

Why stunting matters

Summary of Main Points

1. Stunting is both a direct cause of short adult height and sub-optimal function later in life and a key marker of the underlying processes in early life that lead to poor growth and other adverse outcomes.
2. Stunting is a risk factor for diminished survival, childhood and adult health, learning capacity, and productivity.
3. The most effective interventions to prevent stunting take place during the window of opportunity: the period of gestation and the first 2 years of life.
4. Children worldwide have the capacity to reach their height potential if they grow up in healthy environments and their caregivers follow recommended health, nutrition, and care practices.

Children throughout the world can reach their growth potential if they are nurtured in healthy environments and their caregivers follow recommended health, nutrition, and care practices. Stunting indicates a failure to achieve one's genetic potential for height.¹ The main causes of stunting include intrauterine growth retardation, inadequate nutrition to support the rapid growth and development of infants and young children, and frequent infections during early life.² Although a child may not be classified as "stunted" until 2-3 years of age, the process of becoming stunted begins in utero. The result – a very short height – usually reflects the persistent, cumulative effects of poor nutrition and other deficits that often span across several generations. This technical update summarizes the impact of stunting, highlights research findings particularly in the past 5 years, and discusses policy and program implications.

A common yet often unrecognized problem

Stunting affects one-third of children under five in low- and middle-income countries or a total of 178 million children.³ Stunting often goes unrecognized by families who live in communities where short stature is so common that it seems normal. Even among health workers, stunting generally does not receive the same attention as underweight or wasting (low weight-for-height), especially if height is not routinely measured as part of community health programs. Many families, health workers, and policymakers are unaware of the consequences of stunting, so it may not be viewed as a public health issue.

The prevalence of stunting is highest in Africa (40 percent), and the largest number of stunted children is in Asia (112 million), mostly in south-central

Insight is a series of technical briefs that address the continuum of care for good infant and young child feeding, from initiation of early and exclusive breastfeeding through complementary feeding in later infancy and the second year of life. Alive & Thrive aims to improve feeding practices during this critical period to save lives, prevent malnutrition, and promote optimal growth. The series is developed by the Alive & Thrive team: AED, BRAC, GMMB, IFPRI, Save the Children, UC-Davis, and World Vision.



Measuring stunting

Stunting is identified by comparing a person's height to the standard height for a healthy population of the same age and gender. A child is considered "stunted" if his or her height is more than two standard deviations below the World Health Organization standard. For example, a 4 year-old-girl who is less than 94 cm or 3 feet 1 inch tall would be classified as "stunted" because she is 8.6 cm or 3.4 inches (two standard deviations) below the average for a healthy population.

The child on the left is 26 months old and the one on the right is 52 months old.

Photo by Mercedes de Onis, Department of Nutrition, World Health Organization

Table 1: Stunting in children under 5 years of age, based on WHO Child Growth Standards

	Children <5 years in millions	Number stunted in millions	Percentage stunted
Africa	142	57	40
Eastern	49	24	50
Middle	20	8	42
Northern	22	5	25
Southern	6	2	30
Western	45	17	38
Asia	357	112	31
Eastern	95	14	15
South-central	181	74	41
Southeastern	55	19	34
Western	25	5	21
Latin America & the Caribbean	57	9	16
Caribbean	4	0.3	8
Central America	16	4	23
South America	37	5	37
All developing countries	556	178	32

Source: Black et al, 2008³

Asia, as shown in table 1. Ninety percent of the overall global burden of child stunting is attributable to 36 countries. Stunting is found at many levels in society. In Bangladesh, for example, stunting in children less than 5 years of age was found in one-fourth of the richest households.⁴ In developing countries, stunting is more prevalent than underweight (low weight-for-age, 20 percent) or wasting (low weight-for-height, 10 percent), possibly because height gain is even more sensitive to dietary quality than is weight gain.

A problem that has early beginnings and long-term consequences

During fetal life and the first two years after birth, nutritional requirements to support rapid growth and development are very high. Average height-for-age z-scores are already low at birth (below 0, the standard score or population

average) in several regions and decline sharply during the first 24 months of life, but they show no further decline or any improvement thereafter,⁵ as illustrated in figure 1.

Maternal anemia, tobacco use, and indoor air pollution can restrict fetal growth and result in low birth weight. Diets of poor nutritional quality during pregnancy, infancy, and early childhood lead to inadequate nutrient intake. Frequent infections during the first 2 years of life also contribute to the high risk of becoming stunted during this period.

Children who are stunted usually grow up to be stunted adults.⁶ An opportunity exists to make up some of the height deficit during adolescence because stunted children often experience a delay in skeletal maturation, which lengthens the total period of time for growth in height.

However, the potential for substantially reducing the height deficit during adolescence is limited because the maturational delays are usually shorter than 2 years.⁶ Moreover, adolescents who enter this period stunted are often living under the same adverse nutritional, socio-economic, and environmental conditions that triggered stunting when they were young children.

Consequences of stunting

Childhood stunting is related to long-term consequences in two ways:

- As a direct cause of short adult height and sub-optimal function later in life
- As a key marker of the underlying processes in early life that lead to poor growth and other adverse outcomes

Scientific understanding of stunting as a direct cause of adverse consequences is incomplete, in part because most of the evidence comes from observational studies. Nonetheless, there is growing evidence of the connections between slow growth in height in early life and impaired health and educational and economic performance later in life.

The Maternal and Child Undernutrition Study Group^a reviewed cohort studies from five low- and middle-income countries: Brazil, Guatemala, India, the Philippines, and South Africa. The studies involved long-term follow-up of children into late adolescence and adulthood. The Study Group concluded that small size at birth and childhood stunting were linked with short adult stature, reduced lean body mass, less schooling, diminished intellectual functioning, reduced earnings, and lower birth

a) The Study Group included 24 members from universities, research institutes, and international and development agencies. Findings were published in *The Lancet* series on maternal and child undernutrition.

weight of infants born to women who themselves had been stunted as children.⁷ Recent evidence also indicates that children born to women who are stunted are at greater risk of dying than children of mothers with normal height.⁸ The links between stunting and health, educational, and economic outcomes are discussed below and illustrated in figure 2 on page 4.

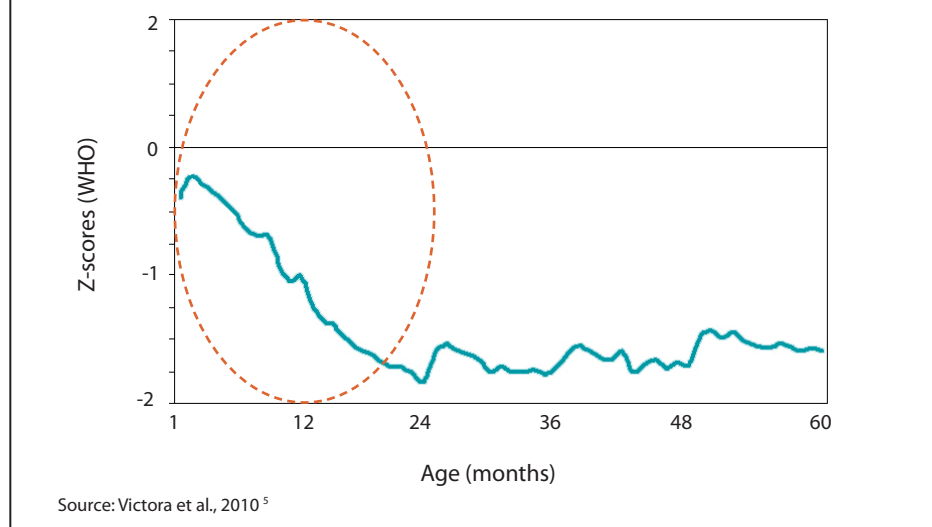
Stunting has long-term negative consequences on health, including for future generations. The health risks associated with stunting begin in the womb and continue through life, often passing to the next generation. As noted in *Repositioning Nutrition as Central to Development*, “Babies born to underweight or stunted women are themselves likely to be underweight or stunted. In this way, undernutrition passes from one generation to another as a grim inheritance.”¹⁰

Maternal stunting increases the risk of negative fetal, newborn, and child outcomes. A woman who is less than 145 cm or 4’7” is considered to be stunted. Her condition presents risks to the survival, health, and development of her offspring.

Effects of intrauterine growth restriction. Maternal stunting can restrict uterine blood flow and growth of the uterus, placenta, and fetus. Intrauterine growth restriction (IUGR) is associated with many adverse fetal and neonatal outcomes.^{3, 11, 12} During pregnancy, IUGR may lead to chronic fetal distress or fetal death.

If born alive, the growth-restricted infant is at higher risk for serious medical complications.³ Infants with IUGR often suffer from delayed neurological and intellectual development, and their deficit in height generally persists to adulthood.

Figure 1: Timing of growth faltering: Mean height for age z-scores by age for 54 studies, relative to the WHO standard



Effects of obstructed labor. Maternal stunting is consistently associated with an elevated risk of perinatal mortality (stillbirths and deaths during the first 7 days after birth),¹³ mostly related to obstructed labor resulting from a narrower pelvis in short women. In a hospital-based study in Nigeria, obstructed labor accounted for 53 percent of perinatal mortality.¹⁴ Perinatal mortality from obstructed labor is largely the result of birth asphyxia. Mothers with height shorter than 145 cm are more likely to have an infant with birth asphyxia.¹⁵

Globally, birth asphyxia accounts for 23 percent of the 4 million neonatal deaths each year.¹⁶ An estimated 1 million children who survive birth asphyxia live with chronic neuro-developmental disorders, including cerebral palsy, mental retardation, and learning disabilities.¹⁷

In a recent analysis of 109 Demographic and Health Surveys conducted between 1991 and 2008 in 54 countries, children under 5 years of age who were born to the shortest mothers (< 145

cm) had a 40 percent increased risk of mortality after adjusting for multiple factors.⁸ Although the percentage of mothers shorter than 145 cm is low in most countries, the analysis showed an elevated risk of child mortality with each lower category of maternal height, compared to mothers > 160 cm in height.^b The effect of maternal stunting on child mortality was comparable to the effect of having no education or being in the poorest 20 percent of households. The likely explanations for this finding include an elevated risk of perinatal death, for the reasons explained above, as well as longer-term effects of IUGR on child nutrition and immune function that increase the risk of child mortality.

Stunting negatively affects maternal and adult health. As mentioned above, short maternal stature increases the risk of disparity in size between the baby’s head and the mother’s pelvis. Due to this disproportion, short mothers are less likely to have a successful spontaneous vaginal delivery,^{18, 19} which increases the risk of maternal mortality and short-

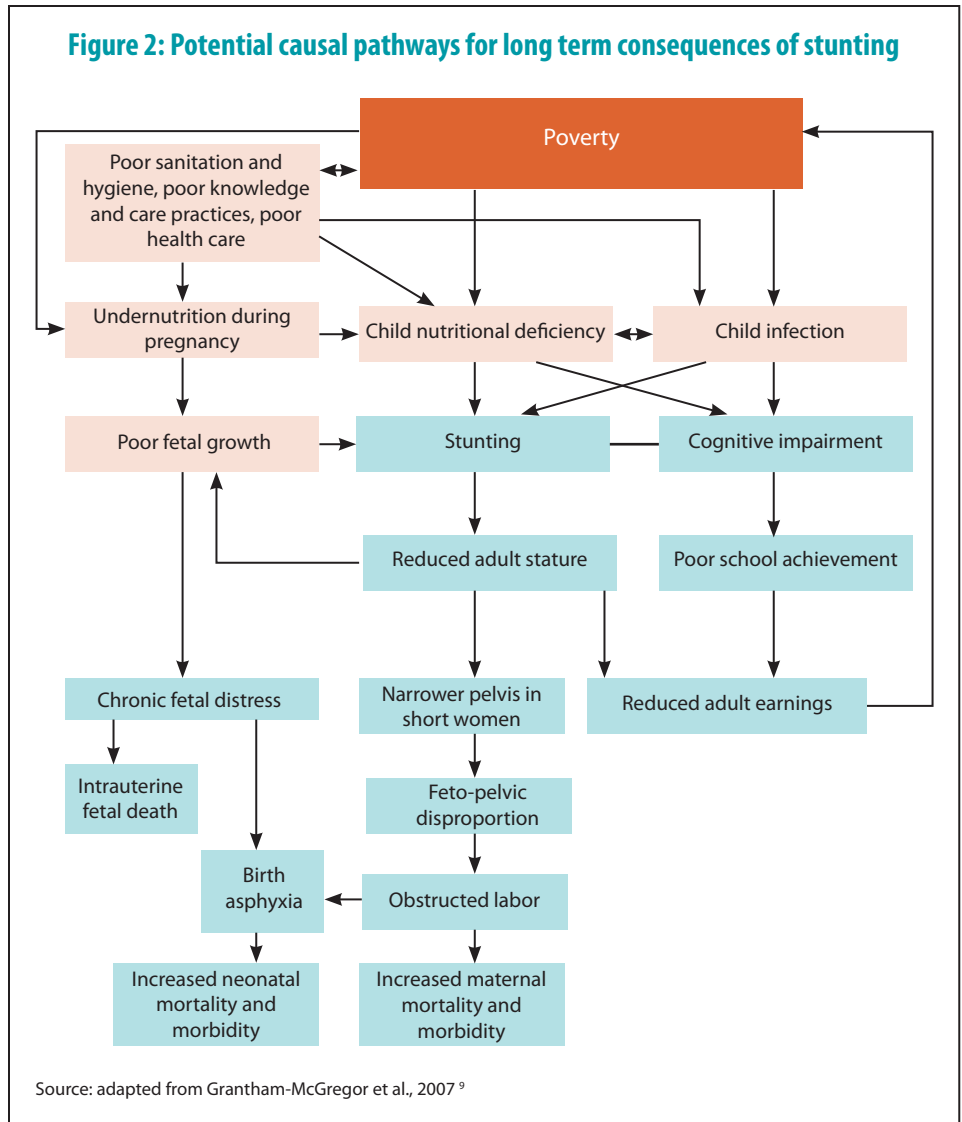
b) Adjusted Relative Risk of 1.06, 1.13, 1.23, and 1.40 for the height categories of 155-159.9, 150-154.9, 145-149.9, and < 145 cm, respectively.

and long-term disability. If timely referral to a well-equipped hospital occurs, a cesarean section can be performed, but even a cesarean section carries potential risks of complications that can jeopardize maternal and newborn health.

Failure to deliver by cesarean section in time may lead to more serious consequences of obstructed labor. These consequences can include injury to the birth passage, postpartum hemorrhage, rupture of the uterus, genital sepsis, or fistula leading to urinary dribbling or incontinence. In the worst case scenario, obstructed labor can lead to maternal death, mostly due to ruptured uterus or puerperal sepsis.

The percentage of maternal mortality attributable to obstructed labor is 4 percent in Africa, 9 percent in Asia, and 13 percent in Latin America and the Caribbean.²⁰ Mothers who survive but have long-term disability due to complications such as fistula experience social, economic, emotional, and psychological consequences that have an enormous impact on maternal health and well-being.²¹

Growth restriction in early life is linked not only to short adult height, but also to certain metabolic disorders and chronic diseases in adulthood. Data from the Maternal and Child Undernutrition Study Group⁷ indicate that lower birth weight (which is strongly correlated with birth length) and undernutrition in childhood are risk factors for high glucose concentrations, blood pressure, and harmful lipid profiles in adulthood, after adjusting for adult height and body-mass-index. The “developmental origins of health and disease” hypothesis posits that the intrauterine and early postnatal environment can modify expression of the fetal genome and lead to life-long alterations in metabolic,



endocrine, and cardiovascular function. In this case, it is likely that the process of stunting is harmful, and not necessarily short stature itself.

Stunting limits educational and economic performance. Stunting is strongly linked to the ability to learn and contribute to national economic development.

Less schooling and diminished cognitive development. The process of becoming stunted, due to restricted nutrient supply and/or frequent infections, is likely a common cause of both short stature and

structural and functional damage to the brain, resulting in delay in the development of cognitive functions as well as permanent cognitive impairments.²² The Maternal and Child Undernutrition Study Group, using the same pooled cohort mentioned above, found that being stunted at 24 months was associated with a reduction in schooling of 0.9 year, an older age at school enrollment, and a 16 percent increased risk of failing at least one grade in school, after controlling for confounding variables such as sex, socioeconomic status, and maternal schooling.²³

Evidence from other developing countries also indicates that being stunted between 12 and 36 months of age is associated with poorer cognitive performance and lower school achievement in middle childhood.⁹

The most convincing evidence on this question comes from long-term follow-up studies of randomized trials such as a large-scale nutritional supplementation trial carried out in Guatemala between 1969 and 1977 (box 1), the only one of the five cohort studies examined by the Maternal and Child Undernutrition Study Group that used an experimental design. This trial demonstrated that a nutrition intervention that increased height gain in early life also resulted in significant improvement on several tests of intellectual functioning at 11-26 years of age and on reading comprehension and intelligence score at 26-42 years of age.

“Babies born to underweight or stunted women are themselves likely to be underweight or stunted. In this way, undernutrition passes from one generation to another as a grim inheritance.”¹⁰

Lower economic productivity and income. Short stature has been linked to lower economic productivity. For example, in a large cross-sectional study in Brazil, a 1 percent increase in height was associated with a 2.4 percent increase in wages.²⁷ Taller men and women earned more even after controlling for education and other indicators of health such as body mass

index, per capita energy intake, and per capita protein intake. Again, the most convincing evidence comes from long-term follow-up studies of randomized trials such as the Guatemala nutritional supplementation trial (box 1). In the Guatemala trial, wages earned by men 26-42 years of age who had received the nutritious supplement during the first 2 years of life – and were taller as a result – were 46 percent higher than among men in the control villages.

Policy and program implications

The evidence described above has contributed to the growing scientific consensus that tackling childhood stunting is a high priority for reducing the global burden of disease and fostering economic development of low-income countries.¹⁰ The most effective interventions are preventive and comprehensive. Strategies to prevent stunting include:

Box 1. Long-term outcomes of a large-scale nutritional supplementation trial in Guatemala

From 1969-1977 the Institute of Nutrition of Central America and Panama (INCAP) conducted a large supplementary feeding trial²⁴ in four rural Guatemalan villages. The study involved pregnant and lactating women and their children from birth to 7 years of age. From 1988-2007, follow-up studies tracked the original population.²⁵

The intervention: The trial included two sets of matched villages. One village in each set was randomly selected to receive either a high-protein (6.4 g/100ml), high-energy (91 kcal/100ml) supplement called ‘Atole’ or a non-protein low-energy (33 kcal/100ml) supplement called ‘Fresco’.^{25,26} Dry skim milk was the predominant source of energy and protein in Atole. From October 1971 until the end of the intervention in 1977, both supplements were fortified with several micronutrients (iron, fluoride, thiamine, riboflavin,

niacin, ascorbic acid, and vitamin A) in equal concentrations by volume.²⁶ Fresco was given as a control for social interaction associated with attending the feeding center, which might have influenced certain outcomes such as cognitive development.

Key findings from the trial and follow-up studies:

- Children in the Atole villages had greater growth in height than those in Fresco villages when the supplement was given during the first 3 years of life; there was no impact on height of supplementation given after 3 years of age.
- During adolescence, children from Atole villages were taller, had greater lean body mass, and scored higher on learning tests than children from Fresco villages.

- Adults 26-42 years of age who were given Atole before 3 years of age had higher reading and intelligence scores (men and women), years of schooling (women only), and wages (men only) than those who were given Fresco as children.
- The infants born to women who were given Atole when they were children had higher birth weight, height, and head circumference than infants of women given Fresco, but there were no differences in measures of fatness.

Conclusions: Supplementation with high-quality fortified food in early life has sizeable effects on human capital formation and economic productivity in adulthood, as well as on growth of future generations.

- Reducing intrauterine growth restriction by improving maternal nutrition and reducing maternal anemia, tobacco use, and indoor air pollution
- Supporting women to practice 6 months of exclusive breastfeeding (breastmilk only)
- Improving complementary feeding practices and dietary quality
- Decreasing infections, particularly diarrhea, through effective disease control interventions
- Planning for healthy timing and spacing between pregnancies with a minimum interval of at least 24 months between a live birth and attempting the next pregnancy

Priority must be given to the following actions:

Raise awareness of the problem. Several key messages need to be communicated and tailored to different audiences. For example:

- Stunting reflects poor nutrition of women, infants, and children.
- Stunting that persists beyond two years of age is often permanent.
- Reducing stunting is important for achievement of the Millennium Development Goals. Universal primary education, eradication of poverty, reduction of mortality, and improved maternal health are among the Millennium Development Goals. Efforts to prevent stunting can contribute to achievement of these goals through enhanced cognitive development, school achievement, higher wages

earned in adulthood, and better health and survival outcomes.

Raise awareness that children throughout the world can achieve their growth potential. Evidence does not support the common assumption that children in certain ethnic and racial groups are “naturally” short. When young children are nurtured in healthy environments and their caregivers follow recommended health, nutrition, and care practices, their average growth patterns are very similar regardless of race or ethnicity. The WHO Multicenter Growth Reference Study demonstrated that the average height of children from birth to 5 years of age in populations with high socio-economic status that followed recommended feeding practices for infants and young children was nearly identical in Brazil, Ghana, India, Norway, Oman, and the United States.²⁸ Although there may be some population-level differences in expected height of adults, which may or may not be genetic, such differences generally do not become apparent until adolescence or later.

Focus on the critical “window of opportunity” and interventions with demonstrated impact on linear growth. Interventions during pregnancy and the first 2 years of life that aim at preventing stunting can be much more effective than those that target children once they have become undernourished. Children 6-24 months of age are most vulnerable to malnutrition and infection. This is the time when they can benefit greatly from nutrition interventions. Nutrition counseling in food secure settings and counseling plus provision of fortified foods or supplements in food insecure settings can reduce stunting.²⁹ Interventions selected to improve complementary feeding should be tailored to the context and include a careful assess-

ment of feeding practices and locally available foods.

Include measurements of height, not just weight. Policymakers should be encouraged to use stunting as an indicator of overall child health and nutrition, rather than monitoring only underweight, and this should be reflected in program evaluation. Stunting as an indicator is particularly important as the “nutrition transition” toward greater overweight accelerates in many developing countries, which can lead to populations with low rates of underweight but persistently high rates of stunting.

Support innovation and research. Much needs to be learned about how to implement successful programs that promote optimal growth and development at an affordable cost. Further research is needed to better understand the pathways by which prevention of stunting can have long-term effects on a variety of outcomes. The follow-up studies in Guatemala demonstrate that a nutritional intervention in early life that improves linear growth also has sizeable effects on human capital formation and economic productivity in adulthood, as well as on growth of future generations. Additional follow-up studies of trials in Africa and Asia would strengthen the case for a global strategy directed at early intervention.

Alive & Thrive, launched with a grant from the Bill & Melinda Gates Foundation, is an initiative to improve infant and young child feeding in Bangladesh, Ethiopia, and Viet Nam and inform policies and programs around the world.

For more information visit our website:
www.aliveandthrive.org

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