Early is best but it's not always too late

Young Lives evidence on nutrition and growth in Ethiopia, India, Peru and Vietnam

Liza Benny, Jo Boyden and Mary Penny

Young Lives
An International Study of Childhood Poverty

The authors

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Standardised height measures

An individual's nutritional status at a given age can be expressed in height-for-age z-scores (HAZ) or height-for-age differences (HAD).

Children's height, or linear growth, is evaluated by comparing their height (or at younger ages their length) with international reference data, expressed as growth curves. These international reference data are based on children growing in optimal environments in different settings. Children are compared to these reference populations in the extent to which their height differs from the average (median) for their age and sex.

Height-for-age scores

The height-for-age z-score (HAZ) indicates the child's relative position expressed in terms of standard deviations from the median compared with the range of normal length or height for that age. A HAZ lower than -2 means that the child's height is more than two standard deviations below the mean height, and she or he is referred to as stunted since in a population of healthy children, no more than 2.3 per cent of children of their sex should have that height at their age.

Height-for-age difference

The height-for-age difference (HAD) indicates the absolute distance from the mean, so that a HAD of -6 means that the child's height is 6cm below the average height for healthy children of the same age and sex.

HAZ and HAD are calculated using the same reference populations according to age. For children aged 0-59 months it is WHO Child Growth Standards, and for children aged 5-19 years, it is the WHO Growth Reference.

Stunting

Stunting, or linear growth faltering, is an indicator of chronic or long-term undernutrition. A child whose height is more than two standard deviations below the median height of reference children of the same age and gender is classified as stunted. The prevalence of stunting in a given population is the percentage of children with heights more than two standard deviations below the median. In a population described as being statistically normal, only 2.5 per cent of the population would have a HAZ more than two standard deviations below the median (HAZ < -2SD). Individual children with HAZ<-2SD are defined as stunted, and are at higher risk of poor developmental, health, and cognitive outcomes. The prevalence of low height-for-age (HAZ<-2SD) can reflect nutritional, health, and environmental constraints to children's optimal growth.

Standardised weight measures

Body mass index

Body mass index (BMI) is used to measure nutritional status in adults and is calculated as weight in kilogrammes divided by the squared height in metres.

Body mass index z-score

A child's body mass index z-score (BMIZ) indicates the child's relative position in the distribution of body mass index for a population of the same age and sex. This is expressed in terms of standard deviations from the median BMI of the reference population.

Weight-for-height z-score

A child's weight-for-height z-score indicates the child's relative position in the distribution of weight for a population of children with the same height, age and sex. This is expressed in terms of standard deviations from the median weight of the reference population.

Wasting

Wasted children have low body weight relative to their height. A child whose body weight is more than two standard deviations below the median weight of reference children of the same age, gender and height is said to be wasted, which is an indicator of acute malnutrition. The reference for children aged 0-59 months is the WHO Child Growth Standards.

Overweight

The definition of overweight varies by age. For children aged 0-59 months, the WHO definition is based on weight-for-height: children who are more than two standard deviations above the median of the WHO Child Growth Standards are classified as overweight. For children aged 5-19 years, they are said to be overweight if their BMIZ is more than 1 standard deviation above the median for a healthy reference child of the same age and gender. For adults aged over 20 years, overweight is defined by having a BMI greater than 25 kg/m^2.

Obesity

As with overweight, the definition of obesity varies by age. For children aged 5-19 years, those who are more than two standard deviations above the median BMI for a healthy reference child of the same age and sex in the WHO reference distribution, are said to be obese. For adults aged over 20 years, obesity is defined by having a BMI greater than 30 kg/m^2.

Dietary diversity

Dietary diversity is a quantitative measure of food consumption that reflects access to a variety of foods and is a proxy for nutrient adequacy of the diet of individuals. It provides a quantitative indicator that positively relates to the probability that the person will have satisfied their dietary requirement for micronutrients.

Food security

Household food security is defined by the World Bank as a situation when all people at all times have access to enough food for an active, healthy life. In Young Lives, food security is measured using the Household Food Insecurity Access Scale (HFIAS) which is a series of questions that have been used across several countries and cultural contexts to distinguish food secure from insecure households. The questions can be used to assign households to different levels of food insecurity from food secure to severely food insecure.

Acronyms

BMI	Body mass index
BMIZ	Body mass index z-score
EMS	Emerging Market Symposium
FAO	Food and Agriculture Organization
HAZ	Height-for-age z-score
HAD	Height-for-age difference
HFIAS	Household Food Insecurity Access Scale
IFPRI	International Food Policy Research Institute
MDG	Millennium Development Goal
NCHS	National Center for Health Statistics
SD	Standard deviation
SDG	Sustainable Development Goal
SUN	Scaling Up Nutrition
UNICE	United Nations Children's Emergency Fund
WFP	World Food Programme
WHO	World Health Organization
WHZ	Weight-for-height z-score

Early is best but it's not always too late

Despite impressive advances in human survival and development, child malnutrition remains a grave problem – with high prevalence of underweight and rising levels of overweight and obesity. Young Lives evidence has demonstrated how better nutrition, better services and greater support to vulnerable households can not only protect the youngest children but may also achieve growth recovery and wider developmental benefits even into early adolescence.

Over the past 25 years, low- and middle-income countries have seen unprecedented progress in child well-being. Children in these countries now generally have much better access to education and there have been major reductions in infant mortality, undernutrition and communicable diseases. These improvements have largely been a consequence of widespread economic growth, which has boosted average household incomes, and enabled governments to invest more in infrastructure and public services – often stimulated by political commitments made under the Millennium Development Goals and similar international accords.[2]

Despite these gains, across many parts of the globe poor health and nutrition remain significant challenges to children's survival, growth and development.[3] Recent UNICEF estimates suggest that 155 million children worldwide experience chronic malnutrition, making them vulnerable to death and disease and impairing their brain and physical development.[4] A further 52 million children worldwide suffer shorter-term undernutrition, leading to wasting or severe wasting, which cause nearly half of all deaths in children under age 5.[5]

Malnutrition can also be transmitted from one generation to the next. The cycle of ill health often begins with undernutrition among women, which increases the risk of complications in pregnancy and undermines foetal growth and development, with effects persisting throughout life.[6] These intergenerational and life-course impacts create significant economic burdens for families, governments and societies – causing major losses in productivity and human development.[7]

In recent years, malnutrition has increasingly been appearing in the form of over-nutrition, leading to rising levels of overweight and obesity in children. An estimated 41 million children globally are overweight,[8] and countries such as India and Peru face the quadruple burden of underweight, micronutrient deficiencies, overweight and obesity.[9] These trends are associated with increasing urbanisation, along with changes in lifestyle, technology and food production and consumption, often exacerbated by low levels of physical activity.[10]

Better child health, nutrition and growth are crucial for achieving the Sustainable Development Goals (SDGs), or Global Goals, which succeeded the Millennium Development Goals (MDGs) in 2015. The Global Goals place children at their centre, establishing the importance for children's well-being not just of reducing poverty and delivering effective services, but also of maintaining high-quality environments. SDGs 2 and 3 focus specifically on ending hunger and malnutrition and ensuring good health and well-being. Other goals address malnutrition and poor health indirectly, through improving the living environment. Thus, SDG 13 calls for action on the climate, and SDG 15 focuses on life on land. SDG 6 aims to ensure clean water and sanitation. SDGs 4 and 5 seek to ensure quality education for all, and reduce gender inequalities, and SDG 10 aims to reduce inequality. All these goals contribute to better nutrition and child growth. If governments are to achieve the ambition of the SDGs to continue reducing under-5 mortality and improving children's health and nutrition, they will need strong political commitment and corresponding financial investment. They will also need to align the various programmes that address critical needs.

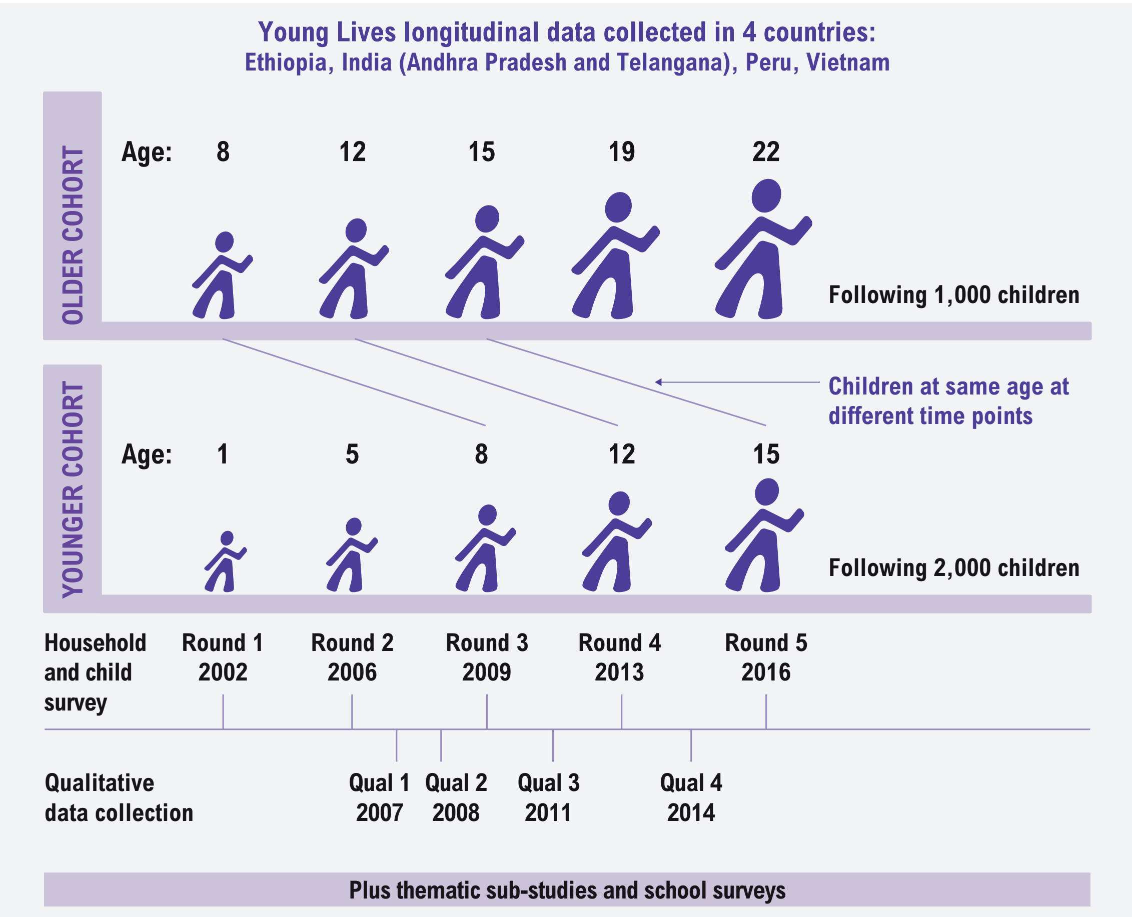
All of this will require a firm evidence base – to inform policy-making, measure progress and guide the efficient allocation of resources to focus on those at greatest risk. The Young Lives study – which over 15 years of research has marshalled findings on the determinants and outcomes of childhood poverty and inequality in four countries, one from each of the world's major developing regions – was set up as a contribution to MDG monitoring and policy guidance. Young Lives has built up a body of evidence – summarised in this report – on the factors threatening children's growth and development, which children are most susceptible at what points in their lives, enabling the study to make a similar contribution to the realisation of the SDGs.

Young Lives

Young Lives is a longitudinal study of childhood poverty co-ordinated from the University of Oxford in partnership with national research and policy institutions. From 2002 to 2016, Young Lives followed 12,000 children from Ethiopia, Peru, and Vietnam, and from India in the states of Andhra Pradesh and Telangana.

Young Lives children were recruited from around 20 different sites in each country. They comprised equal numbers of girls and boys, and were diverse in terms of household economic status, ethnicity, religion, language, and location. However, the sample was not totally representative, since Young Lives over-sampled children in the poorer regions or districts in each country. In Peru, for example, in all major cities the randomisation excluded the richest 5 per cent of districts.

The children were divided into two age groups: 4,000 born around 1994 (the Older Cohort); and 8,000 born around 2001 (the Younger Cohort). The study surveyed these children and their households at about three-year intervals – in 2002, 2006, 2009, 2013, and 2016 – and also undertook four waves of qualitative research with a sub-sample of 200 children. The Older Cohort were around age 8 when first surveyed, and age 22 at the fifth round. The Younger Cohort were approximately 1 year old when first surveyed, and 15 years old at the fifth round. By interviewing the younger children at the same ages as the older ones, but seven years later, the study could compare the development and well-being of the two groups at the same point in their lives. This is an effective way of comparing one generation with another, and seeing how their well-being is affected by interventions or other changes in the contexts in which they live.



Young Lives data cover many aspects of children's lives, well-being and development, capturing a picture of the lived realities of children growing up in poverty. This enables information about children's growth to be assessed in relation to their wider circumstances and outcomes. Findings from Young Lives now provide a baseline for understanding the challenges for the Global Goals, since the longitudinal design makes it possible to trace the links between early life circumstances and later outcomes for children from different social and economic groups and settings. Further information on the Young Lives study design is provided in Appendix 1.

Measuring children's nutrition, health and growth

Linear growth

Children's length or height, commonly termed 'linear' growth, is a good indicator of general health, development and well-being. In infancy, this involves length gain, and thereafter height gain; the appropriate method of measuring linear growth also changes according to the child's age. For newborns, the indicator of healthy foetal growth is typically birth weight and length relative to gestational age. Infant growth is measured from the soles of the feet to the top of the head with the infant lying flat on its back on a measuring board. From two years of age, the measure is the child's height when standing. This growth can be expressed relative to a reference group of children growing in optimal circumstances.[11] Appendix 1 explains the method most commonly used in Young Lives to assess linear growth, and also discusses the implications and debates around the different methods in common usage.

Linear growth occurs in spurts followed by stasis. Growth is rapid in the first two years following conception, slows down in middle childhood, accelerates again before and during puberty, and ends at sexual maturity. The passage through the different growth phases is referred to as the 'growth trajectory'. These phases can be averaged out by serial measures of length and height which may then be compared with those of a reference group of healthy children.[12] These can be presented in smoothed growth curves, showing the median, and usually one and two standard deviations above and below.[13]

Linear growth depends on intrinsic and extrinsic factors, including individual features such as inherited genetic characteristics, past and present health and nutrition, and is also highly sensitive to a child's environment.[14] The sex hormones also play a vital part in growth at puberty, and during adolescence the timing and duration of linear growth varies by sex. Girls start earlier, grow for a shorter period, and stop growing after the onset of menstruation, or menarche, which may contribute to their final adult height being shorter.[15] Boys start puberty later and continue to grow for longer.

Compared with adults, children and adolescents have higher nutrient requirements relative to their body size and are more prone to infectious disease. Intestinal exposure to bacteria and parasites results in changes in their gut mucosa that reduce the absorption of nutrients and decrease appetite.[16] When children become ill, inflammatory processes divert energy from growth. Optimal growth and development thus depend on suitable care, a healthy environment and a varied and nutritious diet in sufficient quantity.

When assessing children's growth, it is difficult to distinguish the genetic and environmental contributions. Nevertheless, some indication of genetic contribution can be gleaned from the height of the parents, particularly that of the mother, whose stature can be linked directly with the child's growth in utero, and with the child's subsequent height.[17] This way of indicating the genetic contribution has some limitations because the parents' heights will, in turn, have also been influenced by the environment in which they grew up, and even by previous intergenerational effects. Nevertheless, a mother's height is widely used as an indicator of her social and economic status and for assessing genetic predisposition.[18]

Genetic and environmental influences on growth

It is hard to determine the relative weights of genetic and environmental influences for individual children, but there have been estimates for some populations. In the United States, for example, the contribution of genes has been estimated as 80 per cent for white men. In Finland, it is assessed as 78 per cent for men and 75 per cent for women. In Asian and African populations, however, the genetic contribution is reckoned to be around 65 per cent.[19] Studies following growth in healthy well-fed children of different ethnic and geographical backgrounds found little variability in growth.[20] Standards for growth later in childhood are based on the National Center for Health Statistics[21] and so the possibility of ethnic and family genetic contribution is less clear. The interpretation of an individual's height during adolescence is also influenced by the onset of puberty and its associated growth spurt.

In undernourished populations in particular, women who experience earlier menarche may be shorter because they have had fewer years in which to grow.[22] This does not explain why the average height of women has been increasing as the age of menarche has been falling. But increases in height have been more frequent in wealthier countries so are most likely due to broader improvements in nutrition and health.[23]

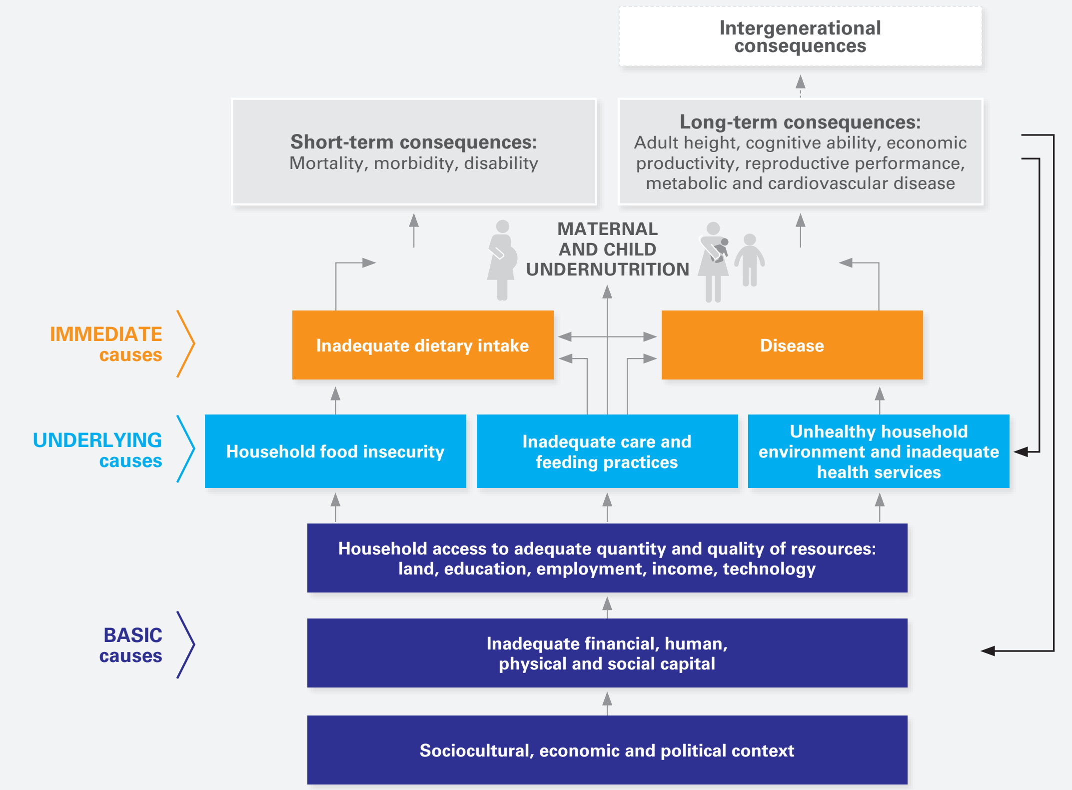
Height in childhood is predictive of future well-being and functioning, as well as of final adult height. Taller adult height, in absolute and relative terms, has been associated with a series of health and societal advantages: including enhanced longevity, lower risk of adverse pregnancy outcomes and cardiovascular and respiratory diseases – though increases the risk of some cancers. There is also an association with improved educational and social outcomes as well as greater productivity and earnings potential.[24] In India, early-life nutrition is also associated with adult marriage rates.[25] Moreover, maternal height influences birth weight and subsequent linear growth of offspring.[26]

Adult height is largely determined during two critical childhood periods: conception to two years, and adolescence. The former is more important. Strong growth in the period of conception to two years establishes most of adult height potential, while also being vital for children's healthy brain and cognitive development.[27]

The indicator typically used as a barometer of child undernutrition or impaired growth is 'stunting', defined as low height-for-age in relation to the WHO growth standards. Stunting represents a chronic lack of the optimum conditions for growth. The extent of stunting is therefore useful for assessing the impact of different environmental factors on children's growth and development.

UNICEF (2015a) has developed a framework, reproduced in Figure 1, which presents the multiple interacting causes of child undernutrition. This framework distinguishes between immediate, underlying and basic causes, and highlights the essential link between child and maternal undernutrition in perpetuating cycles of undernutrition, as well as the short- and long-term consequences and the feedback loops.[28]

Figure 1. *UNICEF framework for determinants of child undernutrition*



The black arrows show that the consequences of undernutrition can feed back to the underlying and basic causes of undernutrition, perpetuating the cycle of undernutrition, poverty and inequities.

Source: Adapted from UNICEF, 1990.

Source: https://www.unicef.org/gambia/Improving_Child_Nutrition_-_the_achievable_imperative_for_global_progress.pdf

So, for example, even before conception or during pregnancy, maternal undernutrition, exposure to toxins, chronic stress, alcohol and drug intake, or conditions such as HIV, can damage foetal development, resulting in stunting during infancy that may persist throughout life, also affecting subsequent generations.[29] Such early disadvantages may be compounded by undernutrition and recurrent infections in early childhood, growth being especially susceptible to disturbances in the first 1,000 days of life starting at conception.

By the time of the final Young Lives round of data collection, the young people in the Older Cohort had completed linear growth and achieved adult height. A substantial proportion of this Cohort also had offspring of their own, for whom Young Lives was able to collect birthweight and anthropometric measurements. As a result, the findings cover three generations – young people in the two cohorts, their caregivers and Older Cohort offspring.[30] This makes it possible to study the impact of linear growth trajectories in infancy and early childhood compared with later growth on adult and next generation outcomes.[31] For the Younger Cohort, Young Lives also collected anthropometric and learning outcome data for their siblings, making it possible to compare the experience of children in the same household, and see how this was affected by such factors as gender and birth order.

Weight and body mass index

Another important indicator of health is appropriate weight gain – 'ponderal growth'. Weight can be assessed as weight-for-age. But weight naturally increases with height so a more appropriate measure is weight-for-height, which is generally the indicator for children under 5 years-old.

'Wasting' normally refers to children with low weight-for-height. For older children and adults, a more useful indicator is weight divided by the square of the height – body mass index (BMI).

These measures indicate whether a child's nutritional requirements are being met or exceeded, and whether for their age and height children are underweight, overweight or obese. Compared with linear growth, weight gain is more variable and can be subject to both short- and long-term imbalances between a child's energy requirements and expenditure. Other indicators of overweight and obesity are abdominal circumference, and skinfold thickness, though the latter was not recorded for Young Lives children.

Children are considered to be moderately wasted when their weight is more than two standard deviations below the median weight for children with the same height in the reference population. If it is more than three standard deviations below, they are identified as severely wasted.[32] Wasting is less common than stunting and when severe is usually the consequence of a more acute short-term episode, such as famine. Children who are wasted are also likely to have compromised immune systems and are thus more vulnerable to infection and disease and have higher risks of mortality.[33] Wasting may be transient followed by recovery, but severe wasting, which in extreme cases is known as marasmus, represents a serious health risk, particularly if associated with stunting.[34] Compared with children with normal growth, children who are both stunted and wasted, even if only moderately, have an increased risk of morbidity and have been estimated as 12 times more likely to die in childhood.[35]

In the Young Lives samples, as in most other populations, wasting is relatively uncommon, and the underlying factors have been less explored in this study than the causes of stunting.[36] It should be borne in mind that percentage levels of wasting and stunting are not comparable. For instance, 13 per cent wasting is considered very high, whereas for stunting the threshold for a high rate is around 40 per cent.

There are also risks from overweight and obesity. Children younger than 5 years of age are considered overweight if their BMI is more than two standard deviations above that of the reference population. Those between 5 and 19 years are overweight if their BMI is more than one standard deviation higher, and obese if it is more than two times higher. Some countries have also assessed overweight and obesity using abdominal circumference.

Children who are overweight or obese are likely to face health problems, both as children and as adults, and to have lower life expectancies. This is primarily because they are more likely to suffer from non-communicable diseases such as high blood pressure, diabetes mellitus and certain forms of cancer, which are increasingly common in low- and middle-income countries.[37] In India, for example, the risks from diet-related non-communicable diseases are among the highest in the world.[38]

Indicators of food security and dietary quality

Given the centrality of nutrition to children's growth it is important to assess, as far as possible, the volume and quality of their nutrient intake. A household's food security is one way of gauging children's access to sufficient food. According to the UN's Food and Agriculture Organization, food security is defined as 'all people, at all times, having physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life'.[39]

Young Lives measured a specific aspect of household food insecurity – the extent to which a household accesses enough nutritionally-adequate food, as specified by the FAO's household food insecurity access scale.[40] Respondents were asked if, and how often, they had experienced the following: concern over not having enough food; eating food that was not their preference; having limited variety and amounts of food; skipping meals; and going to bed hungry. For each household this provided an overall score, which represented the extent of household food insecurity.

From the second survey round (in 2006), Young Lives also recorded diet-quality information, from caregivers when the children were aged 8, and from the children themselves once they had reached age 12. Based on the FAO dietary diversity questionnaire, respondents were asked whether on the previous day they had eaten any food from 15 different food groups – or 11 groups in the second survey round.[41] They were also asked about locally common foods.[42] This allowed analysis of individual dietary diversity, which is a good proxy for individual dietary quality and micro-nutritional adequacy and also consumption of specific food groups.[43]

As a complement to information gathered on household expenditure, families were asked about the monetary value of food items they had procured in the previous two weeks – whether through purchase, their own production or barter. This allowed for comparison across households and when used together with information on food prices provided a measure of household food consumption.

Findings from Young Lives

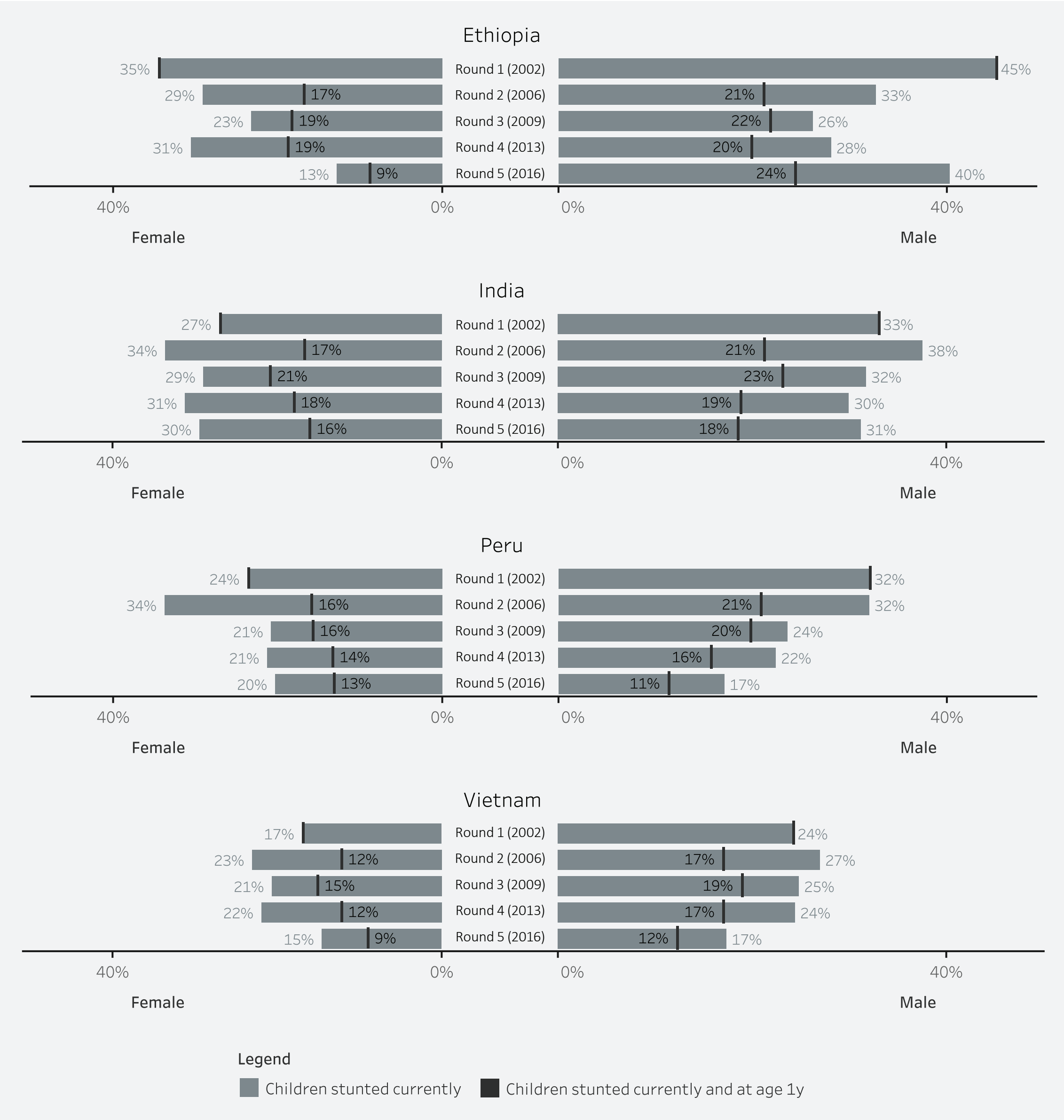
Stunting

The prevalence of stunting among the Young Lives children was recorded using the WHO classification. During the first survey round in 2002, when the Younger Cohort was around age 1, the prevalence was between medium and very high.[44] The rates were: 41 per cent in Ethiopia; 30 per cent in India; 28 per cent in Peru; and 21 per cent in Vietnam. By the time of the second round in 2006 when they were aged 5, stunting in three of the countries was 'high': 31 per cent in Ethiopia, 36 per cent in India, and 33 per cent in Peru; and was 25 per cent in Vietnam. Comparisons of indicators of living standards (such as access to public services and educational levels of caregivers), between Young Lives and nationally representative surveys, show that the samples are similar, with slight disparities possibly explained by differences in survey timing.[45] Nationally representative statistics around the millennium showed the prevalence of stunting among children under 5 to be 57 per cent in Ethiopia (in 2000), 54 per cent in India (in 1999), 31 per cent in Peru (in 2000), and 43 per cent in Vietnam (in 2002).[46]

A high level of stunting might be expected in Ethiopia, the poorest Young Lives country. But it is more surprising in Peru, which by 1987 was classified as a middle-income country and by 2008 as a higher middle-income country. However, the pattern in Peru is by no means unique. Despite global progress in child development in recent decades, stunting among children under 5 years is still quite common in middle-income countries. India is one of the most extreme cases. Classified in 2007 as a lower middle-income country, it nevertheless has one-third of the world's stunted children. This is partly a consequence of the sheer size of India's population. But, more importantly, the rates of stunting are about 20 times the expected level for a healthy well-nourished population, reflecting serious shortcomings in household and community environments across India.[47] Indeed, India's former Prime Minister Manmohan Singh in 2012 described the revelation that about 40 per cent of children under age 5 in nine Indian states were malnourished as a 'national shame'.[48]

Stunting indicates a long-term growth deficit. Young Lives research shows that a high proportion of children with growth deficits as infants continued to suffer poor growth through childhood and adolescence.[49] In all four study countries, children who were stunted early in life were more likely to remain stunted throughout childhood.[50] This is indicated in Figure 2 which shows, based on HAZ, the percentages of girls and boys in the Younger Cohort who were stunted at each age. The dark vertical lines denote the proportion of stunted children at each age who had also been stunted at age 1.

Figure 2. *Prevalence of stunting over childhood*



Note: Shows the percentage of Younger Cohort boys and girls whose HAZ was lower than -2, for each round of data collection.

Figure 2 shows that early stunting was highly predictive of later stunting and also that stunting was very common when the children were around 1 year old, with the prevalence ranging from 17 per cent among Vietnamese girls to 45 per cent among Ethiopian boys.

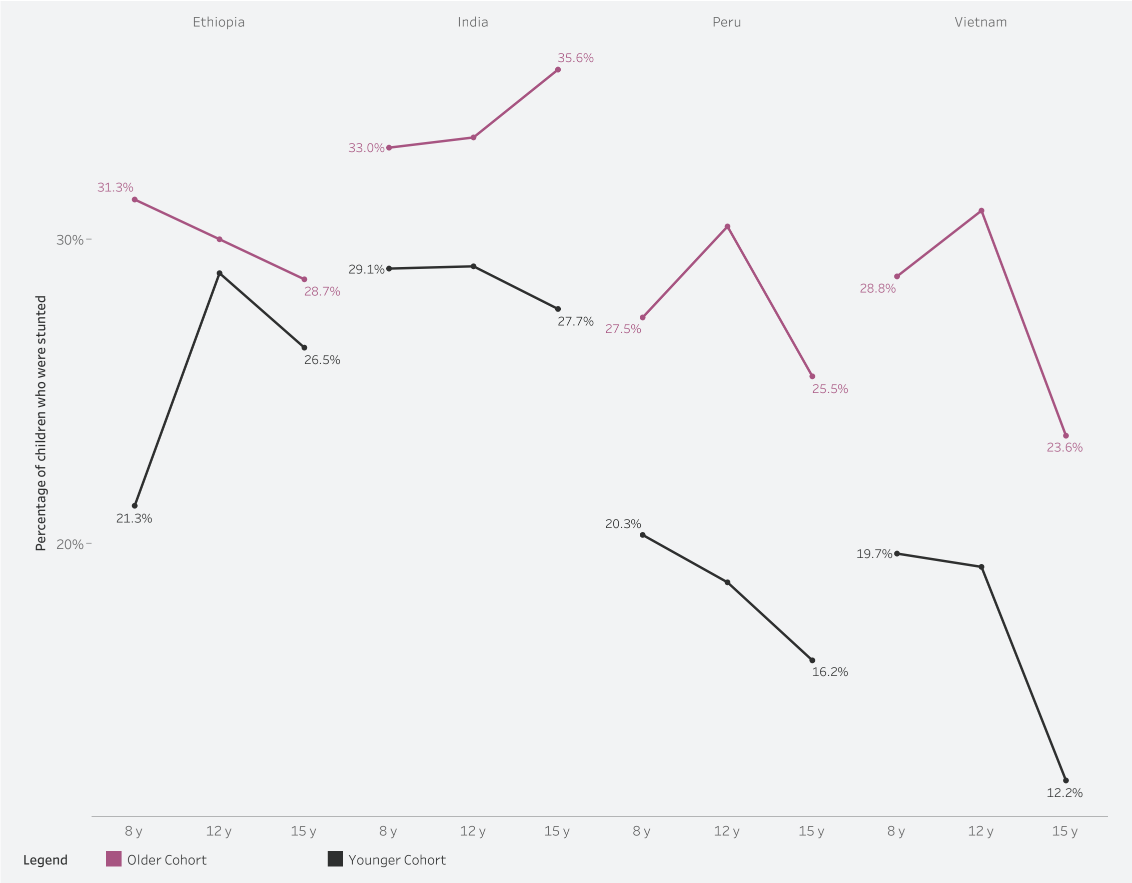
Then, between the ages of 1 and 5 the prevalence of stunting, expressed as HAZ, rose in Peru, India, and Vietnam.[51] This increase was relatively short-lived and most likely reflects the fact that in many low- and middle-income countries when infants start receiving food, alongside or as a replacement for breast milk, this food may be insufficient, or of poor nutrient quality. At the same time, they are more exposed to contaminated water and environments, especially when they become more physically active.

In Ethiopia, however, the rates were already very high at around age 1 – around 50 per cent – and did not rise following early childhood as they did in the other countries. This was probably due to risk factors in pregnancy and the first six months of life.[52] Figure 2 also shows gender or biological differences in all four countries: the prevalence tended to be higher among boys, especially at younger ages.

Crucially, Figure 2 also indicates the potential for growth recovery. The prevalence of stunting was lower among older children, pointing towards substantial recovery for those who were initially stunted – expressed as an improvement in their position in the height distribution of the reference population. The greater improvement for Ethiopian girls at 15 years old may be related to their comparatively late puberty.

There is also wider evidence that children's nutrition and health improved considerably over the period of Young Lives data collection. This is apparent from Figure 3, which compares stunting rates of the two cohorts at ages 8, 12 and 15 and shows that Younger Cohort children were less likely to be stunted. This trend has also been reflected in other studies in four South Asian countries, which have found that rising incomes and better services contributed to healthier growth among children under 5 years old.[53]

Figure 3. *Stunting prevalence over time*



Note: Shows the percentage of children with HAZs lower than <-2 at ages 8, 12 and 15. This indicates the difference in stunting rates between children born seven years apart.

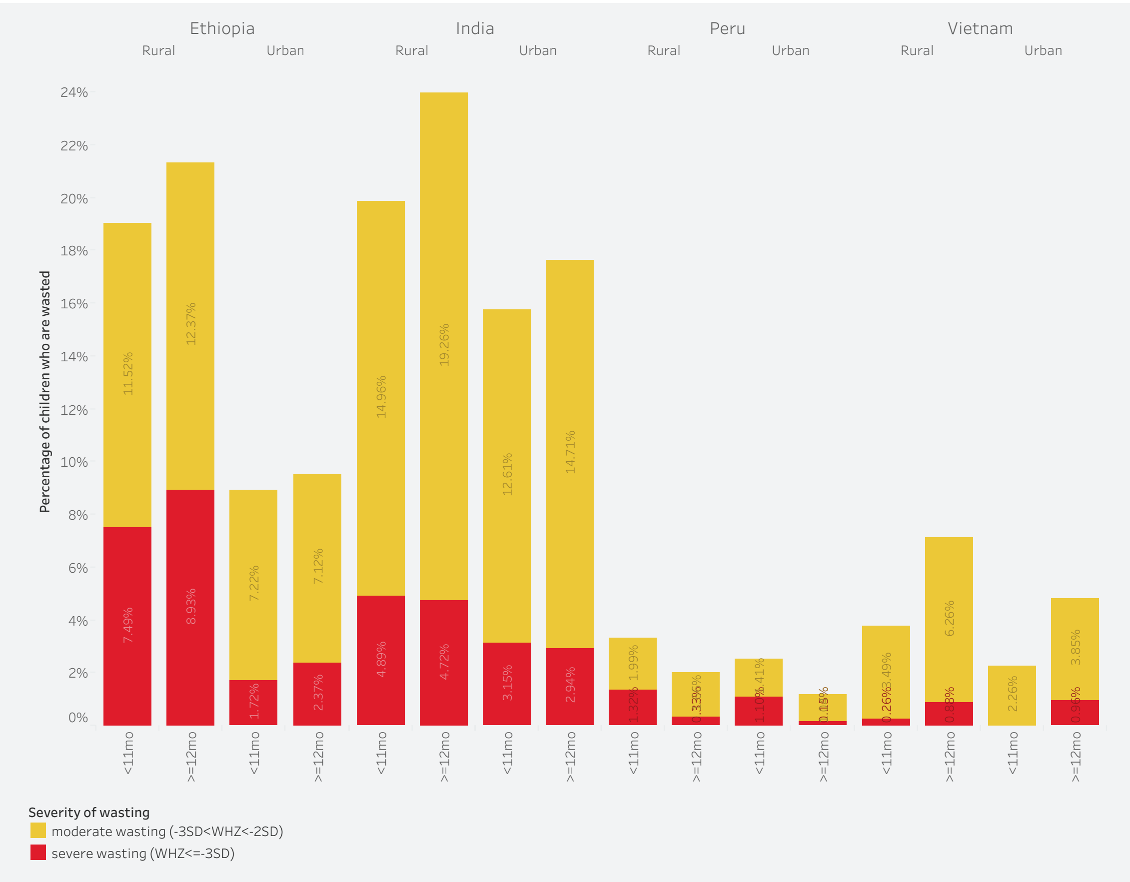
Young Lives data therefore offer some good news, in that recovery from early stunting is possible and also, overall levels of long-term undernutrition are falling. Stunting was lower at older ages, and also among the cohort born later. Nevertheless, the prevalence of undernutrition remains unacceptably high.

Moderate and severe wasting

In many countries, a significant proportion of children experience deficiencies in their diet and health that lead to wasting. This is often associated with sporadic but recurring, or seasonal, food shortages, so compared with levels of stunting, levels of wasting tend to be more variable. Moreover, infants are more likely to be still breastfeeding, which may protect them from short-term food shortages.

Figure 4 shows the prevalence of wasting among the Younger Cohort when they were around 1 year old in 2002 – those with a WHZ score lower than -2. Wasting was relatively low in Peru and Vietnam but much higher in India and Ethiopia, where it affected about 20 per cent of children. It was more prevalent in rural areas of India and Ethiopia, though still quite high in urban areas. Of particular concern is the proportion of children in these two countries who experienced severe wasting, though in all contexts a higher proportion were moderately wasted

Figure 4. *Wasting prevalence across the Younger Cohort, 2002*



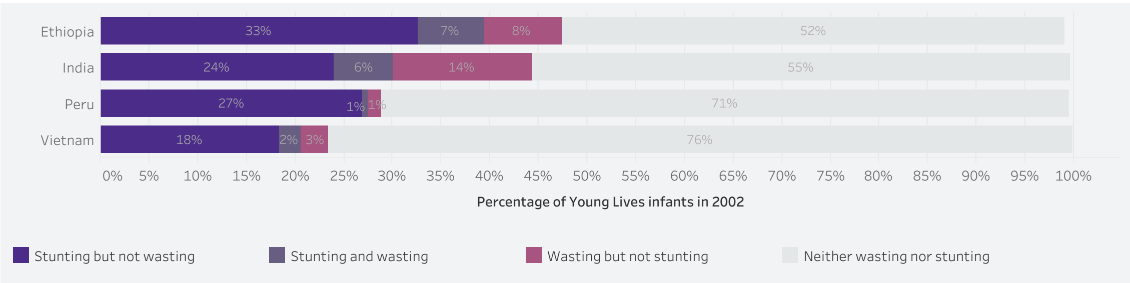
Note: Shows the prevalence and severity of wasting, based on WHZ, for Younger Cohort children around age 1, in rural and urban areas.

Young Lives findings are in keeping with other studies based on demographic and health surveys: in India, wasting was found to be 15.9 per cent; in Ethiopia, 13.0 per cent; and in Peru, 1.2 per cent.[54] Several other studies have also assessed rates of reduction in wasting. In India, between 1992 and 1998 the rate fell from 19.5 per cent to 15.9 per cent, and in Peru, between 1996 and 2000 from 1.5 per cent to 1.2 per cent. In Ethiopia in 2000 the rate was 12.5 per cent, but by 2014 it had fallen to 8.9 per cent, although there were large differences between urban and rural areas. Within countries there were also regional differences. In Ethiopia, for example, the prevalence of wasting was 10 per cent in the south but 20 per cent in the east.

A study in seven countries, including India and Ethiopia, has investigated the causes of wasting.[55] It concludes that high levels in these countries result from a sequence of adverse events – starting with small size at birth, followed by problems with breastfeeding and non-exclusive breastfeeding. Then complementary feeding may be inadequate in quantity and diversity, resulting in energy and nutrient gaps that render the children vulnerable to illness – which in turn increases their nutrient needs, accelerates nutrient losses and may influence their appetite or feeding practices. The relative contribution of these risk factors in the path to wasting varied between countries. In India, a major contribution was small size at birth. In Ethiopia, the most important causes were diarrhoea episodes followed by inadequate infant feeding practices, in particular sub-optimal meal frequencies, including a shorter period of breastfeeding.[56] For instance, in northern Ethiopia there was considerable heterogeneity, but being breastfed for 12 to 23 months without adequate complementary feeding was a predictor of wasting.[57] In both countries, however, the risks also varied according to sex, age and the incidence of diarrhoea.[58] Also important were the heights and BMIs of mothers.

In the most extreme instances, children suffer from both stunting and wasting. This was the case for 6 to 7 per cent of Young Lives children in India and Ethiopia (Figure 5). Other research points out that when wasting (weight-for-height) is used as a measure of malnutrition this underestimates the number of children who are malnourished, as children who are of low weight-for-age but are also stunted may not be recognised because their weight is expressed in relation to this reduced height.[59] They recommend using a compound indicator (Composite Index of Anthropometric Failure) including low weight-for-age and reporting children with all three conditions as experiencing 'overall undernutrition'. Using this compound indicator would mean that these particularly vulnerable children can be more easily recognised and deaths averted.

Figure 5. *Incidence of both stunting and wasting in infants, 2002*



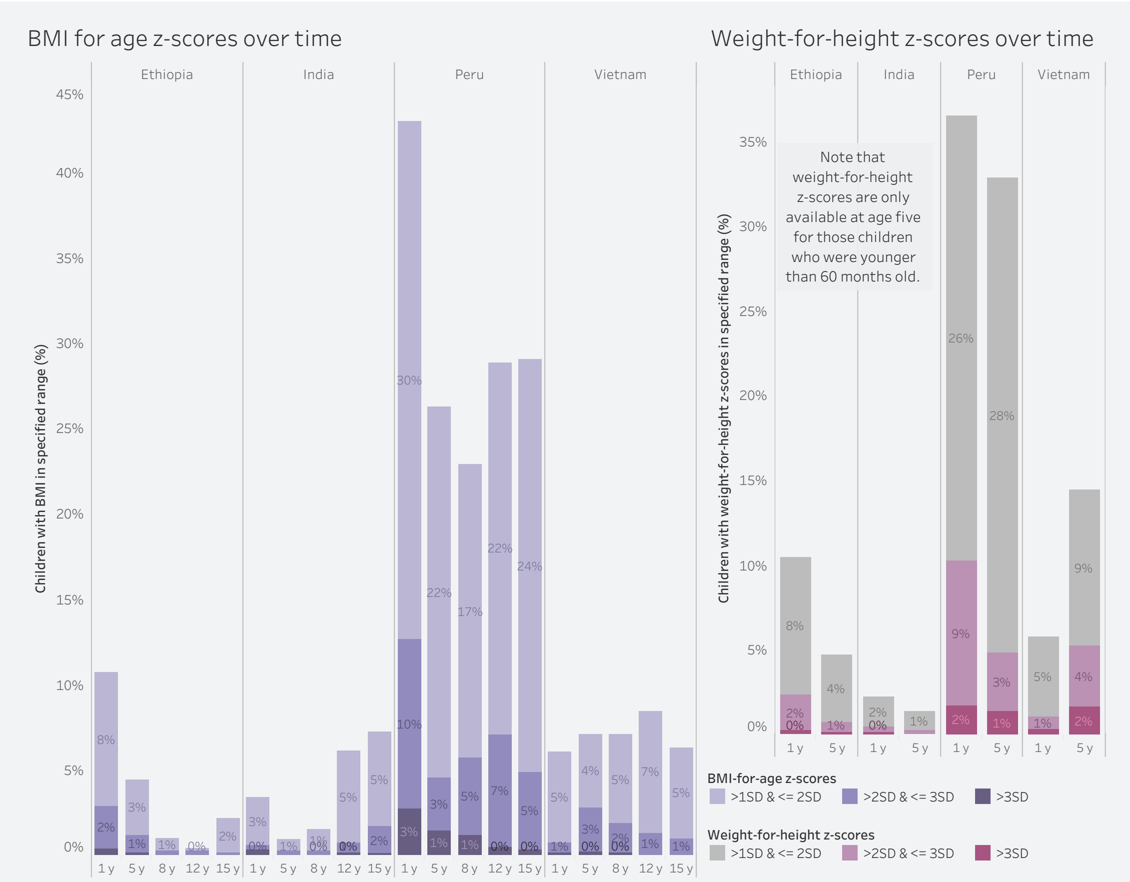
Note: Shows the percentage of children classified as stunted (HAZ<-2) or wasted (WHZ<-2), or both.

Overweight and obesity

Many low- and middle-income countries, while continuing to face persistent stunting, underweight and micronutrient deficiencies, are now also seeing rising levels of overweight and obesity among children – undergoing what has been termed a 'nutrition transition'.[60] Studies have shown that improvements in the technology of food production and distribution have increased the availability of affordable foods and drinks, processed or home-made, and these are high in calories, especially sugar and fat.[61] Together with increased meat production and consumption, this has contributed to higher calorie intake. This may be helpful for younger children whose diets are low in animal-source foods. But for older children it is likely to be detrimental: evidence from a wide range of developing countries has shown the adverse effects of additional fat content accompanied by changes in lifestyles and technology that have reduced physical activity, particularly in urban areas.[62]

Figure 6 tracks the proportion of the Younger Cohort who were overweight or obese at ages 1, 5, 8, 12 and 15. It shows that among the Young Lives children, initially the problem of childhood overweight and obesity was largely confined to Peru. In 2002, 11 per cent of 1 year olds in Peru were found to be overweight (9 per cent) or obese (2 per cent). In the other three countries, the rates were only around 1 per cent. Nevertheless, over the 15 years of Young Lives research, overweight and obesity also became a rising problem among children and adolescents in other countries.

Figure 6. *Proportion of the Younger Cohort overweight or obese at different ages*

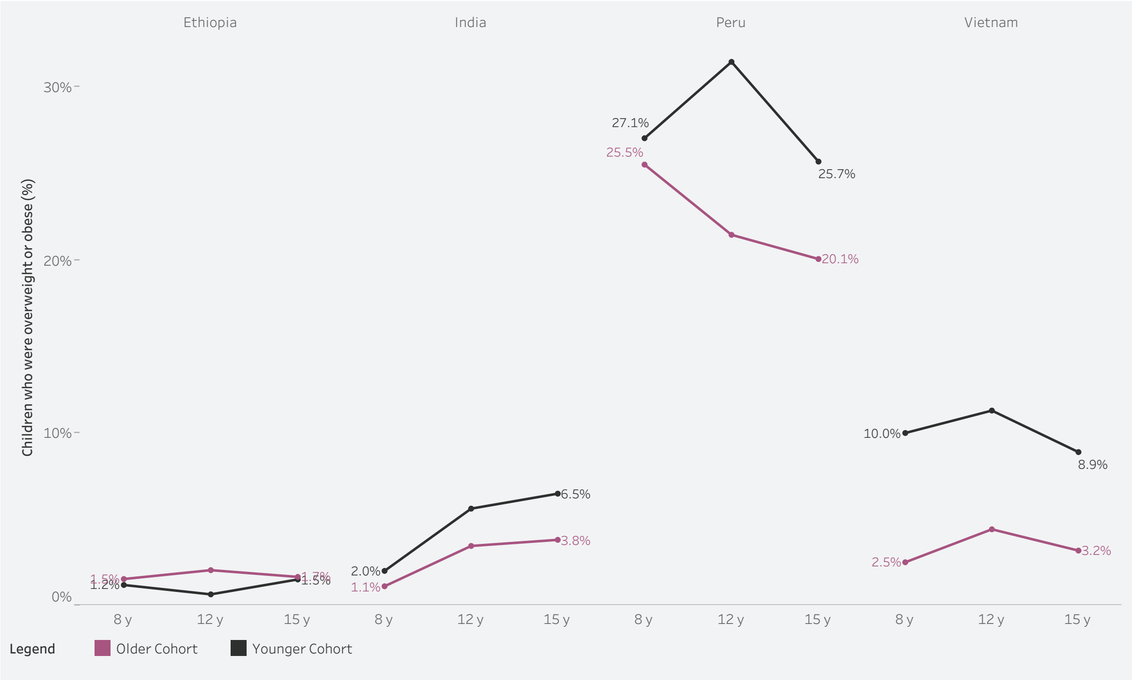


Notes: BMI z-scores are for all children at all data collection rounds. Weight-for-height z-scores are at 1 and 5 years. The definition of overweight varies by age. For children between 0 and 59 months, the WHO definition is based on weight-for-height: children who have WHZ>2 are classified as being overweight. Children between 5 and 19 years old are overweight if their BMIZ>1SD. Children between 5 and 19 years old are obese if their BMIZ>2SD.

At all ages the rates were highest in Peru and Vietnam. In India, overweight and obesity were not common in childhood, but for both boys and girls the risk had increased by mid- to late-adolescence. In 2002, only 1 per cent of 8 year olds were overweight or obese, but in 2017 the rate for 22-year-old Indians was 13 per cent, and 20 per cent in urban areas. In Vietnam in 2016, the rates were 8 per cent in urban areas and 5 per cent in rural areas; 7 per cent overall. Only in Ethiopia did the rates remain relatively low throughout.

Generally, compared with the Older Cohort, the Younger Cohort were better off in their nutrition and health; in particular, they were less likely to be undernourished. But Figure 7 shows that in the case of overweight and obesity the position was reversed: Younger Cohort children were worse off.

Figure 7. *Overweight and obesity rates for Older and Younger Cohort children*



Notes: Shows the difference in overweight/obesity prevalence rates at ages 8 and 15 for children born seven years apart.

The Young Lives data reflect patterns across a wide range of low- and middle-income countries.[63] Overweight and obesity is a major concern, since individuals who gain too much weight in childhood have a higher risk of being overweight or obese in adulthood.[64] Diets and body composition tend to persist over the life course.[65] Efforts to lose excess weight generally reduce the efficiency of the body's metabolism over the long term, so it becomes more difficult to keep weight off. Healthy dietary behaviours learnt in early childhood may thus help lower the risk of excess weight and of chronic diseases in later life.[66] More sedentary lifestyles and lack of physical activity are also important determinants of obesity but were not systematically investigated in Young Lives.


Babysec
Pooh

Links between impaired growth and child development and well-being

Children's development involves multiple functional domains, typically delineated as motor/physical, cognitive, socioemotional, communication/language, and self-help. These domains are interdependent and continuously interact, changing under varying intrinsic and extrinsic influences. Nutrition, health and growth are core contributors to motor/physical development, which, in turn, influence all other developmental domains. Therefore, any impairments to children's growth potentially threatens their wider development and well-being. For example, malnutrition that results in stunting not only affects children's physical growth, but also their neurological development and cognitive functioning.

Stunted growth and wasting

In all four Young Lives countries, children who were stunted at age 1 were likely to perform worse than their peers in a maths test at age 5,[67] and to be older than the appropriate age for their school grade, and to have lower scores in mathematics and reading and a more limited vocabulary at age 8.[68] Similarly, children in the sample who were stunted at age 8 had attained fewer than normal grades at age 12.[69]

Low birthweight was also a risk for being stunted, though in this case it was possible to avoid impaired neurological functioning through subsequent weight gain.[70] Among the children of the Younger Cohort in Vietnam, birth weight was found to predict weight and height at age 8, but was not associated with educational outcomes. However, weight gain that was not predicted by birthweight was associated not only with height and weight at age 8, adding predictive power over birthweight. Importantly, this unpredicted weight gain was associated with educational outcomes at age 8.[71]

Stunting that persists can also be associated with psychosocial outcomes. Though the link may not be causally identified using the Young Lives data, 8 year olds who had lower height-for-age z-scores also tended to have lower self-efficacy, self-esteem and aspirations at age 12.[72] Other research documents a negative effect of stunting that is significant in Ethiopia for receptive vocabulary, in Vietnam for both maths and receptive vocabulary, and India for maths only.[73] Children who were persistently stunted (HAZ lower than -2 SD) at ages 1, 5, and 8 were likely to score lower on tests of vocabulary and maths.[74]

Young Lives also found an interaction between linear growth and ponderal growth. Compared with children of normal height, children who were stunted in infancy were at lower risk of overweight or obesity at ages 5, 8 and 12.[75]

Additionally, Young Lives observed adverse cognitive consequences of wasting. In India, children of lower than expected weight at age 1 performed worse on tests of vocabulary, quantitative reasoning and maths at ages 5 and 8. If they were both stunted and wasted they were more likely to have lower maths scores at age 8.[76] In Peru, children wasted at age 1 had lower maths scores at age 8. Also, children in Peru who were thin or severely thin (with a low BMI for age) had significantly lower cognitive scores at ages 5 and 8.[77]

Young Lives confirms findings from other studies that highlight how early life growth deficits, in the form of wasting and stunting, pose a major risk to children's cognitive and education outcomes, with persistent stunting in particular seriously undermining their developmental potential in these areas over the long-term. Aside from the damage to affected children, this raises serious concerns about their functioning and well-being in adulthood and the impacts on subsequent generations. Young Lives evidence indicates that stunting may even impair wider psychosocial well-being, further compounding the effects.

Overweight and obesity

Other studies have found that, compared with children of normal weight for their height, obese children have lower psychosocial well-being, poorer health, lower levels of motor ability, and weaker cognition and language skills.[78] However, the differences are small, and the trends reported by different studies vary and are likely to be confounded by differences in socio-economic status.[79]

Of the Young Lives countries, the most data on this issue are available from Peru. Here, overweight and obesity were more common in taller, better-off, and urban children.[80] Obese children, and particularly girls, were likely to perform better on a test of Spanish vocabulary at ages 5 and 8. It is hard to make the link directly, however, because the mother tongue is only a rough proxy for several possible determining factors. Additionally, girls that gained weight faster between birth and age 8 had a higher chance of early puberty, which can have repercussions later in life, including higher risk for some cancers, lifelong overweight and obesity, and lower linear growth.[81]

Further analysis of Young Lives data will allow identification of wider developmental outcomes of overweight and obesity.

Impaired growth in children: risk factors

If impaired child growth is to be addressed through preventative and remedial policies and interventions, it is important to identify the most vulnerable children – who they are, where they live, and, whenever possible, why they are susceptible. For this purpose, Young Lives data offer valuable pointers on the immediate, underlying and basic causes not just of stunting and wasting but also of over-nutrition. Across the four countries, there are clear and consistent patterns of vulnerability to stunting and wasting associated with a child's gender and ethnicity, household socio-economic status, maternal height and well-being, service shortfalls and geographic location. Specific factors, such as drought in Ethiopia and civil conflict in Peru and India, have also been identified as presenting significant risks. On the other hand, the factors influencing child overweight and obesity are mostly to do with diet and activity level.

While it is possible to isolate a range of different risk factors, it is important to stress that, in reality, these multiple threats occur simultaneously and interact, so it can be difficult to distinguish between specific influences or say which ones matter most for children's growth. The effects of basic determinants, as defined by UNICEF, can be moderated or mediated by intermediate factors associated with households, families or institutions – which also represent risk or protective factors in themselves. The characteristics of individual children, for example their sex or gender, also play a part. For instance, children from minority ethnic, language, or religious groups are typically poorer than their peers, and are more likely to live in more marginal and remote rural areas with limited or no services. They are also more likely to experience high levels of exposure to extreme climates and to natural and man-made disasters.[82] These circumstances may exert extreme pressure on caregivers, influencing their nutrition and emotional well-being to the point that the condition of mothers especially can seriously affect children's nutrition and health. It is seldom clear which of these many interrelated factors matters most for children's growth.

Identifying the most effective course of action for eliminating malnutrition can therefore be challenging. For example, improving access to services like clean water and sanitation may be a significant priority, implying the need for public sector funding, infrastructural development and effective governance, but availability does not guarantee use, which suggests the need for public health information and other efforts to ensure normative and behavioural change.

The UNICEF framework has been used in the following analysis of the factors Young Lives has identified as shaping linear and ponderal growth in children.

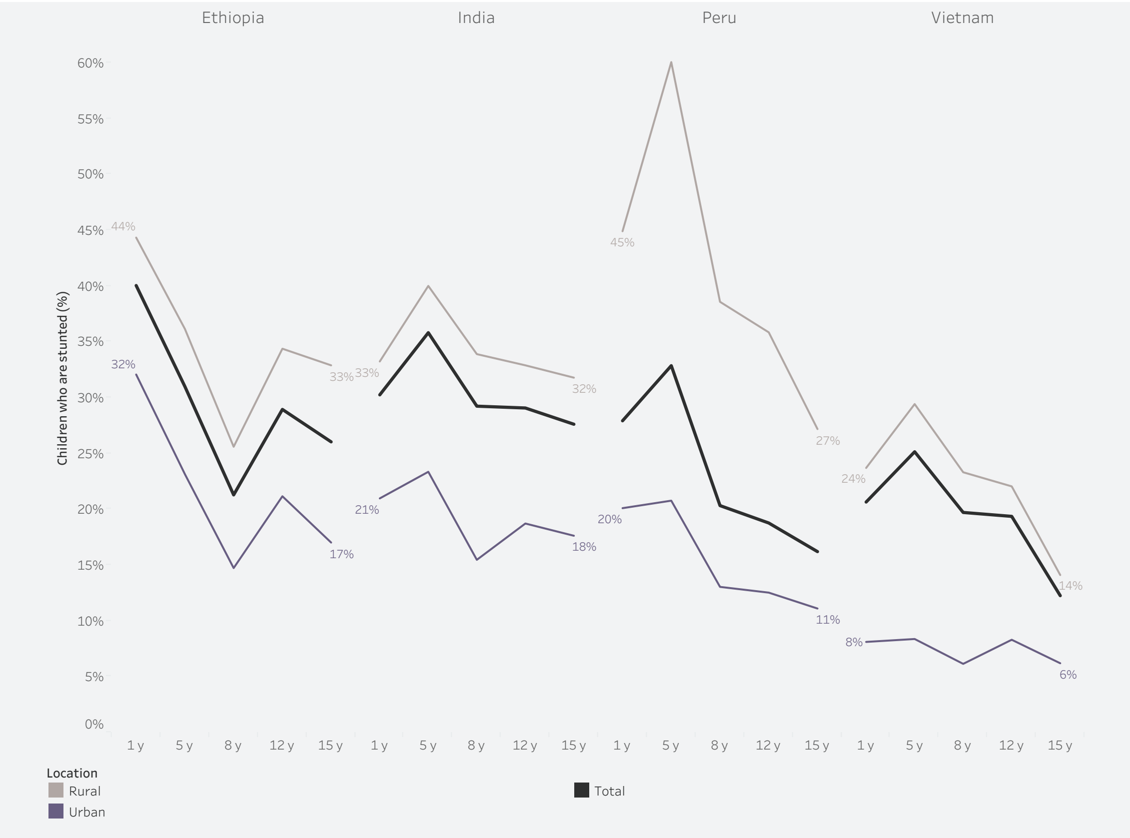
Basic factors in child nutrition and growth

The following sections consider Young Lives evidence concerning the basic factors influencing children's nutrition, health and growth. These included risks due to the natural environment, for example climate, weather, and natural resources, and risks associated with the human-mediated or built environment, for instance buildings, infrastructure and services. Also important are wider societal factors, including cultural values, norms and practices – such as those around infant weaning or hygiene – and discriminatory political-economic and social structures – for example the exclusion of minority religious or language groups from capital, land or services. Young Lives data indicate that many of these basic risk factors differ in their prevalence by rural and urban location.

Rural or urban location

There were significant disparities in child stunting rates between rural and urban areas. In all countries, and at all ages, rural children were more likely to be stunted (Figure 8).

Figure 8. *Stunting rates for Younger Cohort children, by location*



Note: Shows the percentage of children stunted (defined as HAZ <-2SD) by age and location of residence.

As indicated, teasing out the factors underlying these disparities between rural and urban populations is not straightforward. Take the example of Peru, where rural-urban differences in children's length/height were evident from birth. Rural populations are more likely to be of Andean origin and it is possible that in addition to poorer economic status and other drivers of stunting, their shorter adult stature as compared to people of European extraction might also be due to differences in height across ethnic groups.

The original reference populations on which the WHO growth curves are based included children of different ethnic backgrounds and found no differences in growth attributable to ethnic group, something generally borne out in other studies. On the other hand, studies of Andean children living at altitude have demonstrated shorter limb length, apparently at the expense of greater chest volume, but nevertheless resulting in shorter stature.[83] It would be useful to discover whether a combination of ethnicity and altitude contributed, albeit in a minor way, to their reduced stature. This would require further analysis of the geographic location of Young Lives households as well as consideration of other confounding factors.

Patterns of rural-urban disparity were similar across the four countries, but the underlying causes of differences varied.[84] For example, in Ethiopia, rural children's growth lagged behind that of urban children because of lower levels of household wealth and caregiver education. In Vietnam, however, the problems were more related to inadequate rural health services and environments of poor hygiene.

Natural Environment

Across the globe, human activity has created hazards that are particularly damaging for children's health and nutrition. On current trends, environmental damage and climate change in some countries could halt or even reverse progress in child health and nutrition.

One of the most significant problems is the destruction and depletion of natural resources that has reduced the quality of air, water and soil.[85] In addition, climate change has increased the frequency and intensity of extreme weather events such as heat waves, drought, flooding and storms. These processes profoundly affect the Young Lives study countries where levels of exposure are high and governments and other stakeholders have limited capacity to mitigate the impacts. Ethiopia, India and Vietnam are among the world's most climate-vulnerable countries.[86] Peru is the country in South America that will see the greatest temperature increases.[87]

Child nutrition and health are directly affected by environmental hazards as diseases spread faster in different temperatures and rainfall conditions.[88] Climate change, for example, is expected to increase the incidence of respiratory tract infections, diarrhoea, and malaria, which together cause more than half of all deaths in children under age 5 globally – particularly in low- and middle-income countries.[89]

Children may also be affected indirectly as their caregivers and households come under greater stress, and when adverse environmental events rupture livelihoods, food supplies and systems of community support.[90] For example, in eastern and southern Africa, following the 2015-16 El Niño climate cycle, there was a sharp increase in severe acute malnutrition in the form of very low weight-for-height, severe wasting and nutritional oedema.[91]

Young Lives found that children exposed to extreme weather events in early childhood were likely to be shorter than their peers and suffer more infections (such as diarrhoea) in infancy that can affect nutrient absorption and later growth.[92] Extreme weather events may also constrain human development: spells of intense cold, heat or drought that affect the foetus can hinder brain growth and subsequently reduce adult productivity.[93] All these effects combine to threaten brain development and influence later cognitive performance.[94]

Children's growth and development remains sensitive to climate shocks even after early childhood. However, it is difficult to separate the effects of these events from behavioural factors. For example, parents may try to offset harm to their children by spending more on their health, or on their food, thereby reducing the observed impact.[95] However, parents who are poor have limited budgets for children's welfare, and must prioritise their spending, so they may compensate for increased expenditure on health by spending less on education. They may also decide to favour other children who have been less affected.[96] Biological and behavioural factors thus interact to shape the relationships between various aspects of children's development. As a result, children exposed in early childhood to conditions of excessive rainfall or drought, or to sub-zero temperatures or heat waves, may perform better at age 8 in test of maths and vocabulary if parents observe impacts on their growth and respond by spending more on other areas of their development.[97]

Exposure to extreme climate events during childhood can have significant intergenerational effects. For example, some mothers of Young Lives children experienced the Ethiopian famine of 1984. If they had been exposed for more than three months in the first three years of life they were, on average, shorter and had less schooling as adults. In turn, their children suffered from the negative impact of the famine on their mothers' health and education: they were likely to be shorter, have lower levels of schooling and self-esteem, and lower locus of control.[98]

Built Environment

Over the past two decades across the Young Lives countries, there have been many improvements in living conditions, infrastructure and services. But there is still some way to go, particularly in poorer communities – even in Ethiopia and Vietnam, where service development has mostly been pro-poor.

Compared with rural communities, children in urban communities tended to have better outcomes. Services and infrastructure tended to be less developed in rural areas and often those that did exist, were poorly maintained. Urban households were typically wealthier and had access to better services and infrastructure. However, there were even greater disparities within rural and urban areas.[99] For example, in Ethiopia and India, rural-urban disparities in children's growth trajectories were mostly explained by the differences in household wealth and caregiver's education.[100] Moreover, urban lifestyles and consumption patterns carry their own risks. In the Young Lives sample, overweight and obesity were most common in urban settings and in wealthier households which tend to be concentrated in towns and cities.

Health services

A study in India and Young Lives evidence for Vietnam found a clear association between child malnutrition and the utilisation of formal health services and skilled delivery care among their mothers.[101] In the India study, stunting was lower among children who had been given the Haemophilus influenzae type B (Hib) vaccination than among those who were not vaccinated (31 per cent versus 40 per cent) and the vaccinated group had a lower prevalence of underweight (40 per cent versus 48 per cent).[102]

Water and sanitation

Overall, around 1.5 per cent of the total global burden of disease among all age groups and 5.5 per cent of deaths among children under age 5 is caused by inadequate water, sanitation and handwashing hygiene.[103]

In India, roughly half the population, or 600 million people, have no access to, or does not use, improved sanitation facilities.[104] Among the Young Lives sample in Ethiopia and India in particular, access to safe water and sanitation remained low especially among the most vulnerable households. [105]

Deficiencies in water and sanitation, together with congested housing, can trigger the spread of infectious disease.[106] One study in Peru found that children who were exposed to the poorest sanitation, water storage and water sources at age 24 months had 54 per cent more episodes of diarrhoea than children who experienced optimal conditions.[107]

Poor sanitation is a concern not just because it threatens child survival and health directly, but also because it reduces the efficiency of investments in water, education, nutrition, and healthcare. Poor sanitation may lead to intestinal infections that reduce the body's ability to absorb food, or facilitate the spread of parasites that compete for nutrients.

Infrastructure for water supplies is less expensive and easier to maintain than that for sanitation. However, in order to prevent diarrhoea it is more important to have good sanitation. Improved sanitation lessens exposure to open defecation, reducing the risk of faecal-oral contamination and of contact with physical, microbiological, biological and chemical agents of disease.[108] One study in eight countries showed that child health improves with better water and sanitation services, both in terms of diarrhoea incidence and anthropometric measures, but the full health benefits of adequate water resources were diminished without improvements in sanitation.[109] Young Lives confirms that reduced stunting throughout infancy and childhood is consistently associated with access to improved sanitation, although it was not possible to differentiate the extent to which families possessed and used these facilities.[110] Only in Vietnam were better water sources systematically linked with a reduced risk of stunting.[111]

Governments have acknowledged the importance of upgrading sanitation. For example, in Ethiopia the Government sought in its Universal Action in 2005 to achieve 100 per cent household access to pit latrines nationally by 2012. In India in 2014, the Government mounted the Swachh Bharat (Clean India!) Campaign, aiming by 2019 to have built 100 million household toilets and 500,000 community toilets.

Nevertheless, Young Lives found that providing facilities to households does not guarantee good sanitation practices.[112] In Ethiopia, for example, there was no difference in outcomes between children who defecated in forests and those whose households had acquired pit latrines, and this is likely to be associated with low usage of latrines. Rural children perceived latrines to be no cleaner than open defecation, pointing out that they were generally full of houseflies. Some identified latrines as a health risk; a dirty latrine was equated with a "bad life". One explained that cleaning the toilets was a punishment for late arrival at school: "If I am late, I would rather go back home than clean a toilet […] because I might have been sick with a flu because of the bad smell of the toilet." Poor maintenance of facilities can thus be an important deterrent to their use by children.[113]

Population density and pollution

Households in urban areas are generally better off than their rural counterparts and urban children generally fare better in their growth than do rural children. But the urban environment can be of poorer quality in terms of air, congestion and pollution both within and outside the household, all of which impair child health and nutrition. Urban children may therefore face an increased probability of disease and infection associated with high population density and pollution.[114]

Young Lives data for India, for example, indicate that living in an urban slum can lead to poorer average health in children than for children in rural populations.[115] Specifically, among children under 6 years old in Young Lives households in India, indoor air pollution from using solid fuels for cooking was associated with long-term respiratory illnesses.[116] Indeed, according to global estimates, cities in India are amongst the most affected globally by this toxic combination.[117]

Societal factors

A wide range of social and cultural factors can play a significant role in children's nutrition, growth and health. Currently, evidence from Young Lives has identified: membership of a minority ethnic group; the price of food and other goods; and the presence of political strife and conflict as key influences.

Ethnicity

Ethnicity is expressed differently in different countries – in terms of language, caste, religion or cultural group. In Ethiopia, language is the main social marker distinguishing the numerous social and ethnic groups, with over 80 languages in total and Amharic as the lingua franca. In India, religious affiliation is important, amongst which Hindus and Muslims are predominant. Article 15 of the Indian Constitution prohibits discrimination and contains a clause allowing the union and state governments to make 'any special provision for the advancement of any socially and educationally backward classes of citizens or for the Scheduled Castes and Scheduled Tribes.’ Scheduled Caste is the official name given to the lowest and socially most disadvantaged caste. Scheduled Tribes refers to specific indigenous peoples whose status is acknowledged formally as distinct from other religious and socio-cultural groups. Significantly deprived historically and consistently disadvantaged by comparison with other groups, Scheduled Castes and Scheduled Tribes are today the subject of various positive discrimination measures decreed by the Indian government. ‘Other backward class’ is a term used by the government for groups that are socially, educationally or economically disadvantaged, but not by caste.

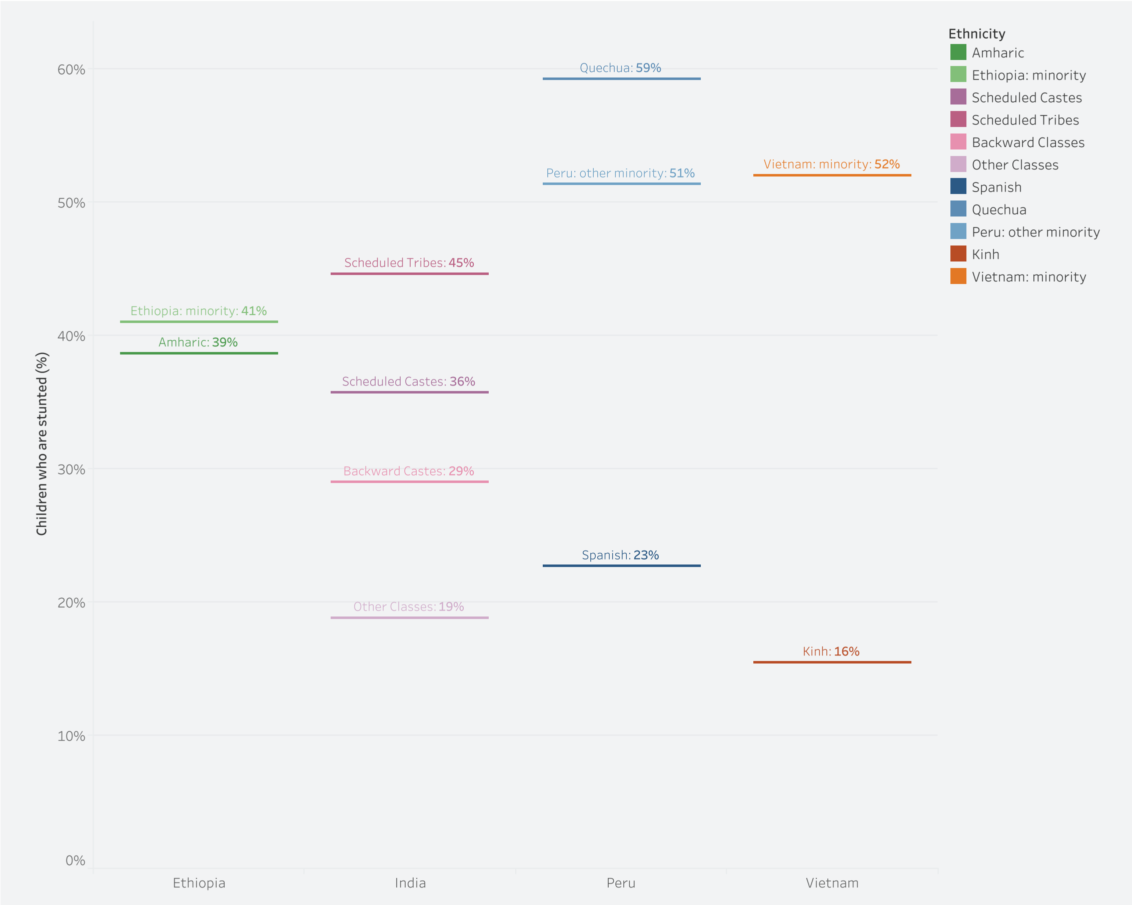
In Vietnam, cultural groupings are used to separate the majority Kinh population from the populations of the northern hills who belong to a range of minority groups. In Peru, the main distinction is between those of largely European descent, among whom Spanish is the mother-tongue and those whose ancestors were indigenous to the country. Among the latter, the main distinction is between populations living in the Andes who speak either Quechua or Aymara as their mother-tongue and those groups in the lowland rainforest who speak a range of indigenous languages.

As illustrated in Figure 9, in all four countries children belonging to minority groups were more likely to be stunted than their peers. These disparities may result in part from biology and genetics, but it is important to bear in mind that ethnicity is often strongly associated with wealth and location of residence, which is linked with many other basic determinants, such as infrastructure and services. Additional contributory factors, such as social stigma and related exclusion from resources and services that undermine growth in children from minority groups, may be far harder to detect and yet can be crucial.

There are country-specific findings around prevalence of stunting at age 1 among ethnic groups:

- **Ethiopia –** Children whose mother tongue was not Amharic, the majority language, were more likely to be disadvantaged, though the differences were small. For example, these children were slightly more likely to be stunted at age 1 than were those whose mother tongue was Amharic.
- **India –** Stunting was greatest among children who belonged to Scheduled Castes and Scheduled Tribes. Compared to other castes, more than one third of these children were likely to be stunted. Scheduled Tribes were more than twice as likely to be stunted compared with children from other social groups.
- **Peru –** Children of predominantly European extraction (Spanish-speaking), tended to be from better-off families and were more likely to live in urban areas. Of these, 23 per cent were stunted at age 1 while among Quechua- or Aymara-speaking children, who come from poorer and often more rural backgrounds, 59 per cent were stunted at age 1.
- **Vietnam –** Of the majority group (Kinh) children, 16 per cent were stunted at age 1. Of non-Kinh children, many of whom live in more marginal areas of the country such as the northern mountain region, 52 per cent were stunted.

Figure 9. *Prevalence of stunting at age 1 among ethnic groups*



Note: Stunting is measured as HAZ <-2SD.

Prices of food and essential goods

Throughout childhood and early adolescence, the healthy growth of Young Lives children was affected by increases in the prices of food and essential goods.[118] In India, for example, the risk of wasting increased with rising food prices.[119]

The greatest burden falls on poor households, who have the least flexibility to adjust their consumption.[120] This was evident when the global financial crisis from 2007 coincided with large increases in global food prices.[121] In India, for example, between 2006 and 2009, three-quarters of Young Lives households were affected by increases in food prices, heightening the risk of wasting.[122] Higher food prices may have increased income and employment opportunities in some rural households. But for poor families who consumed more food than they produced and for households totally dependent on purchased foodstuffs, the impact was serious: they were forced either to buy less food or to buy poorer-quality food at lower cost, leaving less money for healthcare and education.[123] This led to a significant decline in the consumption of staples such as rice, and of animal source protein-rich foods such as eggs and meat.[124]

Children in the Young Lives sample in India, for example, consumed less vegetables, and their *dhal* was watered down. Nutritious curries were replaced with *chetni*, which is made of only one variety of pulse or groundnut, salt, chillies and tamarind. One Young Lives mother commented; "The price of tomatoes has increased to 40 rupees. So now we have started using one tomato instead of two [...] When we dilute the soup and other food, will they give us strength compared to undiluted ones? But that is how we need to manage when we cannot afford. The *dhal* is not thick anymore." The children commented that better-off families were able to adjust to the price rises "by cooking different varieties of food every day [...] they take healthy food which includes fresh fruits, green leaves, and other special items." [125]

Political strife and armed conflict

Young Lives evidence from India and Peru highlights how political strife and armed conflict create multiple risks for children. Not only do they risk death, they can also be exposed to trauma and violence and familial loss, as well as starvation, service interruption and displacement. This can delay their development and impair their physical and mental health and educational attainment, with impacts that persist into adulthood.[126] A study using Young Lives data for India shows that when conflict coincides with extreme climate events the consequences can be devastating.[127] Drought, combined with the political violence associated with the Naxalite uprising undermined livelihoods, impeded access to public services, and restricted flows of aid. Even households not directly affected by the uprising were less able to cope with the drought, possibly because of fear, insecurity or social isolation.

In Peru, some children in the Young Lives sample were affected by the Shining Path conflict.[128] The effects could be identified because the sample covered several areas involved in the conflict, as well as others that remained relatively untouched. To escape the violence, many families chose to migrate. This migration overlapped with general rural-urban migration – a traditional strategy for escaping rural poverty and hardship. Young Lives compared the growth of children of non-migrant mothers with that of children whose mothers had migrated from a conflict zone, as well as with the growth of children whose mothers had migrated from non-conflict zones. 1- and 5-year-old children of migrant mothers had significantly lower levels of stunting than those of mothers who had stayed behind, and appreciably higher levels of cognitive achievement. This could be because the mothers who migrated gained greater access to services and more information on optimal child-rearing practice. However, children whose mothers migrated from areas of conflict had lower cognitive scores and were more likely to be stunted than children whose mothers had left areas unaffected by conflict.[129] In another study in Peru, children exposed to the Shining Path insurgency in early childhood had lower levels of educational attainment.[130]

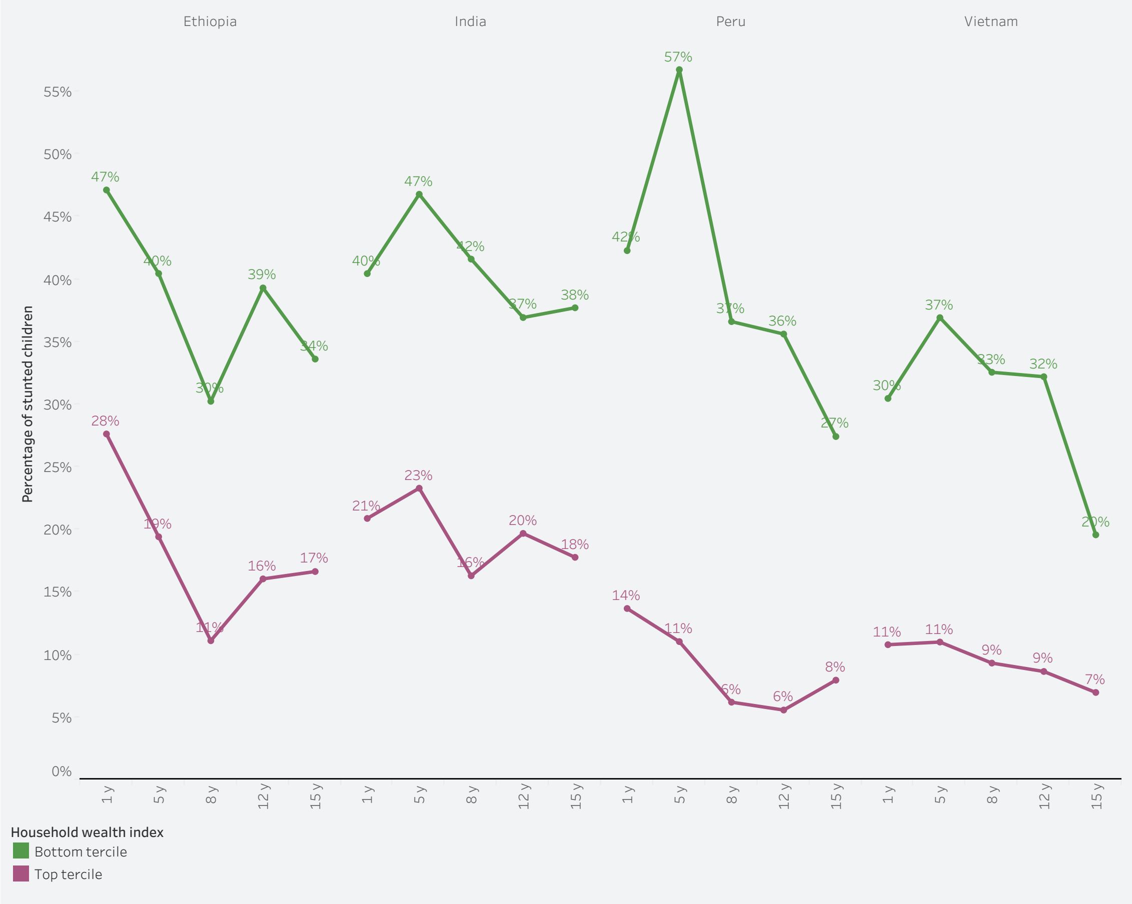
Underlying factors in child malnutrition and growth

Young Lives found that the chief underlying factors influencing child nutrition and growth included household wealth and housing conditions, and also the health, well-being and education levels of caregivers or parents (particularly mothers), as well as the decisions they made for their children.

Household socio-economic status

Household wealth is a significant predictor of children's growth, nutrition and health. Figure 10 shows the association with rates of child stunting, comparing the poorest and richest thirds of households. It uses the Young Lives wealth index, which covers a number of factors that generally contribute to children's growth – households' ownership of durable assets, access to services, and dwelling quality.

Figure 10. *Stunting by household wealth*

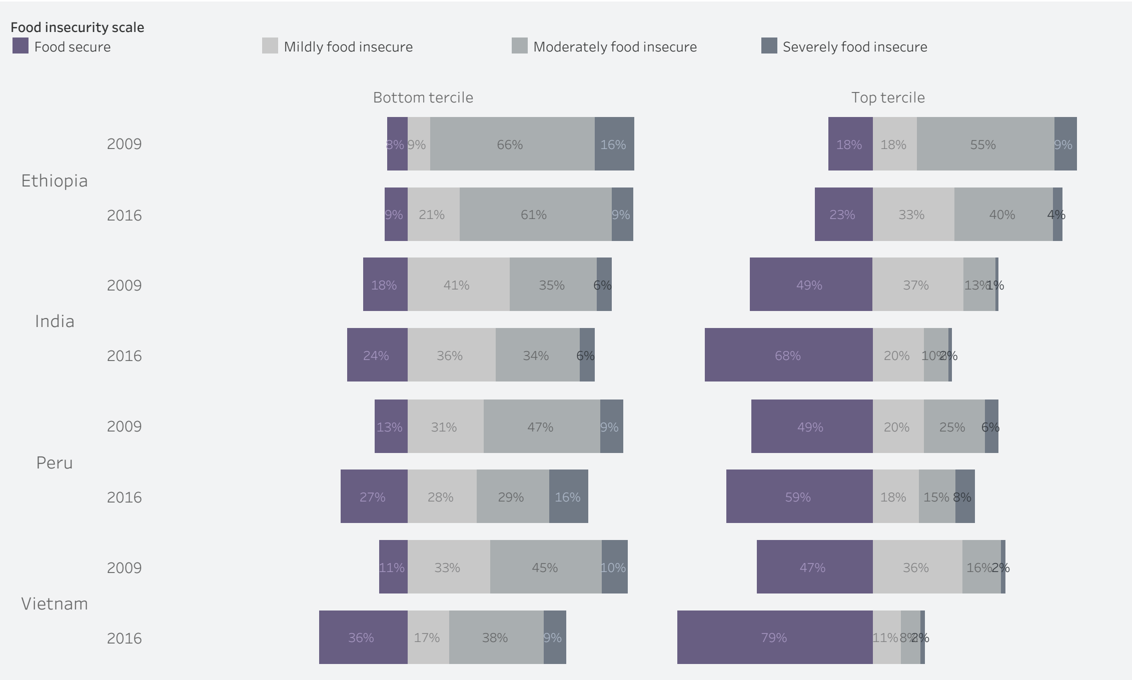


Note: Shows stunting rates (defined by HAZ <-2SD) of children belonging to the poorest and richest thirds of the households as defined by the Young Lives household wealth index.

From the earliest phases of life, differences in household economic status set children on different growth trajectories. The proportion of children who were stunted at age 1 was generally around twice as high in the lowest wealth tercile compared with the top tercile, and in Peru around three times higher. Children from poorer households were more likely to be stunted over the long term, and were less likely to recover from periods of early stunting.[131] These gaps at age 1 persisted through age 12.[132]

Better-off parents typically have greater knowledge and capacity to provide sufficient nutrition for their children.[133] Figure 11 tracks household food security between 2009 and 2016 for the top and bottom household wealth terciles. Though the situation of the poorest households broadly increased over the years of Young Lives research, a significant proportion continued to face food insecurity, especially in Ethiopia and Vietnam.

Figure 11. *Household food security in the previous 12 months, by household wealth tercile in 2009 and 2016 (Younger and Older Cohorts)*



Note: Household food insecurity was measured by the household food insecurity access scale – which uses a standardised questionnaire to distinguish between food insecure and food secure households.

As may be expected, households in Ethiopia reported higher levels of food insecurity than in other countries in both 2009 and 2016. Even though households were generally better off in all countries in 2016 than in 2009, levels of food security were far lower in the poorest tercile than they were in the top tercile.

Parental factors

A child’s growth and development can be profoundly affected by a wide range of factors to do with their parents or caregivers. For example, children may have suffered from the death of or separation from a parent – a grave personal loss which is often compounded by lower household income or labour capacity.[134] And if the mother or father had a prior illness or injury there could be a burden of debt from medical costs. In the 1990s, one of the principal causes of early parental death in many poor countries was the AIDS epidemic. In an affected area in Tanzania, for instance, nearly one-fifth of 15-year-old children had lost one or both parents. When maternal orphans were compared with peers who had not lost a parent, their height at age 15 was two centimetres lower, and their educational attainment was delayed by one year. For households of children whose mothers had died before the children were aged 15, spending was 8.5 per cent lower than in other households.[135]

Parents who are more educated are likely to have more assets, earn more, and have the knowledge and ability to provide adequate nutrition and foster their children’s growth.[136] In all four Young Lives countries, children of better-educated parents tended to grow better in infancy and were more likely to recover from stunting. Particularly important was the mother’s health and level of education. If she was healthy and well-nourished, this not only improved development in utero but also helped the child’s subsequent growth, while more educated mothers were likely to have better childcare practices.[137]

Young Lives found in each country that if mothers were short compared to the median of the WHO reference at age 19, their children were likely to be stunted throughout childhood.[138] On average, across the Young Lives sample, there was a roughly 10 per cent greater chance of children of mothers defined as 'short' being chronically undernourished between the ages of 1 and 12. This could happen through a combination of mechanisms. First, the mother may have passed on her genetic potential for linear growth. Second, her small stature could have led to pregnancy complications and restricted foetal growth.[139] Third, if she was short due to undernutrition, this deprivation could be passed on through poor nutrient quality during breastfeeding. Finally, she and her child may have been sharing the family's poverty and poor sanitation facilities.[140]

On the other hand, Young Lives evidence also shows that wealthier families with more educated mothers were also those whose children were more likely to be overweight or obese.[141] It is also possible for overweight mothers to have stunted children.[142] This is a concern in Peru where it occurred in 15 per cent of Young Lives households, as opposed to less than 3 per cent in the other countries. In Peru, maternal overweight was high in both urban and rural areas.

Children are also more likely to be stunted if their mothers are in psychological distress – for which poverty is a key contributor. In poor countries, it may be difficult to provide mothers with adequate support, but health extension workers can help.[143]

Another important factor, possibly connected with maternal emotional or psychosocial well-being, is the household's integration with the rest of the community. Young Lives children had better growth in infancy and childhood if their mothers had strong links with other individuals locally and participated in community organisations.[144] Other studies have shown that social networks encourage the spread of health knowledge and enable cooperation and support that can protect individual households against shocks.[145] In Young Lives, these aspects were measured differently in each country: in Ethiopia, they were reported as stronger ties to social organisations; in India, as participation in larger and more literate social networks; and in Vietnam, as higher levels of social support and trust in the community.[146] On the other hand, Young Lives also found that poverty can be a source of shame within the community. This can have emotional and psychological consequences that affect the family's well-being with potential knock-on effects on child growth.[147]

Children's growth can be deeply affected by parental decisions in situations of crisis and hardship. In such circumstances, some Young Lives caregivers prioritised by giving more, or more nourishing, food to children whose work supported the household, or to younger children who were thought to be in greater need.[148] A study in India found that during recessions, boys were better protected than girls, as indicated through levels of infant mortality.[149] Likewise, a study in rural South India found that fluctuations in food prices affected the quality of girl's nutrition more than that of boys.[150]

Depending on their circumstances, parents who recognise that they will need to invest in their children may be able to set aside some savings before and during pregnancy. An unplanned pregnancy on the other hand can disadvantage the child. In India and Peru, children in the Young Lives sample who were born after an unplanned pregnancy had lower heights and were more likely to be stunted at age one.[151]

Parental decisions related to child growth can also affect education. For example, in the Philippines and Pakistan it was found that children who were better nourished in early childhood performed significantly better than their peers in school. This was not only because better nourished children were advantaged cognitively and displayed greater productivity per year of schooling, but also because they were sent to school earlier.[152] Young Lives found that children who grew faster than their peers up to age 8, and performed better in achievement tests, had started school earlier. This could be because parents responded to their faster growth by enrolling them in school ahead of their peers, which would then contribute to better performance on tests. In addition, their earlier height growth contributes to better cognitive development and subsequent better performance.[153] Or this may be an example of reverse causality, with some parents investing more in their children's nutrition and health so that they were ready for school earlier, grew better and had better test scores.

Child growth and development is also affected by other adults in the household. In Peru, for example, the presence of grandparents was associated with the likelihood of recovery from stunting among Young Lives children.[154] Moreover, the growth of grandchildren was related to the level of education of grandparents.[155] This could be because grandparents help directly with childcare, or indirectly when they complement maternal education in providing childcare, especially when working mothers are not the primary caregivers.[156]

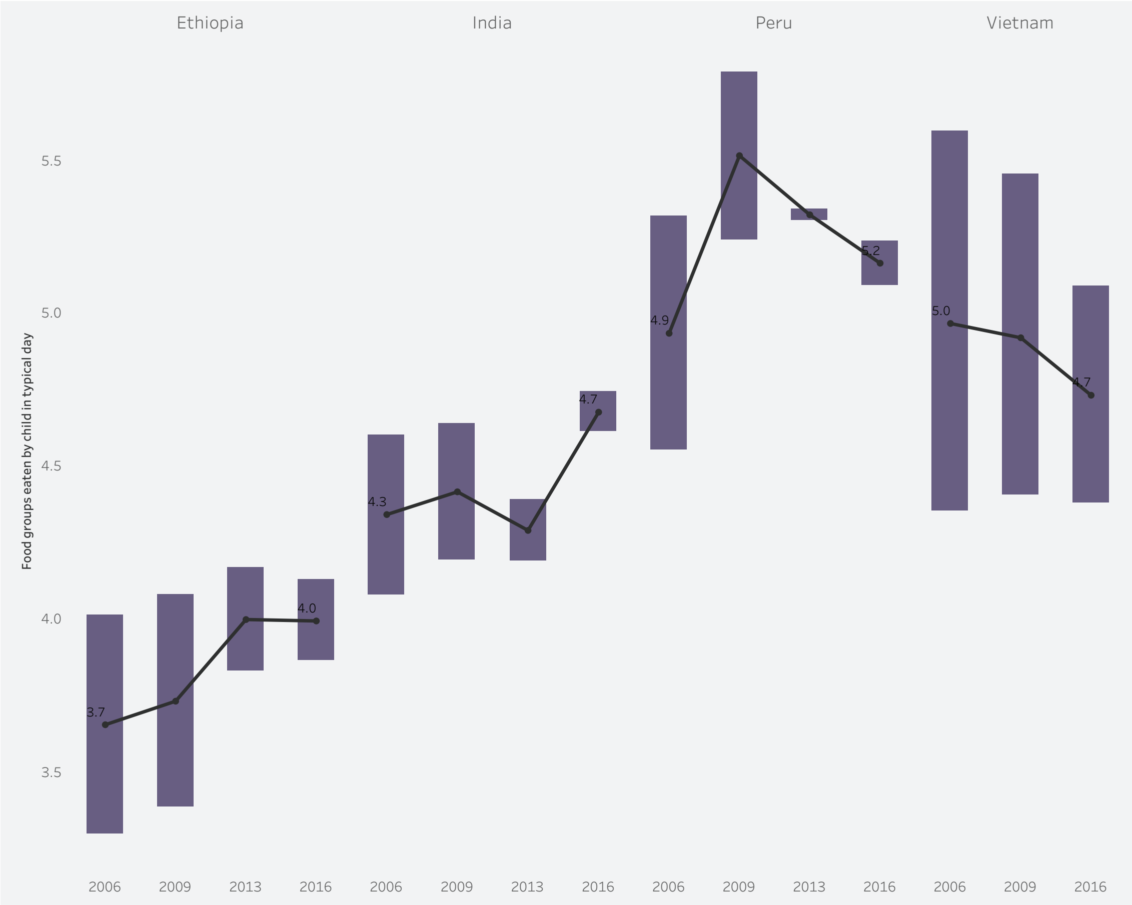
Immediate causes of child malnutrition

Health and diet are immediate determinants of nutrition and growth in children. Since most of the Young Lives health data depended on self-reporting rather than diagnoses, the discussion of immediate factors focuses mainly on dietary quality and volume, as well as considering the influence of gender.

Children's nutrient intake

Over the period 2009 to 2016, children were able to consume a more diverse range of foods. This is illustrated in Figure 12 which shows the number of different food groups the children had eaten the previous day – out of seven groups.[157] In Ethiopia, India, and Peru, there was a significant increase in the number of food groups for children from the poorest households over this period, thereby reducing household wealth-related diet disparities. Over the same period, in all countries, there was an increase in the percentage of children consuming animal-source foods – including meat, fish, poultry, seafood, milk and milk products, or eggs, although in Vietnam there was a small reduction in the number of food groups.[158]

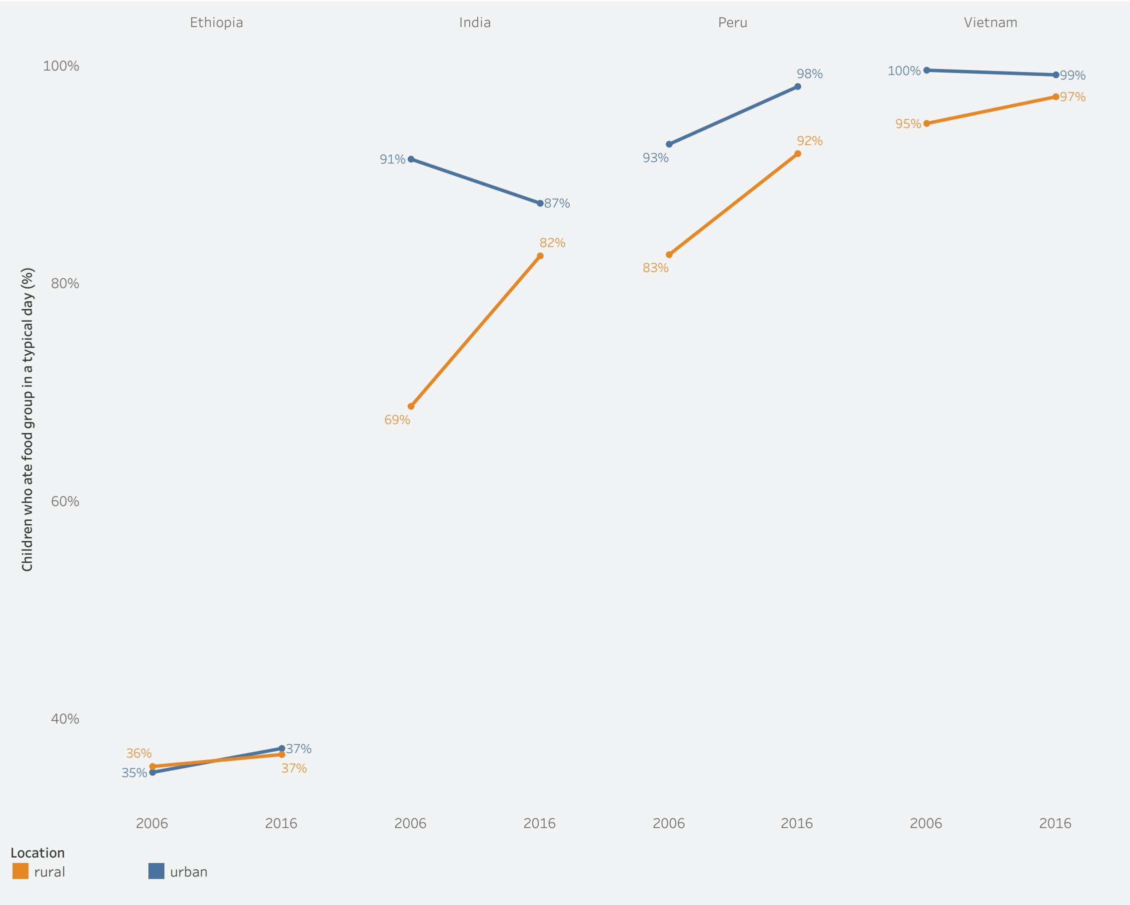
Figure 12. *Disparities in child dietary diversity by household wealth tercile, 2006–2016*



Notes: Shows the average number of food groups that children consumed in a typical day over the survey rounds of Young Lives. The top of the bar marks the number for the least poor tercile, and the bottom of the bar the number for the poorest tercile, so the height of the bars represents the gap in consumption between the wealth terciles. The points, linked by the line, show the average number of food groups consumed across all household wealth groups. Dietary diversity in Vietnam for 2013 is not included due to an error in data collection.

Young Lives data highlight just how quickly diets are changing for the two cohorts. In India, Peru and Vietnam, over this period, the Younger Cohort consumed more animal-source foods (Figure 13). In Peru there was a notable increase in meat consumption.[159] In some respects, this can be positive, since children can have more diverse diets and consume more micronutrients; iron in particular. Nevertheless, it also increases the chances of obesity through consumption of saturated fat and the risk of exceeding calorie requirements, particularly if these come from processed or energy-dense foods, as well as increased consumption of sugar.[160] In urban areas, the effects are likely to be compounded by having less physical activity and by drinking more sugar-sweetened drinks. Young Lives research found that sugar consumption also increased, particularly in Ethiopia and Vietnam.[161] These changes may help explain why, compared with the Older Cohort children, the Younger Cohort children in India, Peru and Vietnam had higher rates of overweight and obesity. For the Older Cohort children, the risks were greater in the wealthier households. In both Peru and Vietnam, compared with those from the poorest households, Older Cohort children aged between 8 and 15 in the wealthiest households faced a higher risk of overweight and obesity.[162]

Figure 13. *Percentage of children eating animal-source foods in 2006 and 2016*



Note: Shows the changes in the percentages of Younger Cohort children who consumed animal-source foods in a typical day between 2006 and 2016.

Individual susceptibility

Young Lives identified characteristics shared by many of the children who were particularly susceptible to growth impairment. Some of these applied across all four Young Lives countries – often displaying common trends in each country.

One the most significant risk factors for retarded growth is low birthweight. Young Lives data indicate that children who had low birthweights tended to have low pre-pubertal height and BMI. In India, Peru and Vietnam, girls who had low birthweight were likely to have younger menarcheal ages.[163] Similarly, in Peru, 40 per cent of girls who had reached menarche by age 12 were overweight or obese at age 15, compared with 24 per cent of girls who had reached menarche later than age 12.

On the other hand, the Young Lives children more likely to be overweight or obese at age 8, were those who had not been stunted and who had gained weight rapidly between birth and ages 6-18 months. This was even after allowing for other determinants such as frequency of active exercise and consumption of high-fat or high-sugar drinks.[164] The risk of overweight, though not of obesity, was also greatest among children born by Caesarean section. This could be a consequence of differences in the gut microbiota of children who are born through Caesarean section.[165] However, other studies have shown that those mothers more likely to opt for Caesarean sections are those with higher incomes, so this pattern may be explained by differences in wealth.[166]

Gender and biology also play a part. During the early phases of childhood, boys in low- and middle-income countries are more likely to be stunted than girls.[167] Such differences arise from a mix of biological, economic and socio-cultural factors, which include genetic and biological makeup: boys are less resilient biologically and are thus more susceptible to disease and premature death.[168] On the other hand, in many contexts, due to a pro-boy bias, boys are fed larger quantities of more nutritious foods than are girls.

Consistent with other studies, among Young Lives children, boys started out life more stunted than girls. Again, the difference was not entirely explained by genetic and biological factors. Disparities between boys and girls also varied according to household economic status. As illustrated in Figure 14, in India, Peru and Vietnam the pro-female gap, whereby girls had lower rates of stunting, was more evident in poorer households. Nevertheless, a child's gender mattered less for growth, as measured by HAZ, than did the socio-economic circumstances of the household.

Figure 14. *Gender gaps in stunting at age 1 by household wealth, 2002*

Note: Shows the percentages of infant boys and girls who were stunted at age 1 (HAZ < -2SD) in the poorest and least poor households in the Young Lives samples.

However, these disparities diminish with age. While boys in the Young Lives sample were more likely to be stunted or wasted in early and middle childhood, the gender difference had mostly disappeared by adolescence.[169] In Ethiopia, without controlling for puberty timing, the picture was slightly more complicated: at age 15 boys remained more stunted than girls. Otherwise there were no significant gender differences in stunting for the Older Cohort by the time they had reached adolescence, or around age 12 years. The additional risk of being stunted for boys in infancy was similar for the top and bottom wealth tercile households.

The prevalence of stunting among boys and girls in adolescence is likely to be influenced by the age of puberty. The onset of puberty is controlled by the hypothalamic-pituitary-gonadal axis: in boys the pituitary tropic hormones stimulate the testes to produce testosterone; in girls the ovaries to produce oestrogen. Boys in general start their pubertal growth spurt later, grow for longer and finish several years later than girls. Girls usually start earlier but stop growing in height soon after menarche. It may also be that the sex-specific growth standards used internationally may not be sufficiently attuned to the growth of boys in low- and middle-income contexts.[170]

In addition, gender differences may be due to cultural factors that affect children's diets.[171] Of the Young Lives countries, this is only a significant issue in India, where there are strong cultural norms around gender. Young Lives identified a pro-boy bias in dietary diversity at ages 5 and 8, which increased in mid-adolescence at age 15.[172] Other studies in rural India show higher school enrolment rates for boys, so this gender disparity could be because parents in the Young Lives sample were also shown to have had higher aspirations for boys, and may have complemented their education with more diverse diets.[173]

For girls in Peru, the risk of obesity was associated with the age at menarche. Girls in the Older Cohort who had experienced early menarche (by age 12) were more likely to have been obese at age 8 (7.9 per cent versus 1.3 per cent for those with later menarche). Early menarche was also associated with an increased prevalence of obesity at age 12 (0.5 per cent versus 0.4 per cent). At age 19, the difference was even greater (14.1 per cent versus 2 per cent). It is not clear whether early childhood obesity was influencing both earlier menarche and later obesity, or whether menarche in some way further accelerated the development of obesity. But the effect of earlier menarche on later obesity was striking. It is said that a minimum amount of fat is needed to start menarche, but this does not necessarily mean that more fat will lead to earlier menarche. The association between obesity, age at menarche, and cardio-metabolic risk and untimely death is well documented. But there are few longitudinal cohort studies on health and nutrition outcomes before and after puberty.[174] Future rounds of Young Lives would contribute to this important area of research.[175]

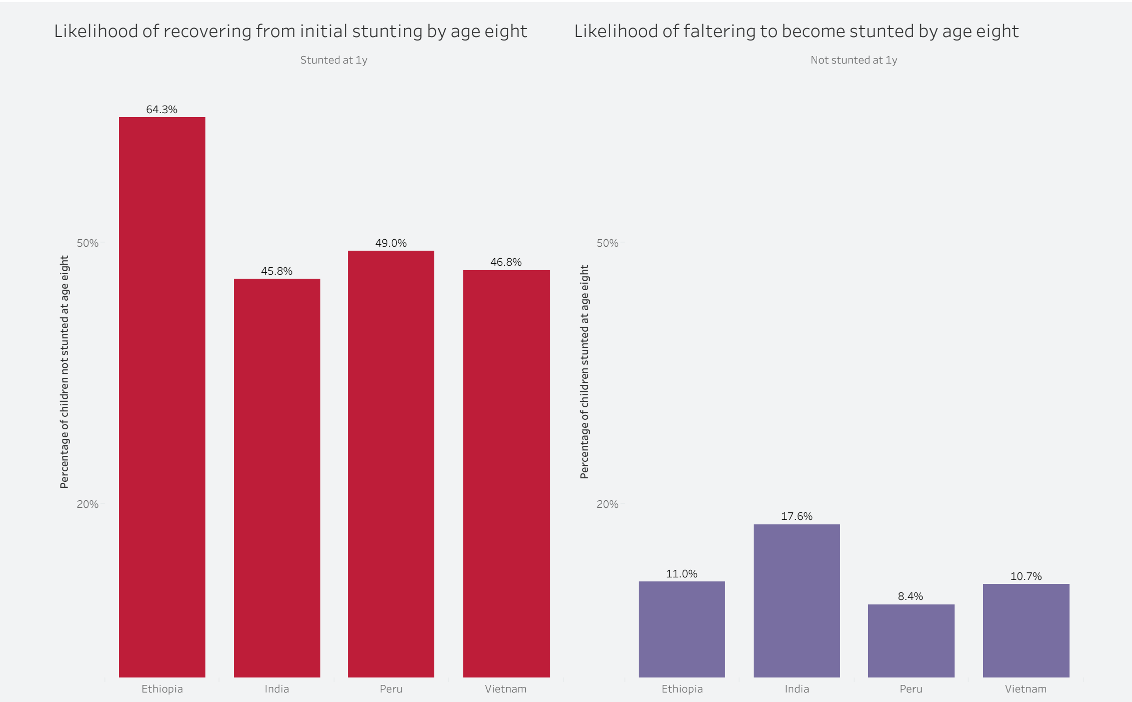
Growth recovery and faltering

Having followed the same children for 15 years, Young Lives found that early growth was a significant predictor of later height and development. It used to be thought that deficits in linear growth during the first 1,000 days of life were irreversible. But Young Lives discovered that this is not always the case, at least as reflected in HAZ scores, which measure the relative position of the individual's height in the distribution of the population.[176] Young Lives findings revealed that growth recovery was not only possible, but for a significant number of children was quite likely.[177] This raises important questions about the timing and wider outcomes of post-infancy recovery, and about the basic, underlying and immediate factors that contribute to this growth dynamism.

Growth dynamism and associated developmental advances in middle childhood

The degree of growth dynamism is illustrated in Figure 15, which shows that a significant proportion of Young Lives children who were stunted in early childhood experienced growth recovery according to HAZ, both between the ages of 1 and 5 and the ages of 5 and 8. Between 27 per cent and 40 per cent of the sample children recovered from initial stunting to become 'not stunted' between ages 1 and 5, and between 30 per cent and 47 per cent of children stunted at age 5 had recovered by age 8.

Figure 15. *Children recovering and faltering in growth*



Notes: Shows, for the Younger Cohort, changes in stunting status between ages 1 and 8 – as defined by HAZ<-2SD. The left-hand chart shows the percentage of children in each country who were initially stunted at age 1 but became 'not stunted' by age 8. The right-hand chart shows the percentage of children in each country who were not stunted at age 1 but became stunted by age 8.

On the other hand, a number of the children whose initial growth had been normal, later faltered to become stunted.[178] Growth faltering was, however, more likely at earlier ages. Of the children who were not stunted at age 1, between 1 per cent and 22 per cent became stunted between the ages of 1 and 5. But only 3 per cent to 6 per cent of children became stunted between the ages of 5 and 8. Stunting status is less likely to change in later periods of childhood – that is, there is lower growth plasticity.[179]

The potential for recovery, as indicated by HAZ data, depends on the degree of stunting. In India and Peru, compared with children with moderate stunting, those who were more severely stunted in infancy were less likely to recover by age 5.[180] In all four countries, among the children who were severely stunted at age 1, 29 per cent were not stunted by age 5, 41 to 43 per cent were not stunted at ages 8 and 12, and 48 per cent were not stunted at age 15. However, those who were moderately stunted at age 1 were more likely to recover: 46 per cent were not stunted at age 5, 59 per cent at ages 8 and 12, and 65 per cent at age 15.

Children can thus recover their position in the height distribution of a population. But it is not clear whether this means they have caught up with peers with growth trajectories that are aligned with the norm, or whether this recovery in growth fully remediates the detrimental effects of early growth retardation in terms of cognition and other aspects of development. Certainly, there can be some improvement. Young Lives children who recovered from being stunted at age 1 subsequently performed better on cognitive tests than did children who remained stunted throughout childhood, especially when recovery occurred at a young age and was of longer duration.[181] This can be tracked through performance in maths tests. Across all Young Lives countries, higher linear growth during and after infancy was associated with improved maths scores in childhood, and those who exhibited sustained growth recovery after infancy also performed better in maths scores than those who did not recover.[182] A substantial share of these associations is accounted for by growth between ages 5 and 8, showing that there is some malleability even during middle childhood.

Young Lives children who recovered from early childhood stunting by age 8 also had better learning outcomes. Children who grew faster than expected compared with their category in the population distribution, i.e. improved their HAZ between ages 1 and 8, were less likely to be over-age for grade and more likely to score higher on tests of vocabulary, maths, and reading.[183] On the other hand, children who experienced growth faltering after age 1 to become stunted at age 8 had lower vocabulary scores than children who were not stunted at both ages. In all four Young Lives countries, children who were stunted at age 8 had attained fewer years of education at age 12,[184] while children whose growth was faster than expected early in life were also likely to grow faster at later ages and have better performance on cognitive tests.[185]

Growth dynamism in adolescence

Over the past decade, rapid advances in neuroscience have enhanced the understanding of adolescence. This is now seen as a second period of dynamic brain development and associated physical, psychological and neurological change.[186] At the onset of puberty, the body undergoes rapid changes in size and composition.[187] Though there is little research on this life phase in low- and middle-income countries, given emerging evidence on physical, psychological and neurological plasticity during adolescence, there is increasing interest in the potential for interventions during this period.[188]

Young Lives research found that recovery from early childhood stunting, whether partial or full, may be possible later than initially thought – extending through early adolescence and up to 15 years of age.[189] For instance, a number of those who were among the shortest 2.3 per cent during infancy were relatively taller, and no longer in this shortest group, at age 15. This provides a window of opportunity during which interventions could pay off in the long term, so that children who were amongst the shortest in their class when they started school may end up closer to the average at age 15.

An important factor in determining final adult height is the timing of puberty. For girls in all Young Lives countries, later puberty was linked with higher levels of adolescent growth – in terms of greater height-for-age difference (HAD) in centimetres.[190] This was evident after controlling for previous height, so that growth was faster in these girls, and it was not simply that they were taller. Height gain in adolescence is important for childbearing and fertility and is also linked with higher earnings in adulthood.[191] Children whose earlier growth was poor could therefore benefit from a longer growth period.[192]

Young Lives has investigated some of the factors influencing the timing of menarche in girls.[193] Higher birth weights were associated with later menarche, but greater height-for-age and higher BMI at age eight were associated with earlier menarche.[194] Another study found no evidence on the effect of height gain in childhood.[195] Emerging analysis for girls aged between 12 and 15 has found that growth recovery is explained not by later puberty, but by increased dietary diversity. This suggests that recuperation in growth in adolescence can be promoted by nutritional interventions.[196] Additional studies are needed to understand the impact of growth recovery in childhood on adult height.

Factors influencing growth dynamism in childhood and adolescence

Among Young Lives children, growth from ages 1 to 12 is influenced by a variety of underlying household and community factors – these factors explain more of the growth differences at earlier ages than at later ages. One of the most significant is household wealth: in the Young Lives sample, the children most likely to recover were those in wealthier households. This has been confirmed in the wider literature: accelerated growth is a result of improvements in living conditions, as well as more immediate determinants such as nutritional supplementation.[197] Also important is the initial severity of stunting at age 1. The shorter the children in terms of HAZ relative to the median for their age, the faster they must grow to recover their height deficit. As a result, children in Ethiopia, India and Peru[198] who were more severely stunted in infancy were less likely to recover.[199] However, in India, one study of the school Midday Meal Scheme found that those who recovered due to the intervention were the more malnourished.[200] Finally, growth dynamism will depend on the child's genetic potential – as indicated by the mother's height. Also significant was the mother's level of schooling, which could be another indicator of social standing, or of the mother's capacity to translate information into better nutrition and sanitary practices.[201]

The persistence of the effects of early nutritional deprivation can also be countered to some extent by environmental conditions in the community.[202] Young Lives found that from conception to early adolescence, growth could be hampered by higher food prices, but could benefit from higher community wages.[203] Children who lived in communities with access to improved sanitation and water, and more health facilities, were more likely to have healthy growth during childhood and early adolescence.[204] Furthermore, the negative effect of early stunting on cognitive development can be offset by later cognitive and educational interventions, or may be combined with later nutritional interventions.[205] Interventions to promote children's linear growth, as measured by HAZ, are most effective in early childhood, though later interventions can also improve relative growth.[206] In Ethiopia and India, policy interventions to reduce stunting were most effective when Young Lives children were exposed to them before age 5.[207]

The potential for recovery, and for faltering, has been corroborated by other longitudinal studies in low- and middle-income countries.[208] This has also been confirmed by studies that found growth recovery due to changes in the child's environment following migration, illness, famine,[209] or adoption.[210] Similarly, studies of randomised interventions, including micronutrient supplementation and deworming among primary school-aged children, found that children who received such treatments had higher gains in height (and weight) than control children.[211] This suggests that the negative effects of early childhood undernutrition can be countered by nutritional interventions in later years.[212] Nevertheless, these are likely to be less effective for more severely undernourished children.


EMPYRE
SURF

Conclusion

Over recent decades, there have been impressive advances globally in human survival and development. Nevertheless, there remains a grave problem of child malnutrition – with high prevalence of stunting, wasting, and micronutrient deficiencies, and rising levels of overweight and obesity. As well as blighting their childhoods and undermining their development, this also has major implications for these children's lives as adults – through chronic conditions such as diabetes and hypertension, along with healthcare costs and losses of productivity.[213] For the future of individuals and their societies, governments, donors and the wider international community must address malnutrition as a matter of urgency. For many countries this now means simultaneously tackling stunted growth in some children, and overweight and obesity in others.

Many have already been doing so. Recent years have seen an increased political momentum for improvements in child growth, nutrition and health. In 2008, the UN Secretary-General established the High-Level Task Force on Food and Nutrition Security, and Heads of State committed to end hunger at the 2009 World Summit on Food Security. Similarly, the 2008 Copenhagen Consensus highlighted how nutrition programmes were among the most cost-effective development interventions.

Another important initiative is Scaling Up Nutrition (SUN), a global movement of countries and organisations that in September 2010 endorsed the Road Map for Scaling Up Nutrition.[214] In 2014, an international expert group started the annual Global Nutrition Report to monitor progress in combating malnutrition, to identify gaps and propose ways to fill them. In 2012, the World Health Assembly adopted the 2025 Global Targets for Maternal, Infant, and Young Child Nutrition, and in 2015 global leaders, through the SDGs, pledged to end all forms of malnutrition for all people by 2030 – and to work to achieving the global targets for stunting and wasting by 2025. In 2016, the UN General Assembly established 2016-2025 as the UN Decade of Action on Nutrition.

Actual achievement, however, is lagging behind the ideals. Despite some successes at local and national levels, progress towards global nutrition targets, including those on stunting and overweight, is in most cases off course.[215] This report on Young Lives research confirms these global concerns.

Young Lives findings make an important contribution to the growing knowledge base on children's growth – not least because some problems can only be detected and monitored through longitudinal data starting in early childhood. The findings are derived from a large and diverse sample of children growing up in four varied countries, so it is reasonable to generalise these to many other situations and many other children.

Young Lives tracked the experiences of children in two age groups across 15 years, and found that there had been significant economic growth and improvements in service access in all four countries. By comparing the growth trajectories of the two cohorts, Young Lives was able to confirm that levels of long-term undernutrition fell in all four countries. Even so, the prevalence of undernutrition – both stunting and wasting – continued to be unacceptably high, with some children made particularly vulnerable through exposure to both conditions. This is particularly concerning given that many of the children who were stunted early in life remained stunted throughout childhood and beyond – with risks to their school achievement and cognitive development, as well as to their emotional and psychological well-being. Other previous studies have established a link with educational and cognitive outcomes, but the Young Lives association with psychosocial well-being is a more novel insight – further emphasising the cumulative impact on the most disadvantaged children.

A second major finding from three of the Young Lives countries (India, Peru and Vietnam) was the worrying levels of child overweight and obesity, partly because of unhealthier diets and more sedentary lifestyles. This trend threatens to accelerate across the globe, with significant adverse consequences for health and longevity, as well as for health budgets and systems. Child overweight and obesity have not traditionally been prioritised by governments in low- and middle-income countries or in overseas development assistance, but Young Lives findings suggest the need for this position to be reviewed.

A third, potentially far more positive, finding concerns the significant plasticity in children's growth. This is reflected in height-for-age z-scores (HAZ), which were surprisingly dynamic even after the first 1,000 days of life. The study found children could recover from early stunting even up to 15 years of age, though their potential for recovery depended on the degree of early stunting. Importantly, this recovery was associated with improvements in educational outcomes and other aspects of children's development. At the same time, other children who had grown normally for the first 12 months subsequently faltered to become stunted in middle childhood – and had lower vocabulary scores than children who were not stunted.

Young Lives has also assessed a range of basic, underlying and immediate factors that are important for growth – signposting outcomes that might be changed or ameliorated by appropriate policies and interventions. Young Lives has indicated some of the most promising paths – though establishing causality will depend on evaluation of specific interventions.

As might be expected, one of the most significant predictors of stunting and wasting is poverty. Children in the Young Lives sample who were from poorer households were more likely to be stunted throughout childhood, and less likely to recover from early stunting. Other predictors of child undernutrition were minority socio-cultural status and exposure to shocks, such as armed conflict and extreme weather events. Rural children fared less well for stunted growth and wasting. But in the case of overweight or obesity, it was urban children who were worse off. However, all these circumstances typically connect and overlap, compounding the disadvantages for the most vulnerable children.

The study also reveals important intergenerational patterns. Children were more likely to be chronically undernourished if their mothers were less-educated, were short, had low psychosocial well-being, or had limited access to social networks. Another risk factor was low birth weight. There were also gender differences: boys were more likely than girls to be stunted or wasted in early and middle childhood, but differences had mostly disappeared by adolescence. For girls, obesity was associated with age at menarche.

Turning to what needs to be done to promote children's healthy growth, interventions can be nutrition-specific – directly addressing the immediate causes of undernutrition such as inadequate dietary intake and poor health. Or they can be nutrition-sensitive – targeting the basic and underlying causes of undernutrition, such as poor access to safe water and sanitation and factors related to poverty.

It has been shown that in countries with a high burden of undernutrition and young age at first pregnancies, nutrition-specific interventions in the preconception period and in adolescence can be extremely effective, although achieving scale and reaching priority populations is acknowledged as challenging.[216] Also recommended is balanced energy protein, calcium, and multiple micronutrient supplementation and preventive strategies for malaria in pregnancy, since these can improve maternal nutrition and reduce foetal growth restriction and small-for-gestational-age births if scaled-up before and during pregnancy.[217] Other nutrition-specific interventions, including strategies to promote breastfeeding in community and facility settings (which have been shown to help enhance exclusive breastfeeding rates) and treatment schemes for severe acute malnutrition with recommended packages of care and ready-to-use therapeutic foods, are confirmed as being effective. Innovation in delivery strategies of nutrition-specific interventions is important for reaching the poorest and most vulnerable children. Community-based delivery platforms are particularly promising for scaling up coverage and have the potential to create demand and deliver services at the household level.[218]

However, evidence of the impact of many intervention approaches is scarce, and there is a need for further effectiveness trials. This includes the need for more evidence of the effects of different nutritional interventions on neurodevelopmental outcomes. There is some evidence on the benefits of nutritional interventions for literacy, numeracy and school achievement, but much less on other aspects of cognitive and intellectual development. These processes are complex, and may benefit from sustained investment in childhood and adolescence.[219]

One of the main challenges is the sheer scale of child and maternal malnutrition in many contexts and the fact that vulnerable children, households and communities may be affected concurrently by multiple forms of malnutrition, so direct nutrition interventions alone will not suffice. International estimates suggest that in the 34 countries with 90 per cent of the world's stunted children, even when scaled up to almost 90 per cent coverage, nutrition interventions would address only 20 per cent of stunting deficits.[220] In countries with a high burden of undernutrition, where the underlying drivers are complex and affect various groups differently, it is vital to use multi-sectoral approaches to tackle basic and underlying determinants.[221]

Responding to global and national concerns

Some problems with child malnutrition demand a global response – particularly those linked with global food pricing that put children at risk of undernutrition, and those associated with global food systems that contribute to overweight and obesity, as well as the deteriorating quality of the environment. The international community aims to address many of the issues that affect child nutrition in vulnerable communities through the Global Goals, which are intended to ensure sustainable development in cities and communities and take collective action on climate change.

But the momentum needs to be sustained to secure improvements in children's health, growth and nutrition. Moreover, even action on climate change requires interventions at national and sub-national levels; here prevention is key.[222] Across all four countries, Young Lives has identified some of the most significant factors for child undernutrition – including poverty, rural location, repeated exposure to environmental hazards, service shortfalls, and belonging to an ethnic/language minority or low-caste group. This underlines the importance of interventions to support vulnerable communities, and especially families with young children. SDG 2 points to measures that could make a vital difference for such communities, including safeguarding sustainable food production systems and improving land and soil quality, so as to expand agricultural productivity and the incomes of small-scale food producers – especially women and indigenous peoples.

Improving water, sanitation and hygiene services

Young Lives research confirms a large body of evidence that children grow better in homes and communities that have access to effective water, sanitation and hygiene services. Access has improved recently, but there remain serious ongoing threats, notably in India which has high rates of open defecation.

Improved sanitation can be achieved in various ways. The most expensive is to flush waste into a piped sewer system. But waste can also be directed to a septic tank. Households may also use composting toilets, or different types of pit latrine. All can prevent contact with human waste – curbing exposure to physical, microbiological, biological and chemical agents of disease. But these systems need to be well installed and maintained, and their use encouraged through continuous and intensive awareness-raising and education efforts.

Providing robust social protection

Faced with precarious livelihoods and food insecurity, many households and communities have evolved informal coping strategies and safety-nets. In Ethiopia, for example, various types of community association provide funds to members in times of need. *Iquib* associations offer substantial rotating funds to help members improve their lives and living conditions. *Idirs*, societies established among neighbours or workers, raise funds for emergencies, such as death. Some of these associations receive external support in the form of credit or training in financial management. These kinds of informal community-based groups can play an important role, but they tend to be more effective at addressing household-level difficulties rather than community-wide shocks which are generally beyond their coping capacity. And some self-help groups can be exclusionary, for example barring those who present a credit risk.

In low- and middle-income countries, the vast bulk of social protection is delivered through formal schemes run by governments or NGOs. Social protection policies and programmes in all four Young Lives countries provide safety-nets for poor households. Some offer additional income that has enabled households to cope with threats to livelihoods and food security. These include workfare and cash transfer programmes such as the Productive Safety Net Programme in Ethiopia, the National Rural Employment Guarantee Scheme in India, and *Juntos* in Peru. All have been studied by Young lives in relation to child growth.[223]

In Peru, for example, *Juntos* cash transfers have contributed to a dramatic reduction in chronic undernutrition in early childhood. Another study has shown that they have had a particularly positive effect for the least-nourished children.[224] There have also been benefits for cognitive development in younger children.[225]

Similarly, governments can improve food security by increasing access to food. Nutritional outcomes for Young Lives children have been improved by the Public Distribution System in India, and by food assistance programmes in Peru.[226] Some social protection programmes feed children directly. For example, India's Midday Meal Scheme is a nationally-mandated school feeding programme that operates in all government primary and upper primary schools. This has contributed to growth recovery among 5-year-old Young Lives children whose families were affected by drought. In Ethiopia, participation in the Productive Safety Net Programme was associated with a 1.0 to 3.5cm increase in height among Young Lives children aged 5 to 15.[227] The programme acted as a significant safety-net, protecting both younger and older children from nutritional shocks.

The most effective use of social protection is as a preventative measure. However, it may also play a remedial role. Improved environments, and investments in later childhood, can at least partially compensate for early stunting – as India's Midday Meal Scheme reveals.[228] Possible remedial measures may also include cash transfers, health insurance and home visits by social workers and medical staff.[229] Given that gender disparities may worsen in adolescence, with girls and young women often enjoying more limited diversity in their diets and fewer calories precisely when they are likely to become mothers and their nutrient requirement is particularly high, social protection interventions need to consider cultural norms and practices so as to encourage gender parity.

Social protection can also help address child overweight and obesity. Young Lives children who participated in Peru's *Vaso de Leche* (Glass of Milk) programme, for example, were less likely to become obese.[230] And girls who participated in the *Juntos* cash transfer programme for more than two years were less likely to be overweight.[231] However, while encouraging behavioural change in households and individuals, these interventions also need to be supported by action by food producers and suppliers, for example reducing food loss by improving food storage and distribution, and clear labelling of food products specifying calorie source, content and volume.[232]

Not all social protection outcomes are positive. Much will depend on the nutritional composition of the food provided. For example, mothers in the Young Lives sample who participated frequently in Peru's *Comedores Populares* (Community Kitchens) programme were almost twice as likely to be obese compared with those who did not.[233] However, it is not clear whether they were obese before they participated in the kitchens programme, so this finding may not be causal.[234] The Public Distribution System in India has also been criticised for providing relatively cheap calories through grains rather than offering a diverse, healthy diet.[235]

A more general concern about social protection programmes is that they do not reach their intended beneficiaries and are not delivered well.[236] In India, for example, the Rajiv Aarogyasri health insurance scheme was accessed by only a tiny proportion of eligible households – especially those in disadvantaged and ethnic minority groups most affected by health shocks.[237] Even in programmes that are generally seen as positive, such as India's Mahatma Gandhi National Rural Employment Guarantee Scheme, participation tends to exclude the most disadvantaged groups.[238]

Supporting girls and mothers

Fulfilling women's rights is vital and an end in itself, but Young Lives has confirmed the value of well-educated mothers for child nutrition. Children whose mothers have higher levels of schooling have a better chance of healthy growth. But there is a long lag between educating young girls and reaping the benefits for the next generation. It would be useful, therefore, to also achieve similar gains more quickly through other means. For instance, the same benefits for children's growth outcomes might also be achieved by targeting nutritional information at mothers – making them more aware of nutritional and environmental risks to children's growth, such as poor sanitation, infection, and an inadequate diet – and encouraging changes in behaviour.[239] It will also be important to alleviate maternal stress through measures that improve household material and social circumstances, also ensuring that women have full access to these resources.

Investing throughout childhood and adolescence – prioritising the first 8,000 days of life

Child and adolescent growth and development are complex processes with opportunities for action at different periods. Preventing early life growth deficits is the major aim. Strong growth in the early years requires investment in nutrition, combined with support in other areas such as cognitive stimulation and parental involvement, as well as measures that promote wider nutrition and health, such as food security, and clean water and sanitation. This confirms well-established priorities.

What Young Lives has found, however, is that while healthy human development relies on early support, it is similarly important to sustain investment in nutrient intake and dietary quality throughout childhood and adolescence. This will consolidate early growth, prevent later growth faltering, and help those children who were initially stunted to recover. In other words, it ensures continued health and development across the first two decades of life, and lays solid foundations for lifelong health and functioning and for subsequent generations.[240]

This window of opportunity for growth recovery extends into adolescence. Even at this stage, it is possible to recover growth in weight and height and improve cognitive and other outcomes. Particular attention is required for adolescent girls. This is partly because at this age, as a result of cultural preferences, girls may have worse diets than boys. Also, longitudinal analysis of Young Lives data has shown that better nutrition for adolescent girls can improve their height, health and labour market productivity in adulthood, and help prevent inter-generational malnutrition cycles.[241]

These findings from Young Lives longitudinal analysis support the case for age-specific investment throughout the first 8,000 days of life made by the authors of the third edition of the Disease Control Priorities volume and reiterated in a 2018 Lancet article.[242] Recognising that a focus on the first 1,000 days is an 'essential but insufficient investment', they call for interventions in three further phases. These are: the middle childhood growth and consolidation phase (5-9 years), when growth is constrained by infection and malnutrition and mortality is higher than previously recognised; the adolescent growth spurt (10-14 years), when significant changes put commensurate demands on good diet and health; and the growth and consolidation that takes place in mid-late adolescence (15-19), when brain maturation, emotional control and intense social engagement require new responses. While endorsing interventions focused on the first 1,000 days, the authors call for broadening of investment in human development in the next 7,000 days. They identify two essential packages: school-based approaches directed at middle childhood and early adolescence; and a mixed approach also involving community, media and health systems for mid- and late-adolescence. The recommendation for extended investment throughout the first 8,000 days of life recognises the holistic nature of human development and the contribution of contextual factors, particularly health and education systems and community processes, which need to be coordinated and brought closer together to support vulnerable families and children.

Thus, in addition to reiterating the message that nutrition-specific and sensitive interventions are essential for preventing early-childhood undernutrition and realising children's full developmental potential, Young Lives evidence makes clear that health and nutrition investments must be sustained across the first two decades of life. This vital policy shift is needed for realisation of the Global Goals across the board, and especially SDGs 2 and 3, which focus on ending hunger and malnutrition and ensuring good health and well-being.

Using research to support evidence-based policy

The Young Lives study identifies multi-country evidence of children faltering and recovery after infancy, and that these changes are linked to cognitive development. There is a clear case to continue to test and deepen understandings of these dynamics throughout childhood. A particular gap is understanding adolescent growth recovery, what its implications are, and whether and how it can be brought about. There is good reason to see adolescence as a second critical window for investment, but the evidence base on adolescent nutrition remains limited. A new generation of progressive policies targeting the early adolescence phase hold significant potential to contribute to improving nutrition across the life-course.

Appendix 1: Strengths and limitations of the Young Lives study design

Bigger picture evidence

Young Lives is one of only a handful of low- and middle-income country cohort studies whose data can be used for life-course analysis across infancy, childhood, adolescence and young adulthood. Young Lives also collected data about five generations: the caregivers of the children in both cohorts; the Older Cohort (born approximately 1994-95); the Younger Cohort (born approximately 2001-02); younger siblings of the Younger Cohort; and the Older Cohort's offspring. While information on the siblings of the Younger Cohort revealed important intra-household dynamics associated with birth order, the gender composition of siblings, and other factors, the multi-generational design was essential for tracking intergenerational pathways of poverty and risk transmission.

Children in the Young Lives sample were selected randomly from a range of sites that in all four countries excluded the wealthiest districts. The sample is large and heterogeneous and drawn from four countries at very different stages of economic and social development. These features ensure high external validity of Young Lives results.

Young Lives is also one of the few multipurpose longitudinal studies of children in these countries. The study gathered information from numerous sources using a range of methods. The household surveys were complemented by community statistics and by four waves of qualitative research gathered from a nested sub-sample of over 200 Young Lives children and their peers. In 2010, a linked school-effectiveness component was added, involving two cycles of surveys in selected primary and secondary schools attended by the Younger Cohort and their peers. In this way, the study has been able to connect data on selected children and their household backgrounds with what happens in schools – to allow exploration of whether and how schools are 'adding value' to learning and development.

This comprehensive approach has made it possible to explore the experiences and perspectives of children from distinct social groups living in very diverse settings, and also to monitor their outcomes across different domains. The study employs a holistic conceptualisation of child development and well-being.[243] The very rich data on index children include: repeated measures of subjective well-being and psychosocial competencies; nutrition (dietary diversity, anthropometry); education history, learning outcomes and measures of cognition, (including foundational cognitive and twenty-first century skills); job and educational aspirations as well as employment, time use and job-related skills; history and expectations around fertility, marriage, cohabitation and parenthood; and sexual activity and risk behaviours (Peru).

This information was set against extensive evidence on the environmental, social and economic realities of their households and communities, as well as details on the younger siblings of the Younger Cohort. These background data include household composition and changes over time, migration, economic shocks, social capital, socio-economic status (wealth, consumption, livelihoods), family food consumption, maternal education, and stress, and maternal and paternal height and BMI.

The attrition rate for the household-based sample across all five rounds (15 years) has been relatively low as compared to other longitudinal studies: the lowest rate registered being for the Younger Cohort in Vietnam (2.5 per cent) and the highest for the Older Cohort in Ethiopia (17.7 per cent). The low attrition is largely due to the strong in-country partnerships Young Lives has developed, and to the efforts invested in tracking, which included following migrant children and their families within the country whenever possible.

Young Lives data have been merged with historical climate data and country-level administrative data and are amenable to merging with many other nationally representative datasets. The survey instruments, ethical and conceptual frameworks and technical notes are available at www.younglives.org.uk/content/our-research-methods, and the full survey datasets, along with composite variables and supporting documentation, and can be accessed from the UK Data Service (https://discover.ukdataservice.ac.uk/series/?sn=2000060).

Limitations

Young Lives offers a unique data source that enables longitudinal cohort studies on childhood poverty and its determinants and consequences. But, as with any data collection exercise, the methodology and financial constraints impose limitations. For Young Lives, the issues include:

Representativeness

Because they oversampled poor areas, Young Lives data are not representative of national populations. Further, the number of children from different ethnic or religious minorities was not always large enough to permit a statistical analysis of how their circumstances and outcomes differed from other groups. Nevertheless, it was possible to discern important descriptive patterns of difference.

Children in remote areas

Young Lives deliberately sought out children from sparsely populated and remote areas who are typically omitted from many similar studies that enrol children through health centres and maternity clinics. In remote areas, however, births are often unattended making it difficult to identify and enrol babies at birth. For these children it was not possible to gather consistent, accurate birthweight and growth information at specific and frequent intervals.

The risk of influencing respondents

Young Lives collected a large amount of information from its respondents, returning to interview them regularly. Though informed consent was sought at each visit, this raises the possibility that the study might become a burden to respondents. It also risks influencing their beliefs, attitudes and behaviours. To minimise both risks it was decided to limit the number and frequency of data rounds.

Data on early growth

Children in the Younger Cohort were only measured once during their first 18 months and subsequently every three to four years. Data from the children's birth and early years were even more limited for the Older Cohort. Mothers were asked if their babies were born earlier than expected, and if so, by how many weeks, but a degree of misreporting is likely. Gestational age at birth will therefore be imprecise, particularly in areas with low levels of access to health and maternity care. The Older Cohort children were already around 8 years old when first measured, so information about their growth in early childhood is entirely lacking.

This makes it difficult to link stunting with early deprivation – to see whether these children had been undernourished during infancy, how severely and for how long, and had been deprived of which nutrients. Subsequently, however, from early childhood to early adulthood, the growth and height measurements provided enough detail to be able to track children's trajectories.

When the study began in 2001, official birth records were incomplete in Ethiopia and India. In these countries, births were less likely to have been registered and even where they were, the registrations did not always give medical information. More data were available in Vietnam, and especially in Peru which had the most reliable and comprehensive information. Where medical records were lacking, Young Lives recorded mothers' perceptions of the size of their babies at birth.

The timing of puberty

For both cohorts of children, Young Lives has limited information on the age of the onset of puberty. This is important because it is linked to adolescent growth spurts. For girls this could be tied to menarche although this occurs at the end of pubescence: they were asked the age (or year) when they had their first period. Even this information could be imprecise due to biased recall, although bias should be relatively low given the short recall period. For boys, fieldworkers observed whether respondents had hair on their chins, and/or their voices had deepened and asked if their voice had changed (deepened). If affirmed, they were asked at what age did they notice it changing, and if and when hair started to grow on their chin.

Environmental factors

Young Lives did not systematically monitor the quality of the natural, built or human-mediated environment. Nor did it gauge environmental health per se. Nonetheless, it was able to capture important down-stream consequences of a range of environmental pressures on communities, households, caregivers and children, and to link these to a variety of developmental and well-being outcomes.

Parental health

The study gathered comprehensive data on parental education, social and economic circumstances, household economic status and livelihood sources, along with other features of children's home and community environments. But it only obtained partial information on parental health – limited to anthropometric measures of mothers (and, in Peru only, the father's height). These measurements were not available for all children, particularly for those who did not live with their parents due to parental death or illness. Parental information is likely to have be missing therefore on children at greater risk of inheriting poor health.

Biological markers

Biological markers for the children did not include specimens such as hair, blood, or saliva, which are now obtainable at relatively low costs and would have facilitated a more complete assessment of health and other outcomes.

Exercise

The study is limited to questions on children's activity and exercise levels, and it was not possible to include equipment measures.

Reporting of illness

Rather than using diagnostic evidence, Young Lives recorded child health through self-reporting of experiences of various illnesses. These did include diarrhoea, but it was not possible to gather accurate on the incidence of diarrhoea which would have required more frequent data collection than was possible or desirable.

Intergenerational dynamics

Some intergenerational information was gathered through anthropometric measurement of the children's mothers, and of the offspring of the Older Cohort, and the siblings of the Younger Cohort. These indicators are useful for assessing intergenerational and intra-household dynamics. However, these data are not fully able to explain the biological and environmental mechanisms underlying children's growth.

Interventions

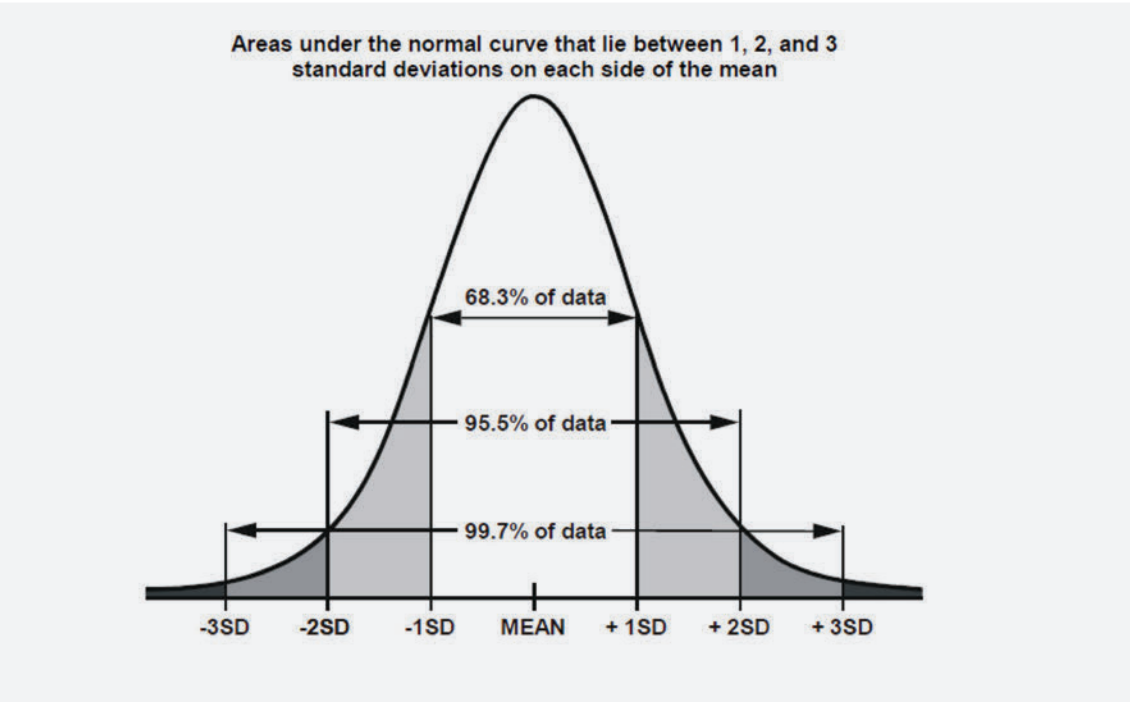
Young Lives is not an experiment-based study. It does not assess the impact on children of specific interventions. This is an observational study of children and adolescents, their caregivers, peers, households, communities and schools in a variety of circumstances. As such, Young Lives is a valuable precursor to intervention research, providing essential information that can then be used to design randomised studies of the impact of interventions that have some probability of success.

Appendix 2: Assessing linear growth

To track change in growth over time, most Young Lives studies used height-for-age z-scores (HAZ). Individual children with HAZ<-2SD are defined as stunted, and are at higher risk of poor developmental, health, and cognitive outcomes. Leroy *et al.* (2015) make the case for an alternative measure – height-for-age difference (HAD). They point out that while HAZ may suggest early post-infancy recovery – 'catch-up growth' – this is simply a function of the measure. Tracking growth using HAD does not suggest any recovery.

The measure that is chosen will depend on what is considered relevant – either the child's absolute height, or the child's position within the normal variation of heights. In a statistically normal population, only 2.5 per cent would have HAZ more than two standard deviations (see Figure 16) below the median (HAZ < -2SD). However, the prevalence of low height-for-age (HAZ<-2SD) may increase as a result of nutritional, health, and environmental shocks or constraints.

Figure 16. *Normal Distribution*



Source: http://my.ilstu.edu/~gjin/hsc204-hed/Module-5-Summary-Measure-2/Module-5-Summary-Measure-28.html

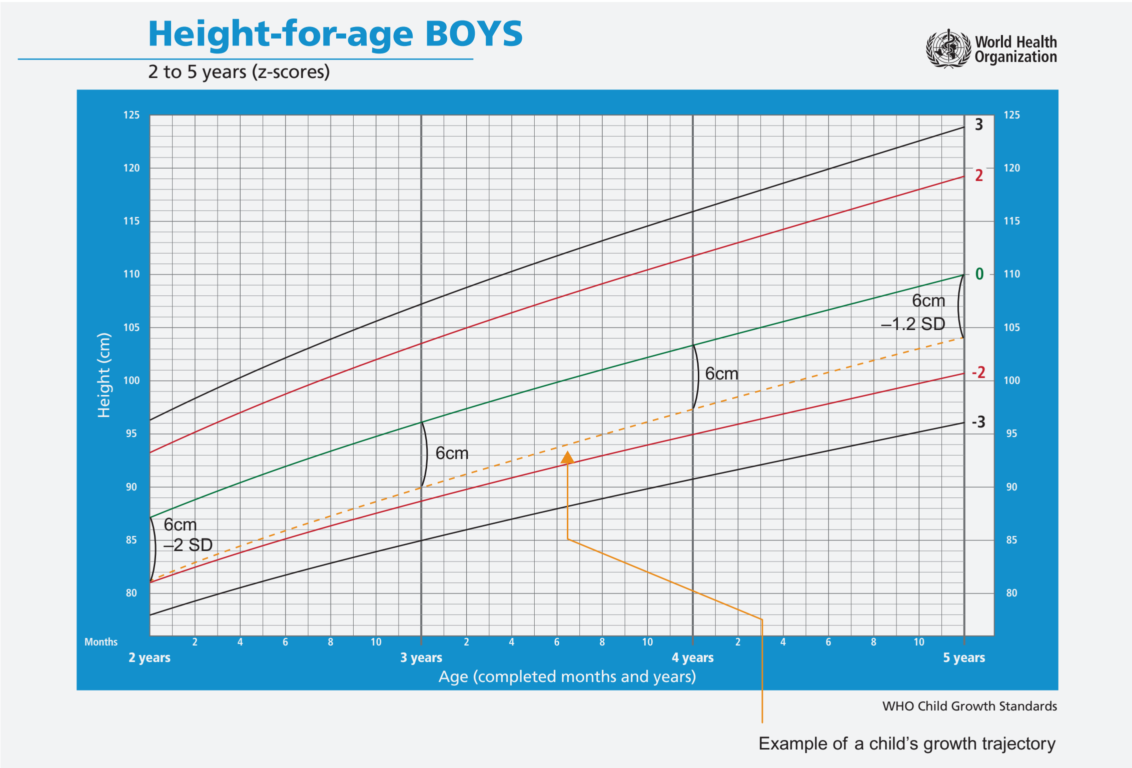
As children grow older there is greater variation in height, and thus a dispersion of the growth curves, and the absolute height differences between 'standard deviations' become larger. Thus, at two years old a boy is more than below the median if he is 6 cm shorter than the average child. At 5 years old, two standard deviations correspond to 9 cm shorter, while at aged 19 years or older the difference is 14 cm. Therefore, as children age HAZ is less likely to be <-2SD, and this may misleadingly imply growth recovery where there is none.

An alternative way of evaluating children's growth does not depend on standard deviations and instead measures the number of centimetres by which a child's height differs from the median of the reference population.

HAZ, nevertheless has been more used and has proved useful for assessing the risk of adverse outcomes for individuals and populations, and for evaluating interventions and policy. Moreover, HAZ takes into account that height variations increase with age, an issue that HAD ignores. Young Lives was mainly concerned with comparisons across populations and growth trajectories, so has tended to express results in terms of HAZ.

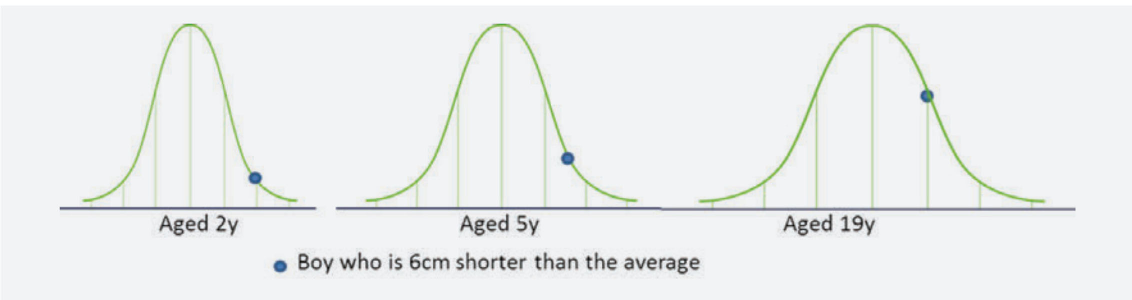
Figure 17 illustrates this point using the WHO growth charts for boys aged 2 to 5 years. This shows that a 6 cm difference in height corresponds to two standard deviations at 2 years old, but to just over one standard deviation at 5 years old. Figure 18 makes a similar point – that a child who is 6 cm shorter than average at 19 years old is much closer to the centre of the normal distribution (see Figure 16).

Figure 17. *WHO growth charts for boys aged 2-5 years*



Source: Adapted from WHO growth charts http://www.who.int/childgrowth/standards/cht_hfa_boys_z_2_5.pdf

Figure 18. *Changes in the relative position in the height distribution over childhood*



This debate is ongoing. But there is an important reason for thinking that something significant is happening when children's growth status improves according to HAZ measures. When children recover physically on this basis, this recovery has also been linked to better outcomes in other aspects of their development. If there were no meaningful recovery, we would not expect to see such a relationship.

Evidence of recovery suggests there may be returns from programming at older ages – through service improvements, social protection and feeding programmes. Less is known, however, about whether – or to what degree – such interventions affect physical recovery. This would need investigation through experimental trials. For a given age, HAZ and HAD are perfectly correlated and therefore equally good predictors of other indicators of human development such as education achievement, cognitive skills, socio-economic success, and health and pregnancy outcomes at any given age. Further studies are needed on changes in the different measures, with age as predictors of such outcomes.

Notes

1 Coates, Swindale, and Bilinsky, 2007
2 EMS, 2017, p 12
3 Grantham-McGregor *et al*. 2007; UNICEF, 2015b; Walker *et al*. 2007.
4 UNICEF 2018
5 UNICEF 2018
6 Black *et al*. 2013; Addo *et al*. 2013; Benny, Dornan, and Georgiadis, 2017
7 Alderman, Hoddinott, and Kinsey, 2006; J. R. Behrman *et al*. 2009; J. R. Behrman, Alderman, and Hoddinott, 2004; Grantham-McGregor *et al*. 2007; Hoddinott, Alderman, Behrman, Haddad, and Horton, 2013; Hoddinott, Rosegrant, and Torero, 2012; Maluccio *et al*. 2009
8 IFPRI, 2016
9 Aurino and Morrow, 2015
10 EMS, 2017
11 Garza *et al*. 2013
12 Lampl and Jeanty, 2003
13 Lampl and Jeanty, 2003
14 UNICEF, 2015a, de Onis *et al*. 2007
15 Perkins *et al*. 2016.
16 Steyn *et al*. 2006, cited in Aurino and Morrow, 2015; Crimmins and Finch, 2006.
17 Behrman *et al*. 2009 ; Addo *et al*. 2013
18 Black *et al*., 2013, Addo *et al*. 2013
19 Bourne personal communication 2017
20 (ref WHO)
21 de Onis *et al*. 2007
22 Okasha, McCarron, Davey Smith, and McEwen, 2001; Onland-Moret *et al*. 2005; Proos and Gustafsson, 2012).
23 NCD risk factor collaboration 2016.
24 J. Behrman and Deolalikar, 1989; Deolalikar, 1988; Hoddinott, Behrman *et al*. 2013; Hoddinott, Alderman *et al*. 2013; Hoddinott, Maluccio, Behrman, Flores, and Martorell, 2008; NCD risk factor collaboration 2016; Strauss, 1993; Strauss and Thomas, 1998; Thomas and Strauss, 1997.
25 Nandi *et al*. 2018
26 Addo *et al*. 2013
27 Martorell, 1989; Perkins, Subramanian, Davey Smith, and Özaltin, 2016
28 Humphries *et al*. 2015; Humphries *et al*. 2017
29 Eriksson, 2005; Stratton, *et al*. 1996; Baillieu and Potterton, 2008
30 Schott *et al*. 2017
31 Himaz, 2018
32 WHO, 2010a
33 Black *et al*. 2008; Prendergast and Humphrey, 2014
34 Khara *et al*. 2017; Olofin *et al*. 2013
35 McDonald *et al*. 2013; Nandy, Irving, Gordon, Subramanian, and Smith, 2005
36 Khara and Dolan, 2014
37 Adair LS *et al*. 2013; Singhal A, 2014; WHO, 2011
38 Patel *et al*. 2011
39 FAO, 2002
40 Coates, Swindale, Belinsky, 2007.
41 In the 11 food groups version roots and tubers; vegetables; and fruits were collated together as a single item.
42 WHO, 2010b
43 Humphries *et al*. 2017
44 http://www.who.int/nutgrowthdb/about/introduction/en/index5.html. The WHO classifies prevalence of stunting as being at medium levels if between 20 and 29 per cent, high if between 30-39 per cent, and very high if between 40-49 per cent.
45 Barnett *et al*. 2013
46 https://data.worldbank.org/indicator/SH.STA.STNT.ZS?locations=IN-ET-PE
47 IFPRI, 2016, Arnold *et al*. 2009
48 Politzer and Singh, 2012
49 Crookston *et al*. 2013; Elizabeth A Lundeen *et al*. 2014; Schott, Crookston, Lundeen, Stein, and Behrman, 2013
50 Himaz 2018; J. Behrman and Duc, 2014; Georgiadis *et al*. 2016
51 Prendergast and Humphrey, 2014; Victora, de Onis, Hallal, Blössner, and Shrimpton, 2010.
52 Serrat, 2014. In addition to the above mentioned nutritional and environmental factors it is possible that in Ethiopia this may be connected with ambient temperature and long bone growth, insofar as bones (and legs) grow longer in hot climates.
53 Headey *et al*. 2015; Headey *et al*. 2016; Headey *et al*. 2017
54 Nandy S., 2008.
55 Nandy and Miranda, 2008
56 Fekadu *et al*. 2015
57 Alemayehu *et al*. 2015
58 Abdulahi *et al*. 2017
59 Nandy and Miranda, 2008
60 P. L. Griffiths and Bentley, 2001; Popkin, Adair, and Ng, 2012; Lobstein *et al*. 2004; Popkin *et al*. 2012.
61 Delgado, 2003; Drewnowski and Popkin, 1997; Du, Mroz, Zhai, and Popkin, 2004; Popkin, 2009; Popkin *et al*. 2012; Popkin and Nielsen, 2003.
62 Bell, Ge, and Popkin, 2001; Ng and Popkin, 2012; Popkin *et al*. 2012
63 NCD risk factor collaboration 2016; Abarca-Gómez *et al*. 2017.
64 Fall, 2011; Ong and Loos, 2006; Popkin *et al*. 2012.
65 Pearce, Scalzi, Lynch, and Smithers, 2016.
66 Kehoe *et al*. 2014, cited in Aurino and Morrow, 2015.
67 Sanchez 2009b.
68 Crookston *et al*. 2013
69 Sanchez, 2009b
70 Sanchez, 2009b; Save the Children, 2013; see also Grantham-McGregor *et al*. 2007.
71 Duc and Behrman, 2017
72 This association remains statistically significant, even after controlling for current household expenditure, maternal psychosocial traits, past cognitive achievement, current body mass index of the child and community fixed effects (Dercon and Sanchez 2013, Outes *et al*. 2011)
73 Georgiadis, 2017b

74 Georgiadis *et al*. 2017
75 Andersen *et al*. 2016
76 Aurino and Burchi, 2016
77 Wisniewski, 2017
78 Cawley and Spiess, 2008; L. J. Griffiths, Dezateux, and Hill, 2011; Lobstein, Baur, and Uauy, 2004; Smith, Hay, Campbell, and Trollor, 2011; Young-Hyman, Schlundt, Herman-Wenderoth, and Bozylinski, 2003.
79 Cawley and Spiess, 2008; L. J. Griffiths *et al*. 2011; Harrist *et al*. 2016; Kamijo *et al*. 2012; Li, Dai, Jackson, and Zhang, 2008
80 Wisniewski, 2017
81 Aurino, Schott, Penny and Behrman, 2017
82 Khara and Dolan, 2014; Piwoz, Sundberg, and Rooke, 2012.
83 Nolan, 2016
84 Nolan, 2016
85 EMS, 2017
86 University of Notre Dame Global Adaptation Index Country Index
87 Nakicenovic *et al*. 2000
88 Parker, Akachi, and Goodman, 2009; Back *et al*. 2007
89 Sheffield and Landrigan, 2010.
90 IFPRI, 2016
91 UNICEF, 2016
92 Georgiadis, 2017b; Georgiadis *et al*. 2016
93 Tafere, 2016. See also Alderman *et al*. 2006 and Hoddinott *et al*. 2013.
94 Gale, O’Callaghan, Godfrey, Law, and Martyn, 2004; Georgiadis, 2017b; Sanchez, 2009a
95 Georgiadis, 2017b
96 Yi, Heckman, Zhang, and Conti, 2015.
97 Georgiadis, 2017b
98 Tafere, 2016
99 Dornan and Ogando Portela, 2014
100 Nolan, 2016
101 For Young Lives evidence on Vietnam, Lavin, Newnham, and Preen, 2016; Lavin, Preen, and Newnham, 2017; and for the Rajasthan study, Nair, Proochista, and Webster, 2012
102 Nair *et al*. 2012
103 Prüss-Ustün *et al*. 2014. These estimates of the burden of diarrhoea attributable to inadequate WASH are lower than previous estimates coordinated by WHO (WHO 2009) and higher than the recent estimate of the 2010 GBD study (Lim *et al*. 2012). There is strong evidence that the number of deaths due to diarrhoeal disease has dropped considerably since 2004 (WHO 2009; Liu *et al*. 2012; Lozano *et al*. 2012) due to a combination of improved management of diarrhoeal disease (especially the use of oral rehydration therapy) and better access to water and sanitation.
104 Cummings and Cairncross (2016) state that improved sanitation ‘concerns technologies and behaviours that serve to safely contain excreta, preventing human contact, and hygiene is commonly used to mean washing with soap at critical times (e.g. after defecation and before eating).’ In practice, lack of sanitation often refers to defecation in the open and improvements in sanitation refer to provision of in house toilets that prevent contact with faeces, especially for children.
105 Aurino, Fernandes, and Penny, 2016; Duc and Thang, 2014; S. Galab, Reddy, and Singh, 2014; Penny, 2014; Woldehanna and Pankhurst, 2014
106 EMS, 2017; 18
107 Cameron, 2009, citing Checkley *et al*. 2004
108 Vyas, Kov, Smets, and Spears, 2016
109 Cameron, 2009, citing Esrey, 1996
110 Georgiadis *et al*. 2017
111 Dearden *et al*. 2017
112 Cameron 2009; Vyas *et al*. 2016.
113 Cameron, 2009
114 Fink, Günther, and Hill, 2014; Guo *et al*. 2015
115 Nolan, 2016.
116 Upadhyay *et al*. 2015
117 EMS, 2017
118 Georgiadis *et al*. 2017
119 Vellakkal *et al*. 2015
120 Dercon, 2002
121 Gustafson, 2013; Dev, 2009
122 Aurino and Morrow, 2015; Vellakkal *et al*. 2015
123 Galab, Kumar, Reddy, Singh, and Vennam, 2011
124 An increase in the price of rice by 10 rupees (12 pence) corresponded to reduced consumption of rice at child level by about 73 grams, where this lower consumption of rice was associated with lower weight-for-height z-scores and increased risk of wasting (Vellakkal *et al*. 2015).
125 Aurino and Morrow, 2015
126 Akresh 2016 review chapter
127 Tranchant, Justino, and Mueller, 2014
128 Leon, 2012
129 Escobal and Flores, 2009
130 Leon, 2012
131 J. Behrman and Duc, 2014; Dornan and Georgiadis, 2015; Dornan and Pells, 2014; Krishna *et al*. 2015
132 Reynolds *et al*. 2017
133 Georgiadis, 2017a
134 Boyden *et al*. 2014
135 Beegle, De Weerdt and Dercon, 2006
136 Georgiadis, 2017a; Georgiadis, 2017b; Himaz, 2009; Moestue and Huttly, 2008.
137 Andrabi, Das, and Khwaja, 2012; J. R. Behrman *et al*. 2009; Black *et al*. 2013; Güneş, 2015; Schott *et al*. 2017)
138 Benny, Dornan, and Georgiadis, 2017
139 Kozuki *et al*. 2015; Özaltin *et al*. 2010; Black *et al*. 2013;
140 Benny, Dornan, and Georgiadis, 2017.
141 Carrillo-Larco *et al*. 2015b.
142 Barnett, 2011
143 Surkan *et al*. 2011.
144 Favara, 2012.
145 Durlauf and Fafchamps, 2005; Favara, 2012
146 Harpham, De Silva, and Tuan, 2006; Mekonnen *et al*. 2005; Moestue, Huttly, Sarella, and Galab, 2007
147 Chuta and Crivello, 2013
148 Chuta and Crivello, 2013; Ogando Portela and Pells, 2014
149 Bhalotra, 2010
150 Behrman and Deolalikar, 1990.
151 Lordan and Frijters, 2013; Upadhyay *et al*. 2016.

152 Glewwe, Jacoby and King 2001 as also occurred in Pakistan (Alderman, Behrman, Lavy and Menon, 2001).

153 Georgiadis, 2017b

154 Crookston *et al*. 2010; Dearden *et al*. 2013

155 Schott, Aurino, Penny and Behrman, 2017

156 Moestue and Huttly, 2008; Schott *et al*. 2017

157 For children aged 5 this came from 11 food groups. Thereafter, three groups (tubers, vegetables and fruits) were subdivided on the basis of micronutrient content – resulting in 15 groups. For this analysis the groups were further reduced to seven to allow comparability between the results. This was possible except in the case of orange vegetables such as carrots which are included as tubers in Round 2 and vegetables in Round 4. This may have caused a slight distortion in this comparison.

158 In 2013 data on dietary diversity was collected differently in Vietnam, making comparison impossible

159 Aurino, Fernandes, and Penny, 2016

160 Aurino, Fernandes and Penny, 2016

161 Aurino, Schott, Penny and Behrman, 2017

162 Carrillo-Larco, Miranda, and Bernabé-Ortiz, 2015b.

163 Aurino, Schott, Penny and Behrman, 2017

164 Andersen *et al*. 2015.; Anderson *et al*. 2016; Penny, Jimenez, and Marin, 2016

165 Behrman *et al*. 2017; Carrillo-Larco, Miranda, and Bernabé-Ortiz, 2015a

166 Behrman *et al*. 2017

167 Black *et al*. 2013; de Onis and Branca, 2016, particularly in sub-Saharan Africa (Keino, Plasqui, Ettyang, and van den Borne, 2014; D.E. Sahn and Stifel, 2002; Svedberg, 1990; Wamani, Åstrøm, Peterson, Tumwine, and Tylleskär, 2007.

168 Pongou, 2013; D.E. Sahn and Stifel, 2002; Wamani *et al*. 2007.

169 Dercon and Singh, 2013; R. Singh and Sarkar, 2014

170 Cronk, 1989; D.E. Sahn and Stifel, 2002; Svedberg, 1990.

171 Aurino, 2016; Aurino *et al*. 2016

172 Aurino, 2016

173 Aurino, 2016; Dercon and Singh, 2013; Pal, 2004.

174 Dreyfus J *et al*. 2015, Charalampopoulos D *et al*. 2014

175 The consequences of a high BMI for age Z-score at 1 year are not necessarily comparable with these measures at later ages for which reason clinically different cut offs and measures are used for younger children , as younger children's weight is judged relative to their height as opposed to their squared height.

176 But early height-for-age, as measured by HAZ, did not necessarily predetermine final adult height. Height-for-age difference, HAD does determine adult height but begs the question of whether the same absolute difference, i.e. the number of centimetres/inches of height deficit in infancy, for instance 6cm, has the same implications as 6cm less than adult height.

177 Lundeen *et al*. 2014

178 Crookston *et al*. 2013; Lundeen *et al*. 2014; Schott, Crookston, Lundeen, Stein, and Behrman, 2013

179 Behrman and Duc, 2014; Georgiadis *et al*. 2016; Rampal, 2013; Schott *et al*. 2013

180 In all four countries, among the children who were severely stunted at age 1, 29 per cent were not stunted by age 5, 41 to 43 per cent were not stunted at ages 8 and 12, and 48 per cent were not stunted at age 15. However, those who were moderately stunted at age 1 were more likely to recover: 46 per cent were not stunted at age 5, 59 per cent at ages 8 and 12, and 65 per cent at age 15.

181 Behrman *et al*. 2013; Crookston *et al*. 2010, 2013; Georgiadis *et al*. 2017.

182 Georgiadis *et al*. 2016.

183 Crookston *et al*. 2010, 2011, 2013; Georgiadis *et al*. 2016

184 Sanchez, 2009b

185 Georgiadis *et al*. 2016

186 Blakemore and Choudhury, 2006; Casey, Jones, and Hare, 2008; Johnson, Blum, and Giedd, 2009

187 Prentice *et al*. 2013; Rogol, Clark, and Roemmich, 2000

188 Campisi, Cherian, and Bhutta, 2017; Das *et al*. 2016

189 Benny, Dornan, and Georgiadis, 2017; Duc and Tam, 2015; Fink and Rockers, 2014.

190 Benny, Dornan, and Georgiadis, 2017; Duc and Tam, 2015; Schott, Aurino, Penny, and Behrman, 2017.

191 Case and Paxson, 2001

192 Perkins, Subramanian, Davey Smith, and Özaltin, 2016

193 Proos and Gustafsson, 2012.

194 Aurino *et al*. (2017)

195 Terry *et al*. 2009

196 Prentice *et al*. 2013; Gigante *et al*. 2005; Rah *et al*. 2010.

197 Outes and Porter (2013) explore the factors associated with catch-up growth and find that children in wealthier households were more likely to experience almost perfect catch-up growth, whereas children who were in the poorer half of the wealth distribution only experienced partial catch-up, though this difference in catch-up growth rates by household wealth was only observed for girls. For boys, the socio-economic status of the household did not affect their catch-up growth. They also find that girls in wealthier households experience higher catch-up than boys in such households, similar to the finding by other studies that catch-up growth is more likely for girls than boys (Deolalikar, 1996; Ruel, Rivera, Habicht, and Martorell, 1995).

198 This analysis has yet to be done for Vietnam.

199 Crookston *et al*. 2010; Outes and Porter, 2013; A. Singh *et al*. 2014

200 A. Singh *et al*. 2014

201 Georgiadis *et al*. 2017

202 Watkins *et al*. 2017

203 Georgiadis *et al*. 2017

204 Crookston *et al*. 2010

205 Watkins *et al*. 2017

206 Georgiadis 2017b; A. Singh *et al*. 2014

207 Young Lives evidence largely agrees with other literature that also documents growth recovery. For instance, Crookston and others 2010) find catch-up growth of 1.13 SD on average, a similar magnitude to that found by Adair (1999) in Philippines and Coly and others (2006) in Senegal, though larger in magnitude than found by A. Singh and others (2014) for India.

208 Lundeen *et al*. 2014, Mendez and Adair, 1999, Prentice *et al*. 2013
209 Prader, Tanner, and Yon Harnack, 1963; Stein, Susser, Saenger, and Marolla, 1975
210 Miller *et al*. 2010; Van Ijzendoorn, Bakermans-Kranenburg, and Juffer, 2007
211 Watkins *et al*. 2017; Stephenson, L S *et al*. 1993; Cooper, E S *et al*. 1995.; Ash, Deborah M *et al*. 2003; Abrams, Steven A *et al*. 2003.
212 Galasso, Emanuela *et al*. 2016.
213 WFP, 2017
214 http://scalingupnutrition.org/
215 Sathyamala, 2017
216 Bhutta *et al*. 2013
217 Bhutta *et al*. 2013
218 Bhutta *et al*. 2013
219 (Bundy and Horton, 2017)
220 Bhutta *et al*. 2013
221 IFPRI, 2016; UNICEF, 2017
222 Tirado *et al*. 2013
223 Andersen *et al*. 2015; Dasgupta, 2013; Ponce, 2012; Porter and Goyal, 2016; Streuli, 2012
224 Baanante and Sanchez, 2011
225 Andersen *et al*. 2015; Sanchez, Melendez, Behrman, 2016
226 A. Singh *et al*. 2014; Vargas and Penny, 2010
227 Porter and Goyal, 2016
228 Currie and Almond, 2011
229 Currie and Almond, 2011. The Currie and Almond review relies mostly on evidence from OECD countries; and the primary focus is on remediation in cognitive skills and behavioural outcomes. Their insight on the possibility of remediation in these outcomes is shared by the child development literature (Rutter, 2012)
230 Rutter, 2012
231 Andersen *et al*. 2015
232 Haddad, 2018.
233 Carrillo-Larco, Miranda, and Bernabé-Ortiz, 2016
234 Carrillo-Larco *et al*. 2016
235 Aurino and Morrow, 2015
236 Morrow, Tafere, Chuta, and Zharkevich, 2017; Tafere, 2012
237 Dhanaraj, 2014.
238 Camfield and Vennam, 2012.
239 Buttenheim and Asch, 2013; Zongrone *et al*. 2018
240 Lodha and Kabra, 2015; Sint *et al*. 2013
241 Benny, Dornan, and Georgiadis, 2017; Dornan and Georgiadis, 2015
242 Bundy *et al*. 2018
243 Boyden *et al*. 2014

References

Abarca-Gómez, L., Z.A. Abdeen, Z.A. Hamid, N.M. Abu-Rmeileh, B. Acosta-Cazares, C. Acuin, and C. Agyemang (2017) 'Worldwide Trends in Body-mass Index, Underweight, Overweight, and Obesity from 1975 to 2016: a Pooled Analysis of 2416 Population-based Measurement Studies in 128.9 million children, adolescents, and adults', *The Lancet* 390.10113: 2627-2642.

Abdulahi, A., S. Shab-Bidar, S. Rezaei, and K. Djafarian (2017) 'Nutritional Status of Under Five Children in Ethiopia: A Systemtatic Review and Meta-Analysis', *Ethiopian Journal of Health Sciences* 27.1: 175.

Abrams, S.A., A. Mushi, D.C. Hilmers, I.J. Griffin, P. Davila, and L. Allen (2003) 'A Multinutrient-fortified Beverage Enhances the Nutritional Status of Children in Botswana', *The Journal of Nutrition* 133.6: 1834-1840.

Adair, L. S. (1999) 'Filipino Children Exhibit Catch-up Growth from age 2 to 12 years', *The Journal of Nutrition* 129.6: 1140-1148.

Adair, L.S., C.H. Fall, C. Osmond, A.D. Stein, R. Martorell, M. Ramirez-Zea, and L. Micklesfield (2013) 'Associations of Linear Growth and Relative Weight Gain During Early Life with Adult Health and Human Capital in Countries of Low and Middle Income: Findings from Five Birth Cohort Studies', *The Lancet* 382.9891: 525-534.

Addo, O.Y., A.D. Stein, C.H. Fall, D.P. Gigante, A.M. Guntupalli, B.L. Horta, and L.M. Richter (2013) 'Maternal Height and Child Growth Patterns', *The Journal of Pediatrics* 163.2: 549-554.

Akresh, R. (2016) 'Climate Change, Conflict, and Children', *The Future of Children 26*.1: 51-71.

Alderman, H., J.R. Behrman, V. Lavy, and R. Menon (2001) 'Child Health and School Enrollment: A Longitudinal Analysis', *Journal of Human Resources* 36.1: 185-205.

Alderman, H., J. Hoddinott, and B. Kinsey (2006) 'Long-term Consequences of Early Childhood Malnutrition', *Oxford Economic Papers* 58.3: 450–474.

Alemayehu, M., F. Tinsae, K. Haileslassie, O. Seid, G. Gebregziabher, and H. Yebyo (2015) 'Undernutrition Status and Associated Factors in under-5 Children, in Tigray, Northern Ethiopia', *Nutrition* 31.7-8: 964-970.

Andrabi, T., J. Das, and A.I. Khwaja (2012) 'What Did You Do All Day? Maternal Education and Child Outcomes', *Journal of Human Resources 47*.4: 873-912.

Andersen, C.T., S.A. Reynolds, J.R. Behrman, B.T. Crookston, K.A. Dearden, J. Escobal, … and L.C. Fernald (2015) 'Participation in the Juntos Conditional Cash Transfer Program in Peru Is Associated with Changes in Child Anthropometric Status but Not Language Development or School Achievement', *Journal of Nutrition* 145.10: 2396–2405.

Andersen, C.T., A.D. Stein, S.A. Reynolds, J.R. Behrman, B.T. Crookston, K.A. Dearden, … and L.C. Fernald (2016) 'Stunting in Infancy Is Associated with Decreased Risk of High Body Mass Index for Age at 8 and 12 Years of Age.' *Journal of Nutrition* 146.11: 2296–2303.

Ash, D.M., S.R. Tatala, E.A. Frongillo Jr, G.D. Ndossi, and M.C. Latham (2003) 'Randomized Efficacy Trial of a Micronutrient-fortified Beverage in Primary School Children in Tanzania', *The American Journal of Clinical Nutrition* 77.4: 891-898.

Aurino, E. (2016) 'Do Boys Eat Better than Girls in India? Longitudinal Evidence on Dietary Diversity and Food Consumption Disparities Among Children and Adolescents', *Economics & Human Biology* 25: 99-111.

Aurino, E., and F. Burchi (2016) 'Children's Multidimensional Health and Medium-Term Cognitive Skills in Low- and Middle-Income Countries', *The European Journal of Development Research* 29.2: 289-311.

Aurino, E., M. Fernandes, and M.E. Penny (2016) 'The Nutrition Transition and Adolescents' Diets in Low- and Middle-income Countries: a Cross-cohort Comparison', *Public Health Nutrition* 380.9859: 1–10.

Aurino, E., and V. Morrow (2015) '*"If we eat well, we can study": Dietary Diversity in the Everyday Lives of Children in Andhra Pradesh and Telangana, India'*, Working Paper 144, Oxford: Young Lives.

Aurino, E., Schott, W., Behrman, J., and Penny, M. E. (2017) 'Prenatal and postnatal nutritional status influence age at menarche in three developing countries'.

Baanante, M. J., and Sanchez, A. (2011) *Impacto del programa Juntos sobre nutrición temprana* (Documento de Investigación No. 61) Lima.

Back, E., Cameron, C., and UNICEF. (2007) 'Our climate, our children, our responsibility: the implications of climate change for the world's children', in *Our Climate, our Children, our Responsibility: the Implications of Climate Change for the World's Children*, Washington, DC: UNICEF.

Baillieu, N., and Potterton, J. (2008) 'The extent of delay of language, motor, and cognitive development in HIV-positive infants', *Journal of Neurologic Physical Therapy* 32.3: 118-121.

Barnett, I. (2011) 'Is the Dual Burden of Over-and Under-nutrition a Concern for Poor Households in Ethiopia, India, Peru and Vietnam?*'*, Oxford: Young Lives.

Barnett, I., Ariana, P., Petrou, S., Penny, M. E., Duc, L. T., Galab, S., Woldehanna, T., Escobal, J.A., Plugge, E. and Boyden, J. (2013) 'Cohort Profile: the Young Lives Study', *International Journal of Epidemiology 42*.3: 701.

Beegle, K., J. De Weerdt, and S. Dercon. 2006. 'Orphanhood and the Long-run Impact on Children', *American Journal of Agricultural Economics* 88.5: 1266–72.

Behrman, J. R., Alderman, H., and Hoddinott, J. (2004) 'Malnutrition and hunger', in B. Lomborg (ed.) *Global Crises, Global Solutions,* 363-420, Cambridge: Cambridge University Press.

Behrman, J. R., Calderon, M. C., Preston, S. H., Hoddinott, J., Martorell, R., and Stein, A. D. (2009) 'Nutritional supplementation in girls influences the growth of their children: prospective study in Guatemala', *The American Journal of Clinical Nutrition* 90.5: 1372-1379.

Behrman, J.R., Contreras, D., Palma, I., and Puentes, E. (2017) 'Wealth Disparities for Early Childhood Anthropometrics and Skills: Evidence from Chilean Longitudinal Data'.

Behrman, J.R., Crookston, B., Dearden, K., Duc, L., Fernald, L., Mani, S., … Stein, A. (2013) 'Intergenerational Transmission of Poverty and Inequality: Young Lives', Grand Challenges Canada Economic Returns to Mitigating Early Life Risks Project.

Behrman, J. R., and Deolalikar, A. (1989) 'Is variety the spice of life? Implications for calorie intake', in *The Review of Economics and Statistics*, 666-672, MIT Press.

Behrman, J. R., and Deolalikar, A. (1990) 'The intrahousehold demand for nutrients in rural south India: Individual estimates, fixed effects, and permanent income', *Journal of Human Resources* 25.4: 665-696.

Behrman, J., and Duc, L. T. (2014) *Early-Childhood Growth Faltering, Post-Infancy Recovery and Educational Outcomes in Late Childhood: Evidence from Vietnam,*GCC Working Paper Series No. 14–4.

Bell, A.C., Ge, K., and Popkin, B. M. (2001) 'Weight gain and its predictors in Chinese adults', *International Journal of Obesity* 25.7: 1079.

Benny, L., P. Dornan, and A. Georgiadis (2017) *Maternal Undernutrition and Childbearing in Adolescence and Offspring Growth and Development in Low- and Middle-Income Countries: Is Adolescence a Critical Window for Interventions Against Stunting?,* Working Paper 165, Oxford: Young Lives.

Bhalotra, S. (2010) 'Fatal fluctuations? Cyclicality in infant mortality in India', *Journal of Development Economics 93*.1: 7-19.

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., … Black, R. E. (2013) 'Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost?' *The Lancet 382*.9890: 452–477.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., and Maternal and Child Undernutrition Study Group. (2008) 'Maternal and child undernutrition: global and regional exposures and health consequences', *The Lancet* 371.9608: 243-260.

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., and Uauy, R. (2013) 'Maternal and child undernutrition and overweight in low-income and middle-income countries', *The Lancet* 382.9890: 427–451.

Blakemore, S.-J., and Choudhury, S. (2006) 'Development of the adolescent brain: implications for executive function and social cognition', *Journal of Child Psychology and Psychiatry 47*.3–4: 296–312.

Borooah, V.K. (2004) 'Gender bias among children in India in their diet and immunisation against disease', *Social Science and Medicine 58*.9: 1719-1731.

Boyden, J. Dercon, S. and Singh, A. 2014 'Child Development in a Changing World: Risks and Opportunities', *The World Bank Research Observer* 30.2: 193-219.

Bundy, D., N. de Silva, S. Horton, G. Patton, L. Schultz, D. Jamison, for the Disease Control Priorities-3 Child and Adolescent Health and Development Authors Group (2018) 'Investment in child and adolescent health and development: key messages from Disease Control Priorities, 3rd Edition', *The Lancet* 391: 687-99

Buttenheim, A.M., and D.A. Asch (2013) 'Behavioral Economics: the Key to Closing the Gap on Maternal, Newborn and Child Survival for Millennium Development Goals 4 and 5?' *Maternal and Child Health Journal 17*.4: 581-585.

Cameron, L. (2009) *Does 'Improved' Sanitation Make Children Healthier? Household Pit Latrines and Child Health in Rural Ethiopia*, Working Paper 42, Oxford: Young Lives.

Camfield, L., and U. Vennam (2012) *From Policy to Implementation: An In-depth Exploration of the Mahatma Gandhi National Rural Employment Guarantee Scheme in Andhra Pradesh*, Working Paper 82, Oxford: Young Lives.

Campisi, S.C., A.M. Cherian, and Z.A. Bhutta (2017) 'World Perspective on the Epidemiology of Stunting between 1990 and 2015', *Hormone Research in Paediatrics* 88.1: 70–78.

Carrillo-Larco, R. M., Miranda, J. J., and Bernabé-Ortiz, A. (2015a) 'Delivery by caesarean section and risk of childhood obesity: analysis of a Peruvian prospective cohort', *PeerJ 3*: e1046.

Carrillo-Larco, R. M., Miranda, J. J., and Bernabé-Ortiz, A. (2015b) 'Wealth index and risk of childhood overweight and obesity: evidence from four prospective cohorts in Peru and Vietnam', *International Journal of Public Health* 61.4: 475-485.

Carrillo-Larco, R. M., Miranda, J. J., and Bernabé-Ortiz, A. (2016) 'Impact of Food Assistance Programs on Obesity in Mothers and Children: A Prospective Cohort Study in Peru', *American Journal of Public Health* 106.7: 1301–1307.

Case, A., and C. Paxson (2001) 'Mothers and Others: Who Invests in Children's Health?' *Journal of Health Economics 20*.3: 301-328.

Casey, B. J., Jones, R. M., and Hare, T. A. (2008) 'The Adolescent Brain', *Annals of the New York Academy of Sciences* 1124.1: 111–126.

Cawley, J., and Spiess, C. K. (2008) 'Obesity and skill attainment in early childhood', *Economics and Human Biology* 6.3: 388-397.

Charalampopoulos, D., McLoughlin, A., Elks, C. E., and Ong, K. K. (2014) 'Age at menarche and risks of all-cause and cardiovascular death: a systematic review and meta-analysis', *American Journal of Epidemiology 180*.1: 29-40.

Chuta, N., and G. Crivello (2013) *Towards a 'Bright Future': Young People Overcoming Poverty and Risk in Ethiopia*, Working Paper 107, Oxford: Young Lives.

Coates, J., A. Swindale, and P. Bilinsky (2007) 'Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide', Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Cooper, E. S., Duff, E. M. W., Howell, S., and Bundy, D. A. P. (1995) ''Catch-up' growth velocities after treatment for Trichuris dysentery syndrome', *Transactions of the Royal Society of Tropical Medicine and Hygiene 89*.6: 653.

Crimmins E, and Finch, C. (2009) 'Infection, inflammation, height and longevity', *PNAS* 2006.103: 498–503.

Cronk, L. (1989) 'Low Socioeconomic Status and Female-Biased Parental Investment: The Mukogodo Example', *American Anthropologist 91.2*: 414-429.

Crookston, B. T., Dearden, K. A., Alder, S. C., Porucznik, C. A., Stanford, J. B., Merrill, R. M., … Penny, M. E. (2011) 'Impact of early and concurrent stunting on cognition', *Maternal & Child Nutrition 7*.4: 397–409.

Crookston, B. T., Penny, M. E., Alder, S. C., Dickerson, T. T., Merrill, R. M., Stanford, J. B., … Dearden, K. A. (2010) 'Children who recover from early stunting and children who are not stunted demonstrate similar levels of cognition', *The Journal of Nutrition 140*.11: 1996–2001.

Crookston, B. T., Schott, W., Cueto, S., Dearden, K. A., Engle, P., Georgiadis, A., … Behrman, J. R. (2013) 'Postinfancy growth, schooling, and cognitive achievement: Young Lives', *The American Journal of Clinical Nutrition* 98.6: 1555–63.

Cummings, O., and S. Cairncross (2016) 'Can Water, Sanitation and Hygiene Help Eliminate Stunting? Current Evidence and Policy Implications', *Maternal & Child Nutrition* 12.1: 91-105.

Currie, J., and Almond, D. (2011) 'Killing me softly: The fetal origins hypothesis', *The Journal of Economic Perspectives* 25.3: 153-172.

Das, J.K., Salam, R. A., Lassi, Z. S., Khan, M. N., Mahmood, W., Patel, V., and Bhutta, Z. A. (2016) 'Interventions for adolescent mental health: an overview of systematic reviews', *Journal of Adolescent Health* 59.4: S49-S60.

Dasgupta, A. (2013) *Can the Major Public Works Policy Buffer Negative Shocks in Early Childhood? Evidence from Andhra Pradesh, India,* Working Paper 112, Oxford: Young Lives.

de Onis, M., and F. Branca (2016) 'Childhood Stunting: a Global Perspective', *Maternal & Child Nutrition 12*.S1: 12-26.

de Onis, M. D., Onyango, A. W., Borghi, E., Siyam, A., Nishida, C., and Siekmann, J. (2007) 'Development of a WHO growth reference for school-aged children and adolescents', *Bulletin of the World Health Organization* 85: 660-667.

Dearden, K., Crookston, B., Madanat, H., West, J., Penny, M., and Cueto, S. (2013) 'What difference can fathers make? Early paternal absence compromises Peruvian children's growth', *Maternal & Child Nutritio*, 9.1: 143–154.

Dearden, K., Schott, W., Crookston, B. T., Humphries, D. L., Penny, M. E., and Behrman, J. R. (2017) 'Children with access to improved sanitation but not improved water are at lower risk of stunting compared to children without access: a cohort study in Ethiopia, India, Peru, and Vietnam', *BMC Public Health* 17.1: 110.

Delgado, C.L. (2003) 'Rising Consumption of Meat and Milk in Developing Countries has Created a New Food Revolution', *The Journal of Nutrition 133*.11: 3907S-3910S.

Dercon, S. (2002) 'Income Risk, Coping Strategies, and Safety Nets', *World Bank Research Observer* 17.2: 141–66.

Dercon, S., and A. Sánchez (2013) 'Height in Mid-childhood and Psychosocial Competencies in Late Childhood: Evidence from Four Developing Countries', *Economics & Human Biology* 11.4: 426–432.

Dercon, S., and A. Singh (2013) 'From Nutrition to Aspirations and Self-Efficacy: Gender Bias over Time among Children in Four Countries', *World Development 45*: 31–50.

Deolalikar, A. . (1996) 'Child Nutritional Status and Child Growth in Kenya: Socioeconomic Determinants', *Journal of International Development 8*.3: 375-393.

Deolalikar, A.B. (1988) 'Nutrition and Labor Productivity in Agriculture: Estimates for Rural South India', *The Review of Economics and Statistics* 70.3: 406-413.

Dev, S.M. (2010) 'Rising Food Prices and Financial Crisis in India: Impact on Women and Children and Ways of Tackling the Problem', Washington, DC: UNICEF.

Dhanaraj, S. (2014) *Health Shocks and Coping Strategies: State Health Insurance Scheme of Andhra Pradesh, India*, WIDER Working Paper No. 2014/003, Helsinki: WIDER.

Dornan, P., and A. Georgiadis (2015) 'Nutrition, Stunting and Catch-up Growth'*,* Oxford: Young Lives.

Dornan, P., and M.J. Ogando Portela (2014) 'How Does Where Children Live Affect How They Develop? Evidence from Communities in Ethiopia and Vietnam', in M. Bourdillon and J. Boyden (eds.) *Growing Up in Poverty: Findings from Young Lives*, 23–50, London: Palgrave Macmillan.

Dornan, P., and K. Pells (2014) 'From Infancy to Adolescence: Growing Up in Poverty Preliminary Findings from Round 4 of Young Lives'*,* Oxford: Young Lives.

Drewnowski, A., and B.M. Popkin (1997) 'The Nutrition Transition: New Trends in the Global Diet', *Nutrition Reviews* 55.2: 31-43.

Dreyfus, J., D.R. Jacobs, N. Mueller, P.J. Schreiner, A. Moran, M.R. Carnethon, and E.W. Demerath (2015) 'Age at Menarche and Cardiometabolic Risk in Adulthood: the Coronary Artery Risk Development in Young Adults Study', *The Journal of Pediatrics* 167.2: 344-352.

Du, S., T.A. Mroz, F. Zhai, and B.M. Popkin (2004) 'Rapid Income Growth Adversely Affects Diet Quality in China – Particularly for the Poor', *Social Science & Medicine* 59.7: 1505-1515.

Duc, L.T., and J.R. Behrman (2017) 'Heterogeneity in Predictive Power of Early Childhood Nutritional Indicators for Mid-childhood Outcomes: Evidence from Vietnam', *Economics & Human Biology 26:* 86–95.

Duc, L.T., and T.N.M. Tam (2015) *Growth in Middle Childhood and Early Adolescence, and Its Association with Cognitive and Non-cognitive Skills at the Age of 15 Years,* Working Paper 138, Oxford: Young Lives.

Duc, L.T., and N. Thang (2014) 'Nutrition and Health: Round 4 Preliminary Findings', Oxford: Young Lives.

Durlauf, S.N., and M. Fafchamps (2005) 'Social Capital', in P. Aghion, and S.N. Durlauf (eds.) *Handbook of Economic Growt*h, Volume IB. North Holland.

EMS (2017) 'Environmental Health in Emerging Markets: Summary and Report', Oxford: EMS.

Eriksson, J. G. (2005) 'Early Growth and Adult Health Outcomes: Lessons Learned from the Helsinki Birth Cohort Study', *Maternal & Child Nutrition* 1.3: 149-154.

Escobal, J., and E. Flores (2009) *Maternal Migration and Child Well-Being in Peru,* Working Paper 56, Oxford: Young Lives.

Fall, C.H. (2011) 'Evidence for the Intra-uterine Programming of Adiposity in Later Life', *Annals of Human Biology* 38.4: 410-428.

FAO (2002) *The State of Food Insecurity in the World 2001.* Rome: FAO.

Favara, M. (2012) *United We Stand Divided We Fall: Maternal Social Participation and Children's Nutritional Status in Peru,* Policy Research Working Paper No. WPS6264, Washington, DC: World Bank.

Fekadu, Y., Mesfin, A., Haile, D., and Stoecker, B. J. (2015) 'Factors associated with nutritional status of infants and young children in Somali Region, Ethiopia: a cross-sectional study', *BMC Public Health* 15*:* 846.

Fentahun, N., Belachew, T., and Lachat, C. (2016) 'Determinants and morbities of multiple anthropometric deficites in southwest rural Ethiopia', *Nutrition* 32*:* 1243-1249.

Fink, G., Günther, I., and Hill, K. (2014) 'Slum residence and child health in developing countries', *Demography* 51.4: 1175-1197.

Fink, G., and P.C. Rockers (2014) 'Childhood growth, schooling, and cognitive development: further evidence from the Young Lives study', *American Journal of Clinical Nutrition* 10.1: 182–188.

Galab, S., S.V. Kumar, P.P. Reddy, R. Singh, and U. Vennam (2011) 'The Impact of Growth on Childhood Poverty in Andhra Pradesh', Oxford: Young Lives.

Galab, S., P.P. Reddy, and R. Singh (2014) 'Nutrition and Health: Round 4 Preliminary Findings*'*, Oxford: Young Lives.

Galasso, E., A. Wagstaff, S. Naudeau, and M. Shekar (2016) 'The Economic Costs of Stunting and How to Reduce Them', Policy Research Note, Washington, DC: World Bank.

Gale, C. R., O'Callaghan, F. J., Godfrey, K. M., Law, C. M., and Martyn, C. N. (2004) 'Critical periods of brain growth and cognitive function in children', Brain *127*.2: 321-329.

Georgiadis, A. (2017a) *Parental Background and Child Human Capital Development Throughout Childhood and Adolescence: Evidence From Four Low- and Middle-Income Countries*, Working Paper 164, Oxford: Young Lives.

Georgiadis, A. (2017b) *The Sooner the Better But It's Never Too Late: The Impact of Child Nutrition at Different Stages of Childhood on Child Development*, Working Paper 159, Oxford: Young Lives.

Georgiadis, A., Benny, L., Crookston, B. T., Duc, L. T., Hermida, P., Mani, S., … Behrman, J. R. (2016) 'Growth trajectories from conception through middle childhood and cognitive achievement at age 8 years: Evidence from four low- and middle-income countries', *SSM-Population Health* 2*:* 43–54.

Georgiadis, A., Benny, L., Duc, L. T., Galab, S., Reddy, P., and Woldehanna, T. (2017) 'Growth recovery and faltering though early adolescence in low- and middle-income countries: Determinants and implications for cognitive development', *Social Science & Medicine* 179: 81–90.

Glewwe, P., Jacoby, H. G., and King, E. M. 2001. 'Early childhood nutrition and academic achievement: a longitudinal analysis', *Journal of Public Economics 81*.3: 345-368.

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., and Strupp, B. (2007) 'Developmental potential in the first 5 years for children in developing countries', *The Lancet* 369.9555: 60–70.

Griffiths, L. J., Dezateux, C., and Hill, A. (2011) 'Is obesity associated with emotional and behavioural problems in children? Findings from the Millennium Cohort Study', *Pediatric Obesity* 6.2-2: e423-32.

Griffiths, L. J., and Bentley, M. E. (2001) 'The nutrition transition is underway in India', *The Journal of Nutrition* 131.10: 2692-2700.

Güneş P.M. (2015) 'The role of maternal education in child health: Evidence from a compulsory schooling law', *Economics of Education Review 47:* 1-16.

Guo, X., Yang, H., Wu, C., Jiang, J., Fan, J., Li, H., and Zhang, J. (2015) 'Molecular characterization and viral origin of the first dengue outbreak in Xishuangbanna, Yunnan Province, China, 2013', *The American Journal of Tropical Medicine and Hygiene* 93.2: 390-393.

Gustafson, D. J. (2013) 'Rising food costs and global food security: key issues and relevance for India', *The Indian Journal of Medical Research 138*.3: 398.

Haddad, L. (2018) 'Reward food companies for improving nutrition', *Nature 556*: 19-22.

Harpham, T., De Silva, M. J., and Tuan, T. (2006) 'Maternal social capital and child health in Vietnam', *Journal of Epidemiology and Community Health* 60.10: 865–71.

Harrist, A. W., Swindle, T. M., Hubbs-Tait, L., Topham, G. L., Shriver, L. H., and Page, M. C. (2016) 'The social and emotional lives of overweight, obese, and severely obese children', *Child Development* 87.5: 1564-1580.

Haughton, D., and Haughton, J. (1997) 'Explaining child nutrition in Vietnam', *Economic Development and Cultural Change* 45.3: 541-556.

Headey, D., Hoddinott, J., Ali, D., Tesfaye, R., and Dereje, M. (2015) 'The other Asian enigma: explaining the rapid reduction of undernutrition in Bangladesh', *World Development* 66*:* 749-761.

Headey, D., Hoddinott, J., and Park, S. (2016) 'Drivers of nutritional change in four South Asian countries: a dynamic observational analysis', *Maternal & Child Nutrition* 12.S1: 210–218.

Headey, D., Hoddinott, J., and Park, S. (2017) 'Accounting for nutritional changes in six success stories: A regression-decomposition approach', *Global Food Security 13*: 12-20.

Himaz, R. (2009) 'Persistent Stunting in Middle Childhood: The Case of Andhra Pradesh Using Longitudinal Data', *IDS Bulletin* 40.4: 30–38.

Himaz, R. (2018) 'Stunting later in childhood and outcomes as a young adult: Evidence from India', *World Development* 104: 344-357.

Hoddinott, J., Alderman, H., Behrman, J. R., Haddad, L., and Horton, S. (2013) 'The economic rationale for investing in stunting reduction', *Maternal & Child Nutrition* 9.S2: 69-82.

Hoddinott, J., Behrman, J. R., Maluccio, J. A., Melgar, P., Quisumbing, A. R., Ramirez-Zea, M., and Martorell, R. (2013) 'Adult consequences of growth failure in early childhood', *The American Journal of Clinical Nutrition* ajcn-064584.

Hoddinott, J., Maluccio, J. A., Behrman, J. R., Flores, R., and Martorell, R. (2008) 'Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults', *The Lancet* 371.9610: 411-416.

Hoddinott, J., M. Rosegrant, and M. Torero (2012) 'Copenhagen Consensus 2012 Challenge Paper: Hunger and Malnutrition', Washington: International Food Policy Research Institute.

Humphries, D. L., Dearden, K. A., Crookston, B. T., Fernald, L. C., Stein, A. D., Woldehanna, T., and Behrman, J. R. (2015) 'Cross-sectional and longitudinal associations between household food security and child anthropometry at ages 5 and 8 years in Ethiopia, India, Peru, and Vietnam', *The Journal of Nutrition 145*.8: 1924-1933.

Humphries, D. L., Dearden, K. A., Crookston, B. T., Woldehanna, T., Penny, M. E., and Behrman, J. R. (2017) 'Household food group expenditure patterns are associated with child anthropometry at ages 5, 8 and 12 years in Ethiopia, India, Peru and Vietnam', *Economics & Human Biology* 26*:* 30–41.

IFPRI (2016) 'Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030', Washington, DC: IFPRI.

Johnson, S. B., Blum, R. W., and Giedd, J. N. (2009) 'Adolescent Maturity and the Brain: The Promise and Pitfalls of Neuroscience Research in Adolescent Health Policy', *Journal of Adolescent Health* 45.3: 216–221.

Kamijo, K., Khan, N. A., Pontifex, M. B., Scudder, M. R., Drollette, E. S., Raine, L. B., and Hillman, C. H. (2012) 'The relation of adiposity to cognitive control and scholastic achievement in preadolescent children', *Obesity 20*.12: 2406-2411.

Kehoe, S.H., G.V. Krishnaveni, S.R. Veena, A.M. Guntupalli, B.M. Margetts, C.H.D. Fall and S.M. Robinson (2014) 'Diet Patterns Are Associated with Demographic Factors and Nutritional Status in South Indian Children', *Maternal and Child Nutrition* 10: 145–58.

Keino, S.H., Plasqui, G., Ettyang, G., and van den Borne, B. (2014) 'Determinants of stunting and overweight among young children and adolescents in sub-Saharan Africa', *Food and Nutrition Bulletin* 35.2: 167-178.

Khara, T., and Dolan, C. (2014) 'Technical Briefing Paper: Associations between wasting and stunting, policy, programming, and research implications'.

Khara, T., Mwangome, M., Ngari, M., and Dolan, C. (2017) 'Children concurrently wasted and stunted: A meta-analysis of prevalence data of children 6–59 months from 84 countries', *Maternal & Child Nutrition* 14.2: e12516.

Kozuki, N., Katz, J., Lee, A. C., Vogel, J. P., Silveira, M. F., Sania, A., and Huybregts, L. (2015) 'Short maternal stature increases risk of small-for-gestational-age and preterm births in low-and middle-income countries: individual participant data meta-analysis and population attributable fraction', *The Journal of Nutrition* 145.11:, 2542-2550.

Krishna, A., Oh, J., Lee, J., Lee, H.-Y., Perkins, J. M., Heo, J., … Subramanian, S. V. V. (2015) 'Short-term and long-term associations between household wealth and physical growth: a cross-comparative analysis of children from four low- and middle-income countries', *Global Health Action* 8.0: 26523.

Lampl, M., and P. Jeanty (2003) 'Timing is Everything: a Reconsideration of Fetal Growth Velocity Patterns Identifies the Importance of Individual and Sex Differences', *American Journal of Human Biology* 15.5: 667-680.

Lavin, T., E.A. Newnham, and D.A. Preen (2016) 'Determinants of Home, Commune Health Centre and Hospital Setting for Vaginal Birth in Vietnamese Women', *Vietnam Journal of Public Health* 4.1: 16–30.

Lavin, T., D.B. Preen, and E.A. Newnham (2017) 'Access to Obstetric Care and Children's Health, Growth and Cognitive Development in Vietnam: Evidence from Young Lives', *Maternal and Child Health Journal* 21.6: 1277–1287.

Leon, G. (2012) 'Civil Conflict and Human Capital Accumulation: the Long-term Effects of Political Violence in Perú', *Journal of Human Resources* 47.4: 991-1022.

Li, Y., Q. Dai, J.C. Jackson, and J. Zhang (2008) 'Overweight is Associated with Decreased Cognitive Functioning Among School-age Children and Adolescents', *Obesity* 16.8: 1809-1815.

Lim, S.S., T. Vos, A.D. Flaxman, G. Danaei, K. Shibuya, H. Adair-Rohani, and M. Aryee (2012) 'A Comparative Risk Assessment of Burden of Disease and Injury Attributable to 67 Risk Factors and Risk Factor Clusters in 21 Regions, 1990–2010: a Systematic Analysis for the Global Burden of Disease Study 2010', *The Lancet* 380.9859: 2224-2260.

Liu, L., H.J. Johnson, S. Cousens, J. Perin, S. Scott, J.E. Lawn, and C. Mathers (2012) 'Global, Regional, and National Causes of Child Mortality: an Updated Systematic Analysis for 2010 with Time Trends Since 2000', *The Lancet* 379.9832: 2151-2161.

Lobstein, T., L. Baur, and R. Uauy (2004) 'Obesity in Children and Young People: a Crisis in Public Health', *Obesity Reviews* 5.s1: 4-85.

Lodha, R., and S.K. Kabra (2015) 'Health and Nutritional Status of HIV Infected Children, *The Indian Journal of Medical Research* 141.1: 10.

Lordan, G., and Frijters, P. (2013) 'Unplannedd Pregnancy and the Impct on Sibling Health Outcomes', *Health Economics 22*.8: 903–914.

Lozano, R., Naghavi, M., Foreman, K., Lim, S., Shibuya, K., Aboyans, V., and AlMazroa, M. A. (2012) 'Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010', *The Lancet* 380.9859: 2095-2128.

Lundeen, E. A., Stein, A. D., Adair, L. S., Behrman, J. R., Bhargava, S. K., Dearden, K. A., … COHORTS Investigators, on behalf of the C. (2014) 'Height-for-age z-scores increase despite increasing height deficits among children in 5 developing countries', *American Journal of Clinical Nutrition* 100.3: 821–825.

Maluccio, J.A., Hoddinott, J., Behrman, J. R., Martorell, R., Quisumbing, A. R., and Stein, A. D. (2009) 'The impact of improving nutrition during early childhood on education among Guatemalan adults', *The Economic Journal* 119.537: 734-763.

Martorell, R. (1989) 'Body size, adaptation and function', *Human Organization* 48.1: 15-20.

McDonald, C. M., Olofin, I., Flaxman, S., Fawzi, W. W., Spiegelman, D., Caulfield, L. E., and Nutrition Impact Model Study (2013) 'The effect of multiple anthropometric deficits on child mortality: meta-analysis of individual data in 10 prospective studies from developing countries', *The American Journal of Clinical Nutrition 97*.4: 896-901.

Mekonnen, A., B. Tefera, T. Woldehanna, N. Jones, J. Seager, T. Alemu, and G. Asgedom (2005) *Child Nutritional Status in Poor Ethiopian Households*, Working Paper 26, Oxford: Young Lives.

Mendez, M. A., and Adair, L. S. (1999) 'Severity and timing of stunting in the first two years of life affect performance on cognitive tests in late childhood', *The Journal of Nutrition* 129.8: 1555-1562.

Menon, P., Bamezai, A., Subandoro, A., Ayoya, M.A., and Aguayo, V. (2015) 'Age-appropriate infant and young child feeding practices are associated with child nutrition in India: insights from nationally representative data', *Maternal Child Nutrition 11*.1: 73-87.

Miller, B.S., Kroupina, M. G., Mason, P., Iverson, S. L., Narad, C., Himes, J. H., and Petryk, A. (2010) 'Determinants of catch-up growth in international adoptees from Eastern Europe', *International Journal of Pediatric Endocrinology* 2010.1: 107252.

Moestue, H., and Huttly, S. (2008) 'Adult education and child nutrition: the role of family and community', *Journal of Epidemiology and Community Health* 62.2: 153–9.

Moestue, H., Huttly, S., Sarella, L., and Galab, S. (2007) ''The bigger the better' – mothers' social networks and child nutrition in Andhra Pradesh', *Public Health Nutrition* 10.11: 1274–82.

Morrow, V., Tafere, Y., Chuta, N., and Zharkevich, I. (2017) ''I started working because I was hungry': the consequences of food insecurity for children's trajectories in rural Ethiopia: a qualitative life-course approach', *Social Science & Medicine* 182: 1-9.

Nair, M., Proochista, A., and Webster, P. (2012) 'What influences the decision to undergo institutional delivery by skilled birth attendants? A cohort study in rural Andhra Pradesh, India', *Rural and Remote Health* 12.2311.

Nakicenovic, N., Alcamo, J., Grubler, A., Riahi, K., Roehrl, R. A., Rogner, H. H., and Victor, N. (2000) *Special Report on Emissions Scenarios (SRES), A Special Report of Working Group III of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press.

Nandi, A., Behrman, J. R., Kinra, S., and Laxminarayan, R. (2018) 'Early-life nutrition is associated positively with schooling and labor market outcomes and negatively with marriage rates at age 20–25 years: evidence from the Andhra Pradesh Children and Parents Study (APCAPS) in India', *The Journal of Nutrition 148*.1: 140-146.

Nandy, S., Irving, M., Gordon, D., Subramanian, S. V., and Smith, G. D. (2005) 'Poverty, child undernutrition and morbidity: new evidence from India', *Bulletin of the World Health Organization* 83.3: 210-216.

Nandy, S., and Miranda, J. J. (2008) 'Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children', *Social Science & Medicine 66*.9: 1963-1966.

NCD Risk Factor Collaboration (2016) 'Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19· 2 million participants', *The Lancet* 387.10026: 1377-1396.

Ng, S.W., and Popkin, B. M. (2012) 'Time use and physical activity: a shift away from movement across the globe', *Obesity Reviews* 13.8: 659-680.

Nolan, L.B. (2016) 'Rural–Urban Child Height for Age Trajectories and Their Heterogeneous Determinants in Four Developing Countries', *Population Research and Policy Review 35*.5: 599–629.

Ogando Portela, M. J., and K. Pells (2014) 'Risks and Protective Factors for Children Experiencing Adverse Events', in M. Bourdillon and J. Boyden (eds.), *Growing Up in Poverty: Findings from Young Lives,* 71–94, London: Palgrave Macmillan.

Okasha, M., McCarron, P., Smith, G. D., and McEwen, J. (2001) 'Age at menarche: secular trends and association with adult anthropometric measures', *Annals of Human Biology* 28.1: 68-78.

Olofin, I., McDonald, C. M., Ezzati, M., Flaxman, S., Black, R. E., Fawzi, W. W., and Nutrition Impact Model Study (2013) 'Associations of suboptimal growth with all-cause and cause-specific mortality in children under five years: a pooled analysis of ten prospective studies', *PloS one* 8.5: e64636.

Ong, K. K., and Loos, R. J. (2006) 'Rapid infancy weight gain and subsequent obesity: systematic reviews and hopeful suggestions', *Acta Paediatrica* 95.8: 904-908.

Onland-Moret, N. C., Peeters, P. H. M., Van Gils, C. H., Clavel-Chapelon, F., Key, T., Tjønneland, A., and Palli, D. (2005) 'Age at menarche in relation to adult height: the EPIC study', *American Journal of Epidemiology* 162.7: 623-632.

Outes, I., and Porter, C. (2013) C'atching up from early nutritional deficits? Evidence from rural Ethiopia', *Economics & Human Biology* 11.2: 148–163.

Outes, I., Porter C,. and Sanchez, A. (2011) 'Early Nutrition and Cognition in Peru: A Within-Sibling Estimation', IDB Working Paper Series No. IDB-WP-241, Inter-American Development Bank.

Özaltin, E., Hill, K., and Subramanian, S. V. (2010) 'Association of maternal stature with offspring mortality, underweight, and stunting in low-to middle-income countries', *Jama 303*.15: 1507-1516.

Pal, S. (2004) 'How much of the gender difference in child school enrolment can be explained? Evidence from Rural India', *Bulletin of Economic Research* 56.2: 133-158.

Parker, D., Akachi, Y., and Goodman, D. (2009) *Global Climate Change and Child Health: A review of pathways, impacts and measures to improve the evidence base* (No. indipa09/5).

Patel, V., S. Chatterji, D. Chisholm, S. Ebrahim, G. Gopalakrishna, C. Mathers, V. Mohan, D. Prabhakaran, R. Ravindran and K. Reddy (2011) 'Chronic Disease and Injuries in India', *The Lancet* 377: 413–28.

Pearce, A., Scalzi, D., Lynch, J., and Smithers, L. G. (2016) 'Do thin, overweight and obese children have poorer development than their healthy-weight peers at the start of school? Findings from a South Australian data linkage study', *Early Childhood Research Quarterly* 35*:* 85-94.

Penny, M. (2014) 'Growth and Nutrition: Round 4 Preliminary Findings', Oxford: Young Lives.

Penny, M., Jimenez, M. M., and Marin, R. M. (2016) 'Early rapid weight gain and subsequent overweight and obesity in middle childhood in Peru', *BMC Obesity* 3.1: 55.

Perkins, J.M., S.V. Subramanian, G. Davey Smith, and E. Özaltin (2016) 'Adult Height, Nutrition, and Population Health', *Nutrition Reviews* 74.3: 149-165.

Piwoz, E., Sundberg, S., and Rooke, J. (2012) 'Promoting healthy growth: what are the priorities for research and action?' *Advances in Nutrition: An International Review Journal* 3.2: 234-241.

Politzer, M., and Singh, S. (2012) 'Malnutrition problem a national shame: PM'. *livemint*. January 11 https://www.livemint.com/Politics/5v8PgCfRwqbBXffYAq8fPL/Malnutrition-problem-a-national-shame-PM.html

Ponce, C. (2012) *Nutritional Trajectories in Childhood: What factors can foster recovery from chronic malnutrition?*, Investigaciones? Pobreza y Política Social No. PM07-2011.

Pongou, R. (2013) 'Why is infant mortality higher in boys than in girls? A new hypothesis based on preconception environment and evidence from a large sample of twins', *Demography* 50.2: 421-444.

Popkin, B. M. (2009) 'Global changes in diet and activity patterns as drivers of the nutrition transition', in *Emerging Societies: Coexistence of Childhood Malnutrition and Obesity*, 1-14, Basel: Karger Publishers.

Popkin, B. M., Adair, L. S., and Ng, S. W. (2012) 'Global nutrition transition and the pandemic of obesity in developing countries', *Nutrition Reviews* 70.1: 3-21.

Popkin, B. M., and Nielsen, S. J. (2003) 'The sweetening of the world's diet', *Obesity* 11.11: 1325-1332.

Porter, C., and R. Goyal (2016) 'Social Protection for All Ages? Impacts of Ethiopia's Productive Safety Net Program on Child Nutrition', *Social Science & Medicine* 159*:* 92–99.

Prader, A., Tanner, J. M., and Von Harnack, G. A. (1963) 'Catch-up growth following illness or starvation: an example of developmental canalization in man', *The Journal of Pediatrics* 62.5: 646-659.

Prendergast, A. J., and Humphrey, J. H. (2014) 'The stunting syndrome in developing countries', *Paediatrics and International Child Health* 34.4: 250-265.

Prentice, A. M., Ward, K. A., Goldberg, G. R., Jarjou, L. M., Moore, S. E., Fulford, A. J., and Prentice, A. (2013) 'Critical windows for nutritional interventions against stunting', *The American Journal of Clinical Nutrition* 97.5:, 911–8.

Proos, L., and Gustafsson, J. (2012) 'Is Early Puberty Triggered by Catch-Up Growth Following Undernutrition?' *International Journal of Environmental Research and Public Health* 9.12: 1791–1809.

Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V., and Freeman, M. C. (2014) 'Burden of disease from inadequate water, sanitation and hygiene in low-and middle-income settings: a retrospective analysis of data from 145 countries', *Tropical Medicine and International Health* 19.8: 894-905.

Puentes, E., Wang, F., Behrman, J. R., Cunha, F., Hoddinott, J., Maluccio, J. A., and Stein, A. D. (2016) 'Early life height and weight production functions with endogenous energy and protein inputs', *Economics & Human Biology* 22*:* 65-81.

Rah, J. H., Akhter, N., Semba, R. D., De Pee, S., Bloem, M. W., Campbell, A. A., and Kraemer, K. (2010) 'Low dietary diversity is a predictor of child stunting in rural Bangladesh', *European Journal of Clinical Nutrition* 64.12: 1393.

Rampal, P. (2013) *Dynamics of Changing Nutritional Status of Children in Andhra Pradesh,* Working Paper 113, Oxford: Young Lives.

Reynolds, S.A., C. Andersen, J. Behrman, A. Singh, A.D. Stein, L. Benny, and S. Krutikova (2017) 'Disparities in Children's Vocabulary and Height in Relation to Household Wealth and Parental Schooling: A Longitudinal Study in Four Low-and Middle-income Countries', *SSM-Population Health* 3: 767-786.

Rogol, A.D., P.A. Clark, and J.N. Roemmich (2000) 'Growth and Pubertal Development in Children and Adolescents: Effects of Diet and Physical Activity', *The American Journal of Clinical Nutrition* 72.2: 521s-528s.

Ruel, M.T., J. Rivera, J.P. Habicht, and R. Martorell (1995) 'Differential Response to Early Nutrition Supplementation: Long-term Effects on Height at Adolescence', *International Journal of Epidemiology* 24.2:, 404-412.

Sanchez, A. (2009a) *Early Nutrition and Cognitive Achievement in Pre-school Children in Peru*, Working Paper 57, Oxford: Young Lives.

Sanchez, A. (2009b) 'Early Nutrition and Later Cognitive Achievement in Developing Countries', paper commissioned for the EFA Global Monitoring Report 2010: Reaching the marginalized.

Sanchez, A., G. Melendez, and J. Behrman. (2016) 'The Impact of the Juntos Conditional Cash Transfer Programme in Peru on Nutritional and Cognitive Outcomes', Lima: GRADE.

Sahn, D.E., and D.C. Stifel (2002) 'Robust Comparisons of Malnutrition in Developing Countries', *American Journal of Agricultural Economics* 84.3: 716-735.

Save the Children (2013) 'Food for Thought: Tackling Child Malnutrition to Unlock Potential and Boost Prosperity',London: Save the Children.

Schott, W., E. Aurino, M.E. Penny, and J. Behrman (2017) 'Adolescent Mothers' Height/BMI Growth Velocity in Childhood Predict Next Generation's Anthropometrics within a Three-Generational Framework in Ethiopia, India, Peru and Vietnam', *Annals of the New York Academy of Sciences* 1021: 1-22.

Schott, W.B., B.T. Crookston, E.A. Lundeen, A.D. Stein, and J.R. Behrman (2013) 'Periods of Child Growth up to Age 8 Years in Ethiopia, India, Peru and Vietnam: Key Distal Household and Community Factors', *Social Science and Medicine* 97*:* 278–287.

Sheffield, P. E., and Landrigan, P. J. (2011) Global climate change and children's health: threats and strategies for prevention. *Environmental Health Perspectives* 119.3: 291.

Sint, T.T., R. Lovich, W. Hammond, M. Kim, S. Melillo, L. Lu, and A.N. Heap (2013) 'Challenges in Infant and Young Child Nutrition in the Context of HIV', *AIDS* 27.2: S169.

Singh, A., A. Park, and S. Dercon (2014) 'School Meals as a Safety Net: An Evaluation of the Midday Meal Scheme in India', *Economic Development and Cultural Change* 62.2: 275–306.

Singh, R., and S. Sarkar (2014) *The Relationship of Household Monetary Poverty and Multidimensional Child Deprivation,* Working Paper 121, Oxford: Young Lives.

Singhal, A. (2014) 'The Global Epidemic of Noncommunicable Disease: the Role of Early-life Factors', in R.E. Black, A. Singhal, and R. Uauy (eds.) *International Nutrition: Achieving Millennium Goals and Beyond*, 123-132, Basel: Karger Publishers.

Smith, E., P. Hay, L. Campbell, and J.N. Trollor (2011) 'A Review of the Association Between Obesity and Cognitive Function across the Lifespan: Implications for Novel Approaches to Prevention and Treatment', *Obesity Reviews* 12.9: 740-755.

Stein, Z., M. Susser, G. Saenger, and F. Marolla (1975) *Famine and Human Development: The Dutch Hunger Winter of 1944-1945*, New York: Oxford University Press.

Stephenson, L.S., M.C. Latham, E.J. Adams, S.N. Kinoti, and A. Pertet (1993) 'Physical Fitness, Growth and Appetite of Kenyan School Boys with Hookworm, Trichuris Trichiura and Ascaris Lumbricoides Infections are Improved Four Months After a Single Dose of Albendazole', *The Journal of Nutrition* 123.6: 1036-1046.

Steyn, N.P., J.H. Nel, G. Nantel, G. Kennedy, and D. Labadarios (2006) 'Food Variety and Dietary Diversity Scores in Children: Are They Good Indicators of Dietary Adequacy?' *Public Health Nutrition* 9.5: 644–50.

Stratton, K., C. Howe, and F.C. Battaglia (eds.) (1996) *Fetal Alcohol Syndrome: Diagnosis, Epidemiology, Prevention, and Treatment,* National Academies Press.

Strauss, J., and D. Thomas (1998) 'Health, Nutrition, and Economic Development', *Journal of Economic Literature* 36.2: 766-817.

Streuli, N. (2012) 'Child Protection: a Role for Conditional Cash Transfer Programmes? *Development in Practice* 22.4: 588–599.

Surkan, P.J., C.E. Kennedy, K.M.. Hurley, and M.M. Black (2011) 'Maternal Depression and Early Childhood Growth in Developing Countries: Systematic Review and Meta-analysis', *Bulletin of the World Health Organization* 89.8: 608–15.

Svedberg, P. (1990) 'Undernutrition in Sub-Saharan Africa: is There a Gender Bias?' *The Journal of Development Studies* 26.3: 469-486.

Tafere, K. (2016) 'Intergenerational Effects of Early Childhood Shocks on Human Capital: Evidence from Ethiopia', Paper presented at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31-August 2.

Tafere, Y. (2012) *Beyond Food Security: Transforming the PSNP in Ethiopia for the Well-being of Children*, Working Paper 83, Oxford: Young Lives.

Thomas, D., and J. Strauss (1997) 'Health and Wages: Evidence on Men and Women in Urban Brazil', *Journal of Econometrics* 77.1: 159-185.

Tirado, M.C., P. Crahay, L. Mahy, C. Zanev, M. Neira, S. Msangi, and A. Müller (2013) 'Climate Change and Nutrition: Creating a Climate for Nutrition Security', *Food and Nutrition Bulletin* 34.4: 533-547.

Tranchant, J.-P., P. Justino, and C. Mueller (2014) *Political Violence, Drought and Child Malnutrition: Empirical Evidence from Andhra Pradesh, India*, Households in Conflict Network Working Paper Series No. 173, Brighton: IDS.

UNICEF (2015a) 'The Achievable Imperative for Global Progress', New York: UNICEF.

UNICEF (2015b) 'Committing to Child Survival: A Promise Renewed', New York: UNICEF.

UNICEF (2016) 'El Niño Eastern and Southern Africa Region Humanitarian Requirements, April 2016', New York: UNICEF.

UNICEF (2018) 'Progress for Every Child in the SDG Era', March 2018, New York: UNICEF.

UNICEF (2017) *Narrowing the Gaps: The Power of Investing in the Poorest Children*, New York: UNICEF.

ND-GAIN (n.d.) 'University of Notre Dame Global Adaptation Index Country Index', South Bend, IN: ND-GAIN.

Upadhyay, A.K., A.A. Singh, K. Kumar, A.A. Singh, I. Rudan, C. Boschi-Pinto, … and P. Mahadevia (2015) 'Impact of Indoor Air Pollution from the Use of Solid Fuels on the Incidence of Life Threatening Respiratory Illnesses in Children in India', *BMC Public Health* 15.1: 300.

Upadhyay, A.K., S. Srivastava, N. Etiler, S. Velipasaoglu, M. Aktekin, R. Sarkar, … and V. Stachour (2016) 'Effect of Pregnancy Intention, Postnatal Depressive Symptoms and Social Support on Early Childhood Stunting: Findings from India', *BMC Pregnancy and Childbirth* 16.1: 107.

Van IJzendoorn, M.H., M.J. Bakermans-Kranenburg, and F. Juffer (2007) 'Plasticity of Growth in Height, Weight, and Head Circumference: Meta-analytic Evidence of Massive Catch-up After International Adoption', *Journal of Developmental & Behavioral Pediatrics* 28.4: 334-343.

Vargas, S., and M.E. Penny(2010) 'Measuring Food Insecurity and Hunger in Peru: a Qualitative and Quantitative Analysis of an Adapted Version of the USDA's Food Insecurity and Hunger Module', *Public Health Nutrition* 13.10: 1488–1497.

Vellakkal, S., J. Fledderjohann, S. Basu, S. Agrawal, S. Ebrahim, O. Campbell, … and D. Stuckler (2015) 'Food Price Spikes Are Associated with Increased Malnutrition among Children in Andhra Pradesh, India', *Journal of Nutrition* 145.8: 1942–1949.

Victora, C.G., M. de Onis, P.C. Hallal, M. Blössner, and R. Shrimpton (2010) 'Worldwide Timing of Growth Faltering: Revisiting Implications for Interventions', *Pediatrics* peds-2009.

Vyas, S., P. Kov, S. Smets, and D. Spears (2016) 'Disease Externalities and Net Nutrition: Evidence from Changes in Sanitation and Child Height in Cambodia, 2005–2010', *Economics & Human Biology* 23*:* 235-245.

Walker, S.P., T.D. Wachs, J. Meeks Gardner, B. Lozoff, G.A. Wasserman, E. Pollitt, and J.A. Carter (2007) 'Child Development: Risk Factors for Adverse Outcomes in Developing Countries', *The Lancet* 369.9556: 145–157.

Wamani, H., A.N. Åstrøm, S. Peterson, J.K. Tumwine, and T. Tylleskär (2007) 'Boys are More Stunted Than Girls in sub-Saharan Africa: a Meta-analysis of 16 Demographic and Health Surveys', *BMC Pediatrics 7*.1: 17.

Watkins, K.L., D.A. Bundy, D.T. Jamison, G. Fink, and A. Georgiadis (2017) 'Evidence of Impact of Interventions on Health and Development during Middle Childhood and School Age', *Disease Control Priorities, (Volume 8): Child and Adolescent Health and Development* 1827.

WFP (2017) 'The Double Burden: The Combined Economic Impact of Undernutrition and Obesity in Latin America and the Caribbean', Rome: World Food Programme

Wisniewski, S.L. (2017) 'Childhood Obesity Among the Poor in Peru: Are There Implications for Cognitive Outcomes? *Economics & Human Biology* 26: 51–60.

Woldehanna, T., and A. Pankhurst (2014) 'Nutrition and Health: Round 4 Preliminary Findings*'*, Oxford: Young Lives.

WHO (2009) 'The Global Burden of Disease: 2004 Update', Geneva: World Health Organization.

WHO (2010a) 'Nutrition Landscape Information System (NLIS) Country Profile Indicators: Interpretation Guide', Geneva: World Health Organization.

WHO (2010b) 'Indicators for Assessing Infant and Young Child Feeding Practices: Part 2 – Measurement', Geneva: World Health Organization.

WHO (2011) *Global Status Report on Noncommunicable Diseases 2010,* Geneva: World Health Organization.

Yi, J., J.J. Heckman, J. Zhang, and G. Conti (2015) 'Early Health Shocks, Intra-household Resource Allocation and Child Outcomes', *The Economic Journal* 125.588: F347–F371.

Young-Hyman, D., D.G. Schlundt, L. Herman-Wenderoth, and K. Bozylinski (2003) 'Obesity, Appearance, and Psychosocial Adaptation in Young African American Children', *Journal of Pediatric Psychology* 28.7: 463-472.

Zongrone, A.A., P. Menon, G.H. Pelto, J.P. Habicht, K.M. Rasmussen, M.A. Constas, and R.J. Stoltzfus (2018) 'The Pathways from a Behavior Change Communication Intervention to Infant and Young Child Feeding in Bangladesh Are Mediated and Potentiated by Maternal Self-Efficacy', *The Journal of Nutrition* 148.2: 259-266.

Young Lives is an international study of childhood poverty following the lives of 12,000 children in Ethiopia, India (in the states of Andhra Pradesh and Telangana), Peru and Vietnam over 15 years.

Its aim is to shed light on the drivers and impacts of child poverty, and generate evidence to help policymakers design programmes that make a real difference to poor children and their families.

Young Lives

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