understood and will likely vary across populations. For example, in Malawi, it was estimated that ~20% of the 10-cm deficit in height (compared with WHO Child Growth Standards) at 3 years of age is already present at birth (Dewey & Huffman 2009). Similarly, analyses using data from 19 birth cohorts estimated that 20% of stunting has *in utero* origins (Christian *et al.* 2013). This may be an underestimate of the influence of prenatal factors, however, as some of the stunting that occurs after birth may have been programmed *in utero* (Martorell & Zongrone 2012). In some settings, prenatal determinants of stunting appear to be more influential than in others. In a study in Indonesia (Schmidt *et al.* 2002), newborn length was a stronger determinant of length-for-age at 12 months than any other factor examined. More recently, using the WHO Child Growth Standards, a study that examined the timing of growth faltering in under-5 years of age children in India, based on nationally representative data, concluded that about half (44% to 55% depending on the survey year) of growth faltering was already present at birth (Mamidi *et al.* 2011).

After birth, the average length-for-age *z*-score among infants in deprived populations continues to decline until around 24 months of age. This sustained growth faltering is observed everywhere, although its magnitude varies by region (Victora *et al.* 2010) (Fig. 4). This timing is not surprising as healthy infants experience maximal growth velocity during the first few months of life (WHO 2009; de Onis *et al.* 2011). Likewise, as discussed later, given the well-documented rapid brain growth in the first 2 years (Tanner 1990), this early period is also critical for long-term neurodevelopment. It is not just a matter of when growth falters but which tissues and organs grow more rapidly during different age ranges. Emphasis on the first 1000 days is thus based not only on the magnitude of faltering but also on its long-term impact on adult human capital (Victora *et al.* 2008). Although stunting at a population level follows the trajectory just described, it is noteworthy that there is widespread variability in stunting patterns when individual child growth curves are examined.

After 24 months of age, and without seeking to underplay the importance of the period from

conception to 24 months, it has recently been proposed that growth continues to falter in poor environments beyond 2 years of age and that there are other windows of opportunity to address stunting that might well offer additional opportunities for intervention (Prentice *et al.* 2013; Leroy *et al.* 2014). In particular, based on longitudinal data from the Consortium for Health Orientated Research in Transitioning Societies (COHORTS) study (Brazil, Guatemala, India, Philippines and South Africa) and from rural Gambia, Prentice and colleagues consider adolescence to provide an additional window of opportunity during which substantial life cycle and intergenerational effects can be accrued (Prentice *et al.* 2013). Published data from four low-income and middle-income countries (Ethiopia, India, Peru and Vietnam) also found substantial recovery from early stunting in school-aged children (Schott *et al.* 2013; Fink & Rockers 2014; Lundeen *et al.* 2014a). However, there has been some debate about using absolute (centimetres) vs. relative (*z*-scores) scales to describe changes in growth over time (Leroy *et al.* 2013; Leroy *et al.* 2014; Lundeen *et al.* 2014b; Victora *et al.* 2014). For example, Leroy and colleagues in a comparison of absolute height-for-age differences (HAD) with height-for-age *z*-scores in 51 surveys showed that, while height-for-age *z*-scores appeared to level off between 24 and 60 months, HAD continued to increase; 70% of the absolute accumulated height deficit (HAD) at 60 months was found to be due to faltering occurring in the first 1000 days (conception to 24 months), and 30% was the result of continued increases in deficit from age 2 to 5 years (Leroy *et al.* 2014). The question of potential recovery beyond 24 months of age is important. The causes and dynamics of continued growth faltering beyond 2 years of age, and whether interventions would effectively improve lean mass rather than increase the risk of long-term obesity, remains to be elucidated.

In addition to the timing of growth faltering, the intergenerational effects on linear growth are well documented. Stunting is a recurrent process whereby women who were themselves stunted in childhood are at greater risk of bearing stunted offspring, thereby contributing to a self-perpetuating intergenerational cycle of poverty and impaired human capital that is difficult to interrupt. Among



**Fig. 4.** Mean length-for-age/height-for-age z-scores by age, relative to the WHO Child Growth Standards, according to WHO region (1–59 months) (reproduced with permission from Victora *et al.* 2010). AFRO, WHO regional office for Africa; EMRO, WHO regional office for the Eastern Mediterranean; EURO, WHO regional office for Europe; PAHO, Pan American Health Organization; SEARO, WHO regional office for South-East Asia; WHO, World Health Organization.

possible mechanisms explaining intergenerational effects on linear growth are shared genetic characteristics, epigenetic effects, programming of metabolic changes and the mechanics of a reduced space for fetal growth. There are also important socio-cultural factors at play such as the intergenerational transmission of poverty and deprivation (Martorell & Zongrone 2012). Substantial improvements in linear growth can be achieved through child adoption and migration and following rapid economic and social development. Despite clearly documented intergenerational effects, it would seem that nearly normal lengths can be achieved in children born to mothers who themselves were malnourished in childhood when profound improvements in health, nutrition and the environment take place before they conceive. In fact, recently published data (Garza *et al.* 2013) provide strong evidence that even short-term nutritional improvement (during intrauterine life and childhood) can result, within a single generation, in a mean gain in adult height up to 8 cm greater than the mean parental height. In other words, in developing countries, trans-generational improvements in height are achievable faster than expected if women of reproductive age have adequate health and nutrition, and access to health care.

### Levels and trends in stunting (1990–2013)

Stunting is the most prevalent form of child malnutrition. United Nations Children's Fund (UNICEF), WHO and the World Bank release yearly updated estimates of child malnutrition worldwide (United Nations Children's Fund, World Health Organization, & The World Bank 2014). Using the WHO Child Growth Standards, in 2013 there were an estimated 161 million stunted under-5 years of age children, which is a 37% decrease from the estimated 257 million in 1990. About half of all stunted children lived in Asia and over one-third in Africa. Although fewer stunted children live in the Americas, several countries in this region have prevalence rates of stunting as high as those found in Asia and Africa.

Global prevalence decreased from an estimated 40% in 1990 to 25% in 2013 (Fig. 5). Regionally, impressive progress has been made in Asia, with a decline in the proportion of stunted children from 48% to 25% between 1990 and 2013. In Africa, there was a substantially lower decline (from 42% to 34%), and owing to population growth, the absolute number of stunted children is increasing. At present, Eastern and Western Africa and South-Central Asia

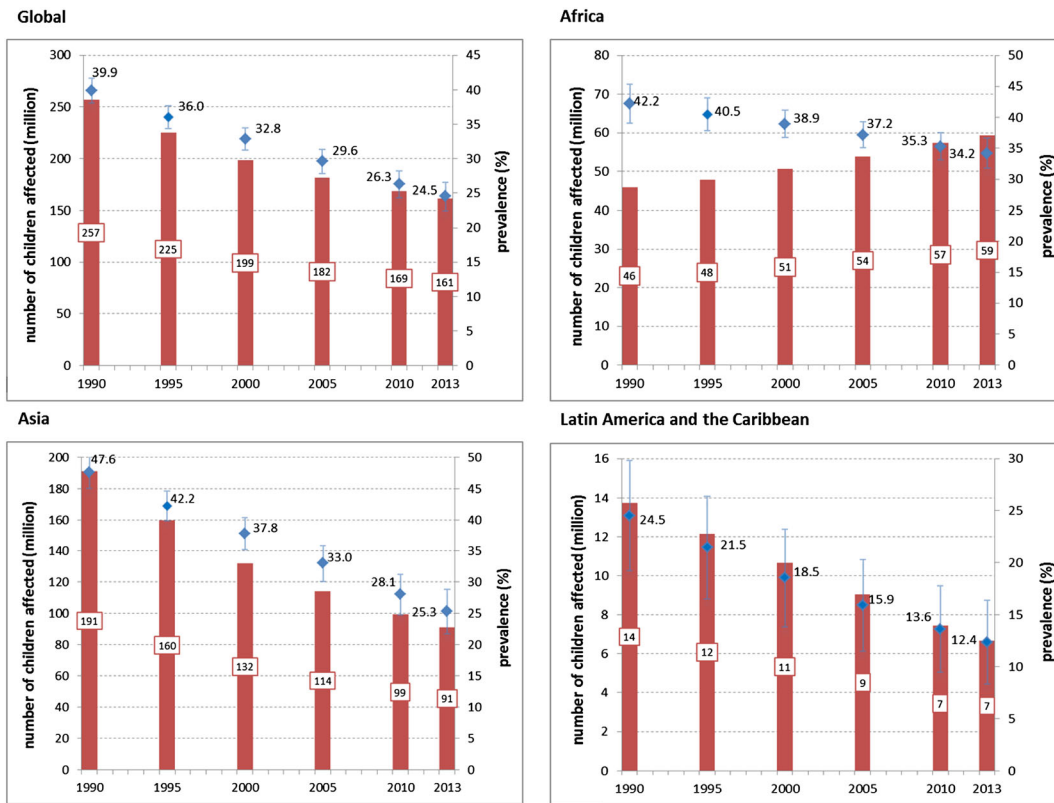


Fig. 5. Global and regional stunting prevalence and numbers (1990–2013).

have the highest prevalence estimates among United Nations subregions (43% in East Africa, 34% in West Africa and 35% in South-Central Asia). Oceania also has a very high rate of stunting (38% in 2013) yet contributes little in numbers affected because of its relatively small population (United Nations Children's Fund, World Health Organization, & The World Bank 2014). Overall, while there has been progress, millions of children are still suffering from stunting's functional consequences.

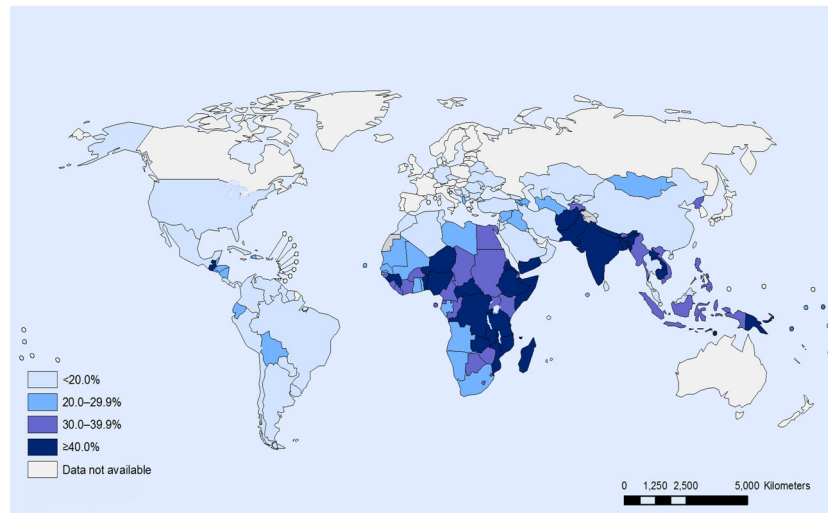
At national level, there is great variation in rates of childhood stunting. Fig. 6 maps countries according to their latest stunting prevalence estimates. Rates are categorized by degrees of severity, ranging from low (below 20%) to very high ( $\geq 40\%$ ). Extremely high levels appear in countries like Timor Leste, Burundi and Niger, with levels above 50% in most recent surveys. Other countries of

sub-Saharan Africa and South-Central and South-Eastern Asia also present high or very high stunting rates.

Within countries, there are substantial inequalities between regions and population subgroups. In most countries, stunting prevalence among children younger than 5 years is about 2.5 times higher in the lowest wealth quintile compared with the highest (Black *et al.* 2013). Sex inequalities in child stunting tend to be substantially smaller than economic inequalities, with rates only slightly higher in boys than in girls (Black *et al.* 2013). Place of residence is also an important risk factor for stunting, with rates consistently higher in rural than in urban areas. Country-specific prevalence data, disaggregated by age group, sex, urban/rural residence and region, are available from the WHO Global Database on Child Growth and Malnutrition ([www.who.int/nutgrowthdb](http://www.who.int/nutgrowthdb)) and the UNICEF/WHO/World Bank joint child



### National prevalence of stunting among children under 5 years of age



Reproduced with permission from de Onis *et al.* 2013.

**Fig. 6.** National prevalence of stunting among children under 5 years of age (reproduced with permission from de Onis *et al.* 2013).

malnutrition estimates (<http://www.who.int/nutgrowthdb/estimates2013/en/>).

### Consequences of stunted growth

Stunting is a syndrome where linear growth failure serves as a marker of multiple pathological disorders associated with increased morbidity and mortality, loss of physical growth potential, reduced neurodevelopmental and cognitive function and an elevated risk of chronic disease in adulthood. A thorough review of the short-term and long-term consequences of stunting is beyond the scope of this paper, which will summarize only the most important ones; the reader is referred to several comprehensive reviews of this topic (Stein *et al.* 2005; Black *et al.* 2008; Victora *et al.* 2008; Dewey & Begum 2011; Stewart *et al.* 2013; Prendergast & Humphrey 2014).

Stunting is associated with increased morbidity and mortality from infections, in particular pneumonia and diarrhoea (Kossmann *et al.* 2000; Black *et al.* 2008; Olofin *et al.* 2013), but also sepsis, meningitis, tuberculosis and hepatitis, suggesting a generalized immune disorder in children with severely stunted growth

(Olofin *et al.* 2013). The interplay of poor nutrition and frequent infection leads to a vicious cycle of worsening nutritional status and increasing susceptibility to infection. Infection impairs nutritional status through reduced appetite, impaired intestinal absorption, increased catabolism and direction of nutrients away from growth and towards immune response. In turn, undernutrition increases the risk of infection by its negative impact on the epithelial barrier function and altered immune response (Scrimshaw *et al.* 1968; Solomons 2007).

Growth failure in the first 2 years of life is associated with reduced stature in adulthood (Coly *et al.* 2006; Stein *et al.* 2010). The magnitude of growth deficits is considerable. For example, in their Senegalese study, Coly and colleagues found that the age-adjusted height deficit between stunted and non-stunted children was 6.6 cm for women and 9 cm for men (Coly *et al.* 2006). For women, maternal stunting is a consistent risk factor for perinatal and neonatal mortality (Lawn *et al.* 2005; Ozaltin *et al.* 2010).

Stunting has important economic consequences for both sexes at the individual, household and community level. There is a body of evidence that shows associations between shorter adult stature and labour-market

outcomes such as lower earnings and poorer productivity (Hoddinott *et al.* 2013). For example, it has been estimated that stunted children earn 20% less as adults (Grantham-McGregor *et al.* 2007) compared with non-stunted individuals, and in World Bank estimates, a 1% loss in adult height due to childhood stunting is associated with a 1.4% loss in economic productivity (World Bank 2006). Yet, for the vast majority of occupations, there is no obvious link between physical stature and productivity, and attained height is considered to act as a marker of human capital dimensions like cognitive ability, social skills attained in adolescence, schooling outcomes or general healthiness (Martorell 1996; Hoddinott *et al.* 2013). For example, data from the COHORTS study showed that adults who were stunted at age 2 years completed nearly 1 year less of schooling compared with non-stunted individuals (Martorell *et al.* 2010). In other analyses, a 1 SD increase in height at age 2 years was associated with a 24% reduced risk of non-completion of secondary school (Adair *et al.* 2013). The body of evidence showing that stunted children have impaired behavioural development in early life, are less likely to enrol at school or enrol late, tend to achieve lower grades, and have poorer cognitive ability than non-stunted children has been summarized elsewhere (Hoddinott *et al.* 2013; Prendergast & Humphrey 2014). Importantly, these damaging effects are aggravated by the interactions that fail to occur. Stunted children often exhibit delayed development of motor skills such as crawling and walking, are apathetic and display diminished exploratory behaviour, all of which reduce interaction with caregivers and the environment (Brown & Pollitt 1996).

The first 24 months of age are critical for brain development. It is known that the development and arborization of apical dendrites from the brain cortex continue post-natally and are completed around the second year of age. The few available studies concerning dendritic spine pathology in undernourished infants during the critical post-natal brain development period show that the changes comprise a shortening of the apical dendrite, a significant decrement of the number of spines and the presence of abnormal forms defined as dysplastic spines (Fig. 7) (Cordero *et al.* 1993; Benítez-Bribiesca *et al.* 1999). It is conceivable that the altered higher brain functions and varying

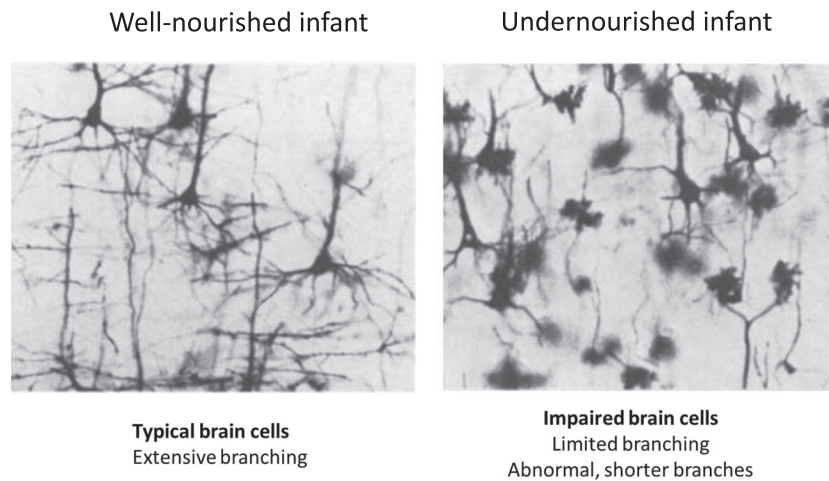
degrees of mental retardation present in infants suffering from nutritional deprivation during early post-natal life are attributable in part to a deficient development of the dendritic spine apparatus. However, much more remains to be learned about the pathways by which undernutrition in early childhood affects brain structure and function (e.g. cognition, attention, memory, fluency, spatial navigation, locomotor skills, learning and visuospatial ability).

Lastly, stunting has also been reported to affect adult health and chronic disease risk. Studies of infants born with low birthweight have demonstrated consistent associations with elevated blood pressure, renal dysfunction and altered glucose metabolism (Huxley *et al.* 2000; Whincup *et al.* 2008). Likewise, data from the COHORTS study show that lower birthweight and greater undernutrition in childhood were risk factors for high glucose concentrations, high blood pressure and harmful lipid profiles after adjusting for adult body mass index and height (Victora *et al.* 2008). The evidence linking stunting with obesity risk or altered energy expenditure is mixed (Stettler 2007; Wilson *et al.* 2012; Adair *et al.* 2013). While it is unclear whether stunting may be a risk factor for obesity per se, rapid weight gain, particularly after the age of 2–3 years among individuals born small at birth, is thought to lead to a particularly high risk of chronic disease in later life (Gluckman *et al.* 2007).

### **The World Health Organization's global target for reducing stunting by 2025**

In 2012, the WHO adopted a resolution on maternal, infant and young child nutrition and agreed on a set of six global targets to hold the world accountable for reducing malnutrition (WHO 2012). Chief among these was a target to reduce by 40% the number of stunted under-5 years of age children by 2025. The stunting target was based on analyses of time series data from 148 countries and national success stories in tackling undernutrition (de Onis *et al.* 2013). The global target translates into a 3.9% annual reduction and implies decreasing the number of stunted children from 171 million in 2010 to about 100 million in 2025. However,

## Effects of undernutrition on brain development



**Fig. 7.** Effects of undernutrition on brain development (adapted from Cordero *et al.* 1993).

at current rates of progress, there will be 127 million stunted children by 2025, that is, 27 million more than the target or a reduction of only 26%. A full account of the rationale for the target and how it was established is provided elsewhere (de Onis *et al.* 2013).

For the global stunting target to be achieved, countries are expected to define how they will contribute and set their own targets. Translating the global target into individual national targets is dependent on nutrition profiles, risk factor trends, demographic changes, experience with developing and implementing nutrition policies and degree of health system development. Establishing national targets will help in developing national policies and programmes and estimating the level of resources required for their implementation. To assist this process, in 2014, WHO, UNICEF and the European Commission jointly developed a tracking tool that allows countries to explore different scenarios taking into account varying rates of progress for the target and the time left to 2025 (<http://www.who.int/nutrition/trackingtool/en/>). The effort required to achieve the target will be largely influenced by current trends in stunting and estimated country-specific population growth rates.

In addition to setting their own national target, a key question is what countries should do to meet the target. The comprehensive implementation plan

illustrates a series of priority actions that should be jointly implemented by member states and international partners (WHO 2012). Because stunting is not treatable, it calls for preventive measures; however, it remains unclear which actions and when in the life course are the most efficacious interventions to be implemented at scale within limited development budgets. Nutrition interventions alone will be insufficient, hence the importance of ongoing efforts to foster nutrition-sensitive programmes and approaches that address the underlying determinants of malnutrition (Ruel *et al.* 2013) and encourage development of multisectoral plans to deal with stunting on a national scale by combining direct nutrition interventions with strategies concerning health, family planning, water supply and sanitation, and other factors that affect the risk of stunting (Casanovas *et al.* 2013). In support of these actions, WHO has developed a policy brief to increase awareness of and investment in a set of cost-effective interventions and policies aimed at reducing stunting among under-5 years of age children (WHO 2014a). A deliberate equity-driven approach targeting the most vulnerable populations will be an effective strategy for reducing national stunting averages. Most of the highly affected countries are characterized by inequities defined by region-specific socio-geographic contexts that call for

adapted strategies, levels of effort and resources for programme implementation (WHO 2014b).

An accountability framework is being developed and surveillance systems are devised to monitor the achievement of commitments and targets (International Food Policy Research Institute 2014). The global monitoring framework on maternal, infant and young child nutrition, endorsed at the World Health Assembly in May 2014, comprises two sets of indicators: a core set to be reported by all countries and an extended set from which countries will select those indicators that suit their specific epidemiological patterns and the actions implemented in response to their priority nutrition challenges. Full details on the framework can be found at [http://apps.who.int/gb/ebwha/pdf\\_files/WHA68/A68\\_9-en.pdf](http://apps.who.int/gb/ebwha/pdf_files/WHA68/A68_9-en.pdf).

The WHO stunting target has raised the profile of nutrition and thus contributed to its positioning within the post-2015 development agenda. As the Sustainable Development Goals are discussed and established; the question arises as to what the 2025 global target for stunting would translate into if taken to 2030. To reach the 2025 global target, the annual average rate of reduction was calculated as 3.9% per year. With a concerted global effort to decrease stunting's prevalence, such as through the SUN movement and other high-profile initiatives, it should be possible to maintain or accelerate this rate of improvement an additional 5 years. Projecting the same annual average rate of reduction of 3.9% until 2030, the estimated number of stunted children in 2030 should not exceed 86 million. This translates into roughly a 50% reduction in numbers of stunted children compared with the 2012 baseline. Major country and regional differences in the stunting burden exist, and new data on stunting reduction rates are emerging. These estimates would need to be fine-tuned accordingly.

## Conclusions

Childhood stunting is the best overall indicator of children's well-being and an accurate reflection of social inequalities. Stunting is the most prevalent form of child malnutrition, affecting millions of children globally. Despite its high prevalence and consensus regarding

how to define and measure it, stunting often goes unrecognized in communities where short stature is the norm.

Growth faltering often begins *in utero* and continues for at least the first 2 years of post-natal life. The severe irreversible physical and neurocognitive damage that accompanies stunted growth is a major barrier to human development. Increased awareness of stunting's magnitude and devastating consequences has resulted in its being identified as a major global health priority and the focus of international attention at the highest levels with global reduction targets set for 2025 and beyond. The challenge ahead is to prevent linear growth failure while keeping child overweight and obesity at bay.

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## Conflicts of interest

The authors declare that they have no conflicts of interest.

## Contributions

MdO conceptualized and wrote the paper. FB presented at the workshop and read and approved the final submission.

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