CHILDREN'S INVESTMENT FUND FOUNDATION

Institute of Development Studies

Ending Undernutrition:
Our Legacy to the Post 2015 Generation

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Introduction

Over 4 in 10 children under the age of 5 in South Asia and Sub-Saharan Africa are undernourished.[2] Their stunted height is a grisly marker of multiple deprivations of food intake, care and play, clean water, good sanitation and adequate health care. About 7-15% of children in the same regions are wasted, that is, very thin.[3]

Stunting and wasting in the first 1000 days after conception are depressingly accurate predictors of foregone individual and societal potential in current and future generations. During this time the body is laying down fundamental human hardware and software—and doing it very quickly with very demanding nutrient requirements. Any disturbance of this intensive activity, if not quickly reversed, has a terrible legacy.

This paper provides a brief overview of the evidence on the benefits of preventing undernutrition and why prevention would turn a dark legacy into a bright one. It brings together and summarises research on the impacts of undernutrition on mortality and morbidity; school and cognitive outcomes; psychosocial outcomes; labour force outcomes; chronic disease outcomes and GDP outcomes.

The paper argues that the multiple benefits from nutrition for development are substantial. It argues for nutrition to be positioned as a way of "supercharging" the demographic dividend that the high undernutrition countries are hoping to realise in the next 15 years.

1. Undernourished children are more likely to get sick and are less able to withstand the sickness, frequently resulting in death and disability

The prevention of undernutrition in mothers and young children would prevent at least 35% of child deaths--approximately 3 million deaths. The effect on overall disease burdens is also large. Malnutrition increases the susceptibility to infection, which in turn increases nutrient requirements and depresses appetite, which in turn makes the immune system even weaker. The latest estimates of the Global Burden of Disease show that underweight in young children is the number one risk factor for the burden of disease (for all individuals, not just children) in East, West and Central Africa and the 4th most important factor in South Asia (Figure 1).[4]

[1] I would like to thank Harold Alderman at IFPRI for excellent comments on an earlier version of this paper. All errors are mine.

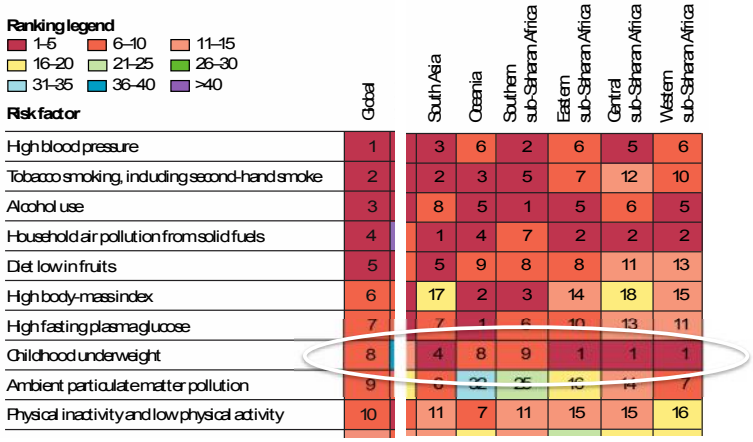
[2] de Onis, Mercedes, Monika Blössner, and Elaine Borghi. "Prevalence and trends of stunting among pre-school children, 1990–2020." *Public Health Nutrition* 1.1 (2011): 1-7.

[3] Underweight (low weight for age) is the MDG poverty and hunger indicator and is a hybrid of these two indicators.

[4] Murray, Christopher JL, et al. "GBD 2010: a multi-investigator collaboration for global comparative descriptive epidemiology." *The Lancet* 380.9859 (2012): 2055-2058. Note that corresponding estimates for stunting and wasting were not undertaken.

Figure 1: The Global Burden of Disease and Underweight (all individuals)

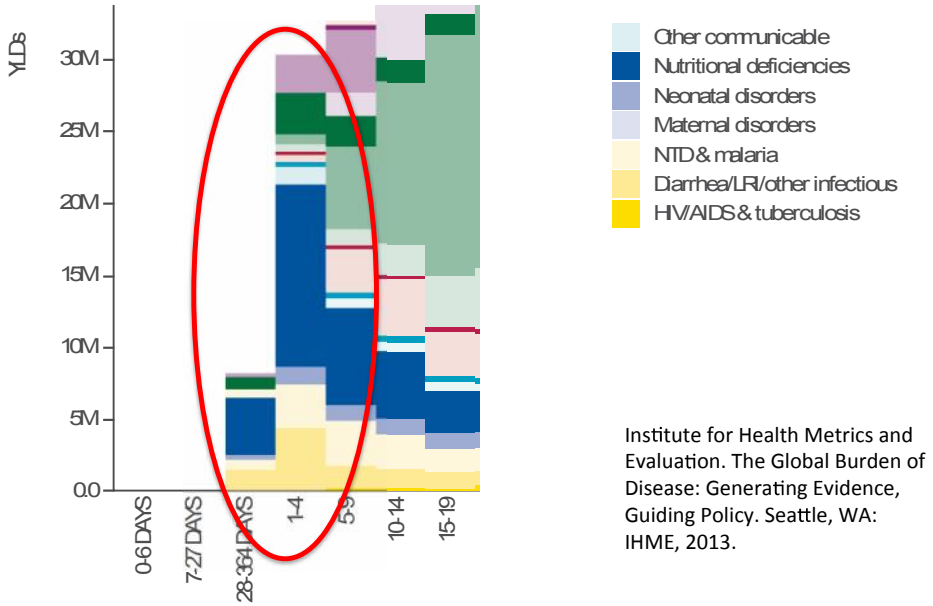
Underweight (no data for stunting) is still the biggest single risk factor for the attributable burden of disease in most of Sub-Saharan Africa and 4th in South Asia



Risk factors ranked by attributable burden of disease, 2010
Lancet. Vol 380 December 15/22/29, 2012

The Global Burden of Disease study also finds that undernutrition is responsible, globally, for one half of all years lived with disability for children under the age of 4 (the dark blue column in the left of Figure 2). Lives are lost, potential is wasted, talent is never realised.

Figure 2: Undernutrition is responsible for 50% of years lived with disability, children under 4

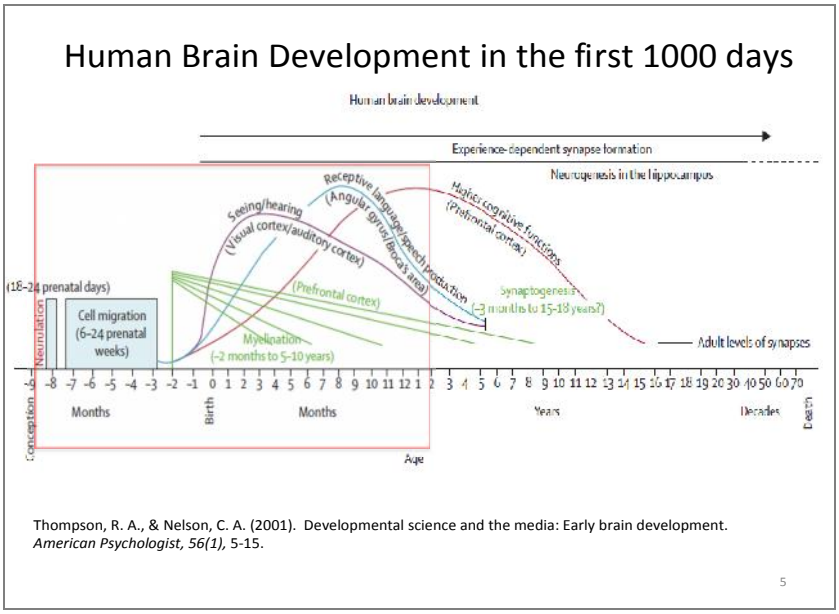


Institute for Health Metrics and Evaluation. The Global Burden of Disease: Generating Evidence, Guiding Policy. Seattle, WA: IHME, 2013.

2. Improved nutrition status improves performance in school and cognitive outcomes

Why might undernutrition prevention improve schooling outcomes and cognitive achievement? Figure 3 shows how the peak levels of activity for all brain functions are thought to occur within the 1000 day period (the red rectangle), even the higher cognitive functions.

Figure 3: Human Brain Development in the First 1000 days



There are several types of evidence that lead to the conclusion that children who avoid stunting[5] and other forms of undernutrition in the first 2-3 years of life perform better in school: (1) one study from Guatemala that looks at the relationship in a direct way by examining the long term impacts of stunting prevention from a randomized intervention, (2) studies that follow individuals from birth through to adulthood (e.g. the COHORTS collaboration) and (3) studies that examine the impacts of early childhood shocks on the educational attainment of population cohorts later in life.

(1) The Guatemala study. This is the only study of its kind in that it is a longitudinal and compares two interventions that were randomly assigned. It therefore yields the most credible estimate of the link between stunting prevention and development outcomes, although it is only one study from 4 communities. The study follows up children 25 years later who were living in communities randomly assigned into two groups: a protein plus energy supplement (Atole, proven to be highly effective in reducing stunting) and an energy only supplement, Fresco, which was proven much less effective in reducing stunting).

The first results on education outcomes were presented in Maluccio et. al. 2009.[6] They find:

"*significantly positive, and fairly substantial, effects of the nutritional intervention a full 25 years after it ended. These include increased grade attainment by women (1.2 years) via increased likelihood of completion of primary school and some secondary school; speedier grade progression by women; higher scores on reading comprehension tests for both women and men (one-quarter of a SD); and higher scores on nonverbal cognitive tests for both women and men (one quarter of a SD).*"

[5] Note, that most of the evidence on schooling, learning and wages is signaled via height. But there are other negative effects of undernutrition on these dimensions that are not picked up by height and so the true impacts of undernutrition are likely to be larger.

[6] Maluccio, John A., et al. "The Impact of Improving Nutrition During Early Childhood on Education among Guatemalan Adults." *The Economic Journal* 119.537 (2009): 734-763.

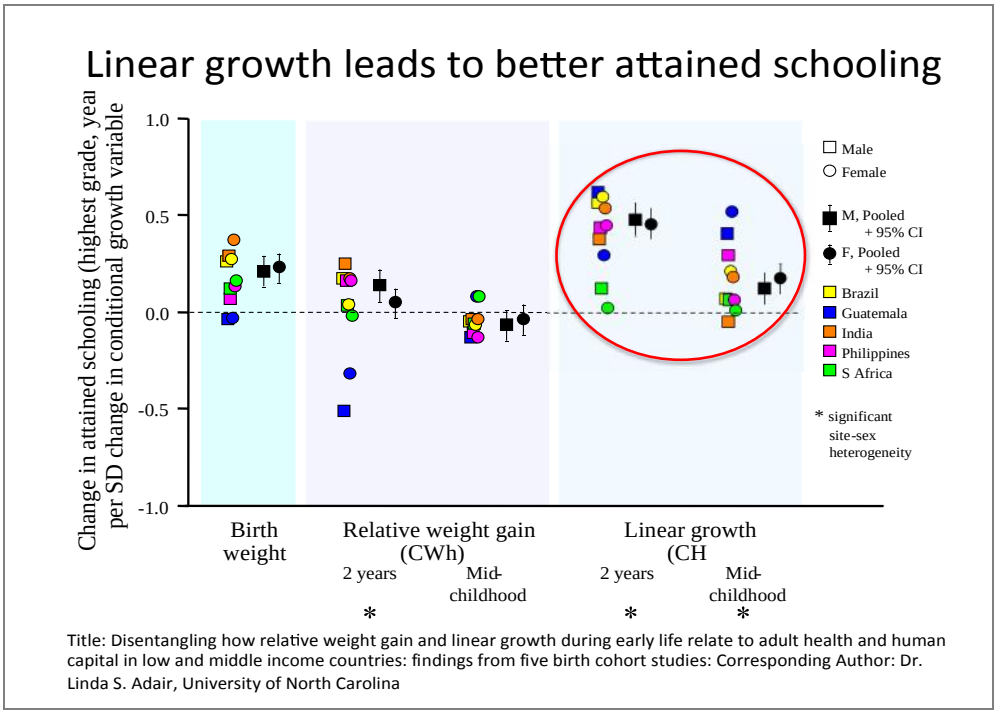
For women, an increased grade attainment of 1.2 years due to the nutritional supplement is a significant increase as the mean highest grade attainment for them was 4.3 years—an increase at the mean of over 25%.[7]

Other school and cognitive results for the Guatemala study are published in Hoddinott et. al 2011 and are presented as the difference an absence of growth failure at 36 months makes. They conclude that individuals not stunted at 36 months:[8]

- Leave school nearly 3 years later with a highest grade attained that is 3.4 higher
- Score more than a full standard deviation higher on the Successful Intelligence Assessment test (analytics) and nearly a full standard deviation on Raven's progressive matrices (nonverbal cognitive ability): these are large increases
- Are more likely to form adult partnerships with individuals with schooling attainments of nearly 4 grades higher

(2) The COHORTS study. This is a set of 5 longitudinal studies from Brazil, Guatemala (as above), India, the Philippines and South Africa.[9] The research collaborators have conducted a series of meta analyses that separate out linear growth and weight gain independent of linear growth for infant, child and adolescents and then link both features of growth to a number of young adult outcomes. Results for education outcomes are presented in Figure 4.

Figure 4: Linear Growth leads to better-attained schooling in the 5 COHORTS countries



[7] It is important to note that increased years of schooling does not automatically lead to improved cognitive outcomes: schooling and learning are not always the same thing.

[8] The Consequences of Early Childhood Growth Failure over the Life Course. John Hoddinott John Maluccio Jere R. Behrman Reynaldo Martorell Paul Melgar Agnes R. Quisumbing Manuel Ramirez-Zea Aryeh D. Stein Kathryn M. Yount. IFPRI Discussion Paper 01073 March 2011

[9] COHORTS study

From the pooled results across all 5 countries, there is significant association of linear growth (child height) for the 0-2 age group with highest grade attained (which increases by about 0.5 grades for males and females). This association does not hold for the "mid childhood" age (which is >2 to 4 years, except for the Philippines where the upper bound is 8 years). In addition, they find no association with relative weight gain. This is a powerful result because: (a) the schooling effect is much stronger for height gain compared to weight gain and (b) the effect holds only for height gain in the 0-2 age group.

(3) Studies using shocks. The final type of study is from shocks that are thought to have some randomness in their allocation. The shocks tend to be famine related. The study from China (Meng and Qian 2009) follows up cohorts of individuals who were in utero at the peak of the Chinese famine (1959-1960).[10] They conclude that exposure to famine reduced educational attainment by 0.6 years.

The study by Neelsen and Stratman (2012) examines the consequences of the Greek famine of 1941-42 on subsequent likelihood of completion of upper secondary school.[11] They estimate that being born in the cohort where there is famine exposure in utero results in a 3% reduction in the probability of subsequently completing upper secondary school. The authors give various reasons why they think this is a significant underestimate of the true consequence.

Almond and Mazumder (2010) find that being exposed to Ramadan in early pregnancy in Uganda, controlling for other confounders, has large health effects. Diurnal fasting in early pregnancy increases the likelihood of adult disability by over 20% among Uganda's Muslims and Iraqis, with substantially larger effects for mental/learning disabilities. Almond and Currie (2011) note that "The fact that Ramadan is also a relatively mild health shock leads us to consider other more commonly-experienced exposures."

In a study of the consequences of drought and civil war shocks for every young infants in Zimbabwe on their subsequent schooling attainment, Alderman, Hoddinott and Kinsey (2006)[12] conclude that if preschool children were not stunted they would have achieved an additional 0.7 grades in school.

Finally, Field, Robles, and Torero (2009)[13] explore the potential effects of a positive in utero shock in Tanzania in the 1980s: iodine supplementation during pregnancy. They find that on average there is an extra half a year of schooling, with larger improvements for girls.

3. Improved nutrition status improves labour market returns to nutrition

There are two types of study that link nutrition to economic outcomes.

(1) Direct studies: studies that can trace individuals who were stunted or not in early life and assess their economic circumstances as adults. The Guatemala study is the main study of this kind, although the other COHORT countries will join in time as their cohorts age. A second China study is also in this category although it does not have as strong an empirical design as the Guatemala study.

(2) Indirect studies: these link increases in school grades attained from not being undernourished to the economic returns to education. They tend to draw on the literature on the estimated returns to

[10] Meng, Xin, and Nancy Qian. The long term consequences of famine on survivors: evidence from a unique natural experiment using China's Great Famine. No. w14917. National Bureau of Economic Research, 2009. (country-birth year mean)

[11] Sven Neelsen and Thomas Stratmann. 2012. Early-life Famine Exposure and Later-Life Outcomes: Evidence from Survivors of the Greek Famine. George Mason University Department of Economics Paper No. 12-02

[12] Alderman, Harold, John Hoddinott, and Bill Kinsey "Long term consequences of early childhood malnutrition." *Oxford Economic Papers* 58.3 (2006): 450-474.

[13] Field, Erica, Omar Robles, and Maximo Torero. 2009. Iodine Deficiency and Schooling Attainment in Tanzania. American Economic Journal: Applied Economics 1 (4): 140–69.

increased years of schooling in the labour market. Psacharopoulos and Patrinos (2004) provide the most recent multicountry review of the labour market returns to education[14] Table 1 from their report shows the average lifetime market return to an extra year of schooling. The returns (private and social) are highest for Sub-Saharan Africa, where the levels of stunting are high and persistent.

Table 1: The Average Lifetime Market Return to an Extra Year of Schooling

Table 1. Returns to investment in education by level, full method, latest year, regional averages (%)

	Social			Private		
Region	Primary	Secondary	Higher	Primary	Secondary	Higher
Asia*	16.2	11.1	11.0	20.0	15.8	18.2
Europe/Middle East/North Africa*	15.6	9.7	9.9	13.8	13.6	18.8
Latin America/Caribbean	17.4	12.9	12.3	26.6	17.0	19.5
OECD	8.5	9.4	8.5	13.4	11.3	11.6
Sub-Saharan Africa	25.4	18.4	11.3	37.6	24.6	27.8
World	18.9	13.1	10.8	26.6	17.0	19.0

Source: Table A1.
*Non-OECD.

Direct studies

The Guatemala study--Hoddinott et. al. 2011 concludes that individuals who were not stunted at 36 months:

- Are 28% more likely to undertake work classified as skilled or white collar
- For men, a one-standard deviation increase in height- for-age at 36 months for boys raises hourly earnings by 20 percent
- For women, a similar increase raises the likelihood that they operate their own business from which they derive an independent source of income by more than 10 percentage points.
- Are 33.9 percentage points less likely to live in poor households as adults

In addition, a one-standard-deviation increase in height-for-age[15] raises the per capita consumption level of the household that they live in by nearly 20 percent.

An earlier analysis of the same data (2008 Hoddinott et. al.)[16] finds male wage rates 46% increase for men who received the Atole supplement.

The China study by Chen and Zhou (2007)[17] is similar to the Meng and Qian (2009) paper in that it analyses the consequences of the Chinese famine for those in utero in 1959. They focus on the adult labour supply of this birth cohort. They estimate the labour supply to home gardening is approximately 11% lower if the excess death rate increases by 1 per thousand people due to the famine. This is more than six times the marginal effect of the famine on total labor supply.

Indirect studies

[14] Education Economics, Vol. 12, No. 2, August 2004. Returns to Investment in Education: A Further Update. George Psacharopoulos and Harry Anthony Patrinos

[15] Note that 95% of the range of standardized height for age is covered by 4 standard deviations, so a one standard deviation increase moderately large.

[16] Hoddinott, John, et al. "Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults." *The Lancet* 371.9610 (2008): 411-416.

[17] Chen, Y. and L. Zhou. 2007. The long-term health and economic consequences of the 1959–1961 famine in China. Journal of health economics 26.4 (2007): 659-681.

A review of the literature on the economic consequences of moving a child out of the low birth weight category (Alderman and Behrman 2006)[18] concludes that:

"The estimated economic benefits, under plausible assumptions, are fairly substantial, at about $510 per infant moved from a low-birth-weight status. The estimated gains are primarily from increases in labor productivity (partially through more education) and secondarily from avoiding costs due to infant illness and death."

This is important for nutrition, because nutrition interventions have been shown to reduce low birth weight by 20%. A recent meta-analysis that included 11 trials found a significant 20% reduction in the risk of low birth weight associated with antenatal supplementation with iron alone or combined with folic acid.[19] An earlier Cochrane Collaboration review came to the same conclusion.[20]

A widely cited paper is by Horton and Ross (2003), focusing on the economic consequences of iron deficiency anemia. The study reports high losses from physical and cognitive impairments. The median loss as a percent of GDP is 4.1%. However, more recent research (Lancet Paper 1 2013) concludes that evidence for the impact of iron deficiency on child mental development is limited,[21] while the evidence for motor development is strong. Factoring this evidence in one decade later would reduce the estimated median GDP consequences to 0.6%. One can see how sensitive the estimates are to assumptions and new evidence.

It is important to note that labour market returns are not only determined by school performance and cognitive achievement. They are also influenced by psychosocial factors, although the evidence base on the consequences for labour market returns in high burden countries is sparse.[22]

Nevertheless, there is evidence that undernutrition in early childhood has a significant legacy in the psychosocial domain. Adolescents who were malnourished at 2 years of age, controlling for potentially confounding factors, show higher levels of anxiety, depression and self-esteem[23]. There are also persuasive links with suicide[24] and attention deficits in adults.[25] It is important to accumulate more evidence on the strength of this link with early undernutrition because mental health is increasing its share of the global burden of disease. As the Global Burden of Disease study showed, Major Depressive Order moved up from the 15th to the 11th most important contributor of the global burden. It is a top 10 disease contributor in every region except South Asia and SSA where it is a top 20 cause (Murray et. al. 2012).

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[18] Alderman, Harold, and Jere R. Behrman. "Reducing the incidence of low birth weight in low-income countries has substantial economic benefits." *The World Bank Research Observer* 21.1 (2006): 25-48.

[19] Imdad A, Bhutta ZA. Routine iron/folate supplementation during pregnancy: Effect on maternal anaemia and birth outcomes. *Paediatric and Perinatal Epidemiology* 2012; **26**(s1): 168-77.

[20] Pena-Rosas J, Viteri F. Effects of routine oral iron supplementation with or without folic acid for women during pregnancy (Review). 2009.

[21] Although there is evidence that the effects of iron supplementation together with psychosocial stimulation can have a significant positive effect on cognition -- see Economic Perspectives on Integrating Early Child Stimulation with Nutritional Interventions 2013. Harold Alderman, Jere R. Behrman, Sally Grantham-McGregor, Florencia Lopez-Boo, and Sergio Urzua. IFPRI.

[22] The only window into this potential effect is from a new study from Gertler et. al. which finds that children receiving 2 years of weekly family visits from Jamaican health workers helping with parenting skills around the psychosocial stimulation of under 5's led to a 42% increase in wage rates 20 years later, compared to a randomly assigned control group. Gertler, P., Heckman, J., Pinto, R., Zanolini, A., Vermeerch, C., Walker, S., ... & Grantham-McGregor, S. (2013). Labor Market Returns to Early Childhood Stimulation: a 20-year Followup to an Experimental Intervention in Jamaica.

[23] Galler, J. R., et al. "Early childhood malnutrition predicts depressive symptoms at ages 11–17." *Journal of Child Psychology and Psychiatry* 51.7 (2010): 789-798.

[24] Cheung, Yin Bun, and Per Ashorn. "Linear growth in early life is associated with suicidal ideation in 18-year-old Filipinos." *Paediatric and perinatal epidemiology* 23.5 (2009): 463-471.

[25] Galler, Janina R., et al. "Infant malnutrition is associated with persisting attention deficits in middle adulthood." *The Journal of nutrition* 142.4 (2012): 788-794.

Not only does undernutrition increase the chances of labour market losses for the current generation, it increases the chances of these effects being transferred to the next generation. Undernutrition has the ability to travel not just throughout a lifecycle but also to jump across them because stunted mothers are more likely to give birth to stunted and underweight babies.[26]

Short mothers are 3 times as likely to have children who are stunted by age 2 (Yaw Addo et. al. 2013 from Brazil, Guatemala, India, the Philippines, and South Africa)[27]. Short mothers were themselves more likely to be stunted, and so the negative legacy of malnutrition is unwittingly passed down the generations. Ending infant malnutrition breaks the cycle of malnutrition for life and for good.

4. Undernutrition early in life is a risk factor for disease and disability later in life

Increasingly the first 1000 day window is being seen not just as an opportunity to prevent undernutrition, but also to prevent overweight, obesity and the onset of chronic disease later in life (Victora et. al. 2008[28]; Uauy et. al. 2011[29]). For example, one effective way to address childhood obesity is to ensure feeding patterns very early in life reduce stunting by promoting height gain.[30] Overweight and obesity are key risks for chronic diseases later in life, such as diabetes, hypertension and some forms of heart disease.

Preventing low birth weight early in life reduces the risk of chronic disease striking decades later (Risnes et. al. 2011).[31] Risnes et. al. conclude: "This systematic review reveals evidence that lower birthweight is associated with increased all-cause mortality in men and women. The results also show strong evidence of an inverse association of birthweight with cardiovascular mortality that do not differ by sex. For cancer mortality, there was a strong positive association of birthweight with cancer mortality in men, but not in women. The findings suggest that birthweight is an indicator of developmental processes that influence long-term health. However, the available data cannot determine whether social factors, genetic factors, the intrauterine environment or life course exposures are more influential in explaining the observed associations."

The empirical evidence linking undernutrition early in life with chronic disease later in life is not as strong as the impacts on schooling and wages. On the longitudinal side, the Guatemala study (Hoddinott et. al. 2011) did not find any effects (positive or negative) on outcomes linked to greater risks of cardiovascular or other chronic diseases. The COHORTS study (Adair et. al. 2013) also failed to find any decrease or increase the levels of risk factors for chronic disease from an increase in height in the first 24 months (unlike for weight gain independent of height, which did increase the level of risk factors). This lack of strength of evidence may well be that these cohorts are not yet old enough for the chronic disease risks to manifest themselves sufficiently to be detected.

5. Malnutrition depresses GDP

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[26] Özaltin, Emre, Kenneth Hill, and S. V. Subramanian. "Association of maternal stature with offspring mortality, underweight, and stunting in low-to middle-income countries." JAMA: the journal of the American Medical Association 303.15 (2010): 1507-1516.

[27] Addo, O. Yaw, Aryeh D. Stein, Caroline H. Fall, Denise P. Gigante, Aravinda M. Guntupalli, Bernardo L. Horta, Christopher W. Kuzawa et al. 2013. Maternal Height and Child Growth Patterns. The Journal of Pediatrics

[28] Victora CG, Adair L, Fall C, et al. Maternal and child undernutrition: consequences for adult health and human capital. *Lancet* 2008; 371(9609): 340.

[29] Uauy, Ricardo, Juliana Kain, and Camila Corvalan. "How can the Developmental Origins of Health and Disease (DOHaD) hypothesis contribute to improving health in developing countries?." *The American journal of clinical nutrition* 94.6 Suppl (2011): 1759S-1764S.

[30] Bruce, Kimberley D., and Mark A. Hanson. "The developmental origins, mechanisms, and implications of metabolic syndrome." *The Journal of nutrition* 140.3 (2010): 648-652.

[31] Risnes, Kari R., et al. "Birthweight and mortality in adulthood: a systematic review and meta-analysis." *International journal of epidemiology* 40.3 (2011): 647-661.

There are a few studies that try to add up all the different components of returns to undernutrition prevention. They are forced to make a great many assumptions, nevertheless they give us a sense of the order of magnitude of the consequences of undernutrition in ways that macoeconomists can relate to. The two main initiatives are (a) the Cost of Hunger studies and (b) the Horton and Steckel study based on a review of wage rate-adult height studies.

Cost of Hunger Studies

An ambitious study linking undernutrition to economic growth via a number of mechanisms, is the 2008 study from UN-ECLAC (Martinez and Fernandez 2008) entitled the Cost of Hunger.[32] The study generates estimates from 7 Central American countries on the economic burden of underweight rates. They focus on a range of estimated benefits, with the productivity gains from labour market returns to enhanced schooling attainment being by far the largest. The calculations for all 7 countries rely significantly on an adaptation of the estimates made in a longitudinal study conducted in Chile between 1987 and 1998 (Ivanovic, 2005)[33]. The Ivanovic paper finds that individuals who were underweight under five years old are at 1.65 times the risk of repeating a grade in school compared to those who are not underweight and have similar socioeconomic characteristics.

Linking the cost of repeating a grade to economic productivity losses using estimates similar to Psacharopoulos and Patrinos (2004), the ECLAC study estimates the cumulative costs of underweight in each country. They find that the economic costs of underweight experienced by each living cohort (from morbidity, mortality and low productivity) range between 1.7% in Costa Rica to 11.4 % for Guatemala, reflecting the range of underweight from relatively low to relatively high. The economic cost of every new cohort of underweight children added is relatively small: 0.02% to 0.47% (again for Guatemala). The results for each country are presented in Table 2.

Table 2: An estimate of the economic costs of undernutrition in Central America

[32] Martinez, Rodrigo, and Andrés Fernández. *The cost of hunger: Social and economic impact of child undernutrition in Central America and the Dominican Republic*. ECLAC, 2008.

[33] Ivanovic, Danitza (2005), Factores que inciden en la permanencia del educando en el sistema educacional, en el marco de un estudio de seguimiento. Región Metropolitana, Chile, 1987-1998. INTA, Universidad de Chile. Data base reprocessed by ECLAC.

TABLE 1
INCIDENTAL RETROSPECTIVE COST OF UNDERWEIGHT IN EACH COUNTRY (2004)

	Country							TOTAL
	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama	Dominican Republic	
Total (millions of US$)	**318**	**1 175**	**3 128**	**780**	**264**	**322**	**672**	**6 659**
Percentage of GDP	1.7%	7.4%	11.4%	10.6%	5.8%	2.3%	3.6%	
Percentage of Public Social Spending	9.3%	136.6%	185.4%	80.9%	64.3%	8.5%	59.1%	

Source: Authors' compilation, based on official data from countries and ECLAC: Social Spending database.

Cumulative costs are high

TABLE 2
PROJECTION OF UNDERWEIGHT COST FOR CHILDREN UNDER FIVE (2004)

	Country							TOTAL
	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama	Dominican Republic	
Total NPV (millions of US$)	**48**	**147**	**1 607**	**291**	**78**	**65**	**35**	**2 271**
EAC (millions of US$)	3.9	11.8	129.4	23.4	6.3	5.2	2.8	182.9
Percentage of Public Social Spending	0.12%	1.37%	7.67%	2.43%	1.53%	0.22%	0.25%	
Percentage of GDP	0.02%	0.07%	0.47%	0.32%	0.14%	0.04%	0.02%	

Annual future costs are relatively small

This methodology is being applied to Africa by researchers at the African Union Commission. Preliminary results are shown below—with GDP losses varying by country (from 1.9 to 16.5 percent). The full report is not yet available. When it is it will be important to see how the methodology has been adapted for the 4 African countries.

The following data, and all data in this document, are preliminary and are currently under consideration by the national governments in each of the participating countries. The values have been reviewed at technical level at national workshops; however, readers shall refrain from quoting these values until the COHA reports are officially approved and launched at national level.

Country	Losses in Local Currency	Losses in USD	Equivalent % of GDP
Egypt	EGP 20.3 billion	$3.7 billion	1.9%
Ethiopia	ETB 55.5 billion	$4.5 billion	16.5%
Swaziland	SZL 783 million	$76 million	3.1%
Uganda	UGX 1.8 trillion	$899 million	5.6%

Source: The Cost of Hunger in Africa. The Social and Economic Costs of Child Undernutrition Preliminary Results from Four Pilot Countries in Africa. Presented to the African Union Conference of Ministers of Economy and Finance and Conference of African Ministers of Finance, Planning and Economic Development of the Economic Commission for Africa March 2013, Abidjan, Cote d'Ivoire

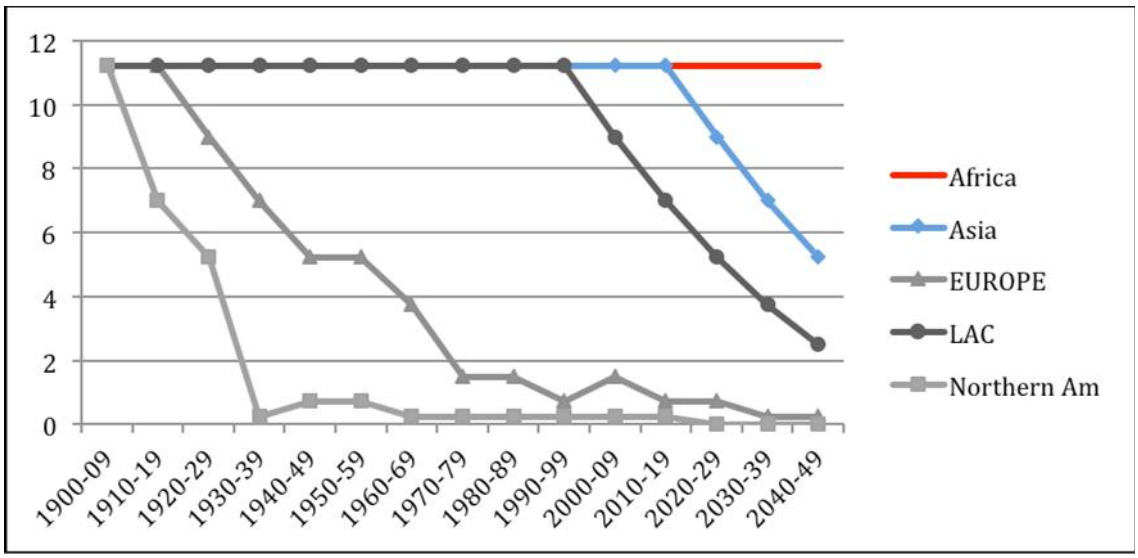
The Horton and Steckel Study

The newest economic growth study is by Horton and Steckel (2013)[34]. They estimate that global GNP lost to undernutrition in the 20th century was 8%, declining to 6% by 2050 (on the basis of business as usual). The

[34] Malnutrition. Global economic losses attributable to malnutrition 1900-2000 and projections to 2050. Sue Horton and Richard H. Steckel. 2013. In "The Economics of Human Challenges", ed B. Lomborg. In Press. Cambridge University Press.

estimates for Africa and Asia are for GDP losses of 11%, which will begin to decline for Asia before 2019 but will remain at 11% for Africa until 2050 unless action is taken (Figure 5).

Figure 5: Estimated % of GNP lost due to poor nutrition, geographic regions, 1900-2010, and projections 2010-50



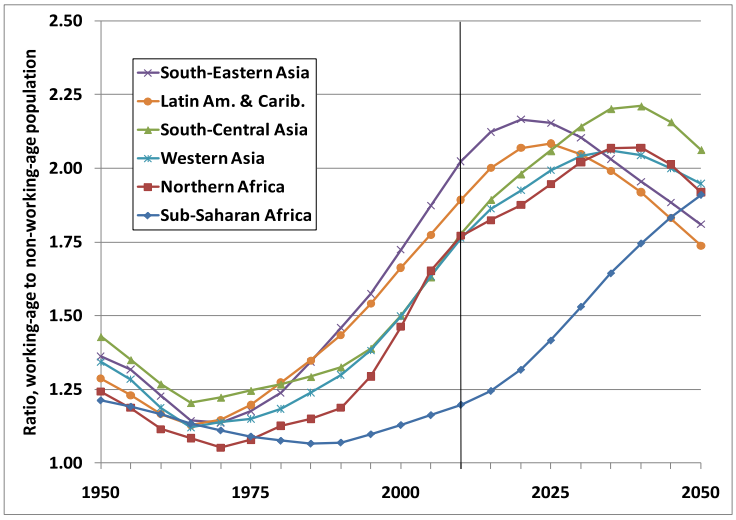
These estimates hinge on a rigorous review of rigorous studies estimating the relationship between male height and wage rates. Height is used as a proxy for improved nutrition. The studies from the developed countries show a median effect of a one cm increase in height on wages of 0.5% where mean height is 178cm. The corresponding median effect is 4.5% on wages for developing countries where mean height is 170 cm. They model the tapering off of this effect between 170 cm and 178cm (zero thereafter) as heights increase. They consider their estimates as conservative (they assume no increase in productivity loss below 170 cm; using height as a nutrition proxy does not fully capture micronutrient and calorie effects on work productivity; the productivity of other factors of production beyond labour are not assumed to be improved by better human nutrition). Their GDP estimates do not factor in health care costs of any non-communicable diseases whose onset is not delayed due to undernutrition.

6. Nutrition can Supercharge the Demographic Dividend

When death rates and birth rates converge, populations grows more slowly. The group of individuals born during the period when there is a big gap between birth and death rates are often called "baby boomers". They are born in a period when death rates are low but birth rates are yet to follow suit. In much of the developing world these "boomers" are now beginning to enter working age. When large groups of people enter labour force age and a smaller number of infants are born after them, the ratio of working age to non-working age population increases. The ratio of working age to non working age populations are yet to peak (Figure 6).

Figure 6: The Potential Demographic Dividend

Figure 2: Projections of the Ratio of Working Age to Non Working Age Population



Bloom and Canning 2011[35]

This increasing ratio has the potential to act as a spur to economic growth. This potential is called the "demographic dividend". Most estimates suggest that a demographic dividend would add 1-3% to economic growth rates (Eastwood and Lipton 2011)[36].

A significant proportion of the potential dividend works through the labour market. There will be large cohorts of young people entering the labour force and if enough of them can find productive work they will boost growth. Broad based growth is best developed via wide access to education. This is thought to be one key factor for earlier onset of high growth rates in China compared to India (Bloom and Canning 2011). The potential dividend would be further enhanced by more rapid fertility declines. The main public policy actions to accelerate fertility decline are the expanded use of family planning services and the increased survival chances of new-borns through improved public health provision (Cleland 2012)[37].

It is clear that Investments in nutrition can help realise the potential demographic dividend. Consider each of the factors thought to be vital to the delivery of the dividend. First, as we have seen from the evidence children who are not malnourished do better in school, earn more in the labour market, are more likely to own their own sustainable business, and are less likely to live in poor households as adults. Second, stunted children are more likely to die as children who are not. The faster the child death rate declines, the faster desired fertility will decline. Hoddinott et. al. 2011 found that Guatemalan women not stunted at age 36 months were less likely to experience stillbirths or miscarriages and had 1.86 fewer pregnancies.

Conclusions

If undernutrition in the first 1000 days can be prevented, we can turn this dark legacy into a bright one by locking in these benefits forever--throughout the life cycle and across the generations. Table 3 summarises some key findings

Table 3: Key Findings from Review

[35] Bloom, D. and D. Canning. January 2011. Demographics and Development Policy. PGDA Working Paper No. 66. Harvard University

[36] Eastwood, R. and M. Lipton. 2011. The demographic dividend: retrospect and prospect. University of Sussex. Department of Economics. Brighton. UK

[37] Cleland, J. 2012. Will Africa Benefit from a Demographic Dividend? November. http://www.heart-resources.org/wp-content/uploads/2012/12/Demographic-Dividend-November-2012.pdf

Undernutrition = 11% of GNP in Asia and Africa Undernutrition = 2-11% of GDP in Central America		
45 % of all under 5 child deaths (3 million deaths) are caused by undernutrition: multi country	Underweight remains the number one contributor to the Burden of Disease in Sub-Saharan Africa and number 4 in South Asia	Reducing stunting adds about one grade to school attainment: multi country
One extra cm of adult height corresponds to a 4.5 % increase in wage rates: multi country	Guatemala: • Hourly earnings up by 20% • Wage rates up by 48% • 33% more likely to escape poverty • women 10% more likely to own their own business	The economic benefit of preventing LBW is $510 per infant: multi country
Preventing undernutrition and low birth weight early in life reduces the risk of chronic disease striking decades later	Stunted women are 3 times as likely to give birth to children who are stunted by 2 years of age	Preventing undernutrition will supercharge the demographic dividend

If these benefits are so large, why are they so difficult to realise?

First, income growth does not take care of malnutrition automatically. It helps, but it is not nearly enough. Second, most parents cannot do it on their own. They don't have the money, time, information or know-how needed to prevent these deficits occurring. Third, markets cannot be relied on to resolve the situation on their own: most malnutrition is invisible, irreversible and intergenerational—all three features constrain market solutions and demand public action.

But public action is held back by a number of factors. Sometimes governments are oblivious to the extent of the problem. Sometimes they fail to grasp the magnitude and kaleidoscopic breadth of the consequences for their nation's development prospects. Often they do not know what to do or where to start. Finally, even with all the commitment in the world, they simply may not have the human, organisational or financial capacity to reduce malnutrition.

This is why public action has to take place at three levels.

First, scale up a set of proven nutrition interventions.

As Figure 6 illustrates, the benefit cost ratios (BCR) of investing in proven nutrition interventions are large, ranging from 4-54 with a median of approximately 20.

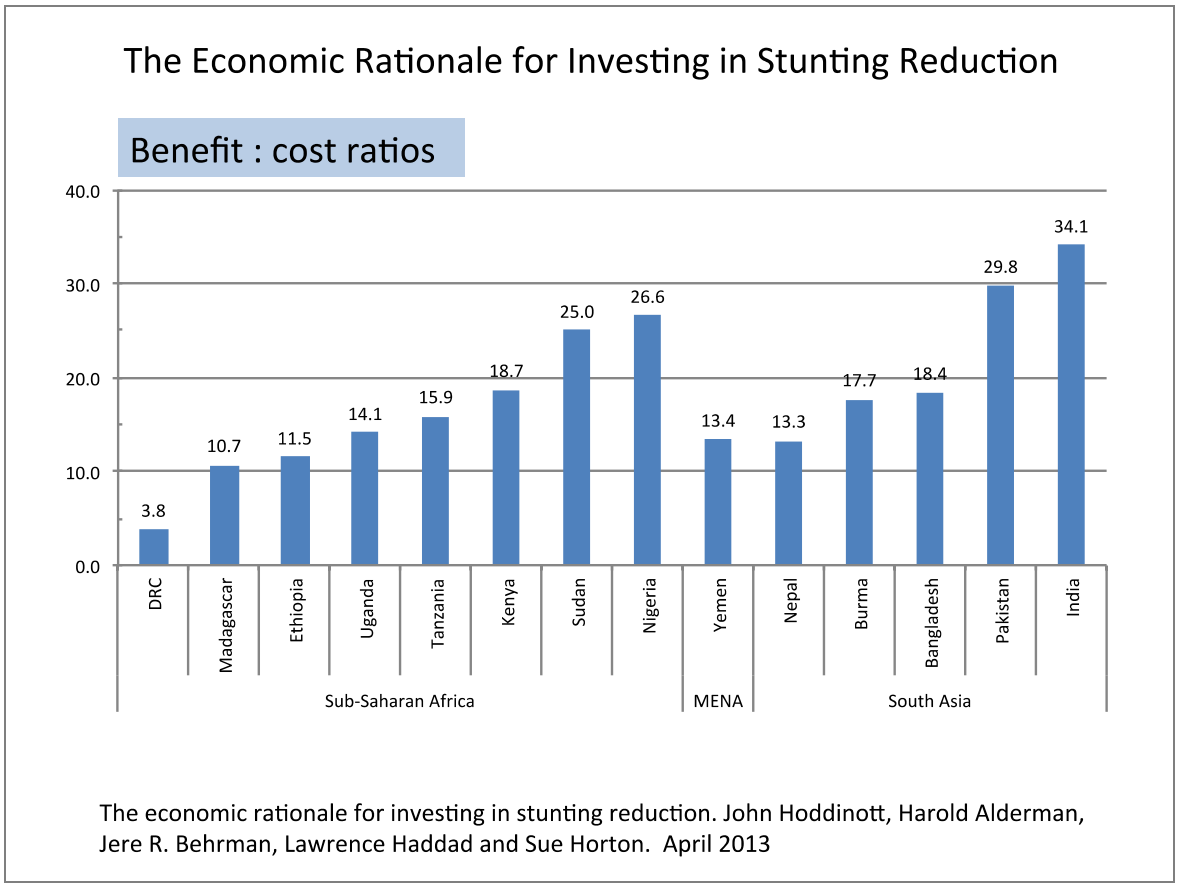
These ratios compare favourably to BCRs from investments[38] in:

- large scale irrigation in 11 sub-Saharan Africa, with BCRs in the 10-50 range (Zhi You 2008)

[38] UNEP 2010. "Share the Road: Investment in Walking and Cycling Road Infrastructure" UNEP, November 2010
WHO 2012. Global costs and benefits of drinking-water supply and sanitation interventions to reach the MDG target and universal coverage. WHO/HSE/WSH/12.01. http://www.who.int/water_sanitation_health/publications/2012/globalcosts.pdf
Zhi You, L. 2008. Africa infrastructure country diagnostic: Irrigation Investment Needs in Sub-Saharan Africa. June. World Bank. http://www.eu-africa-infrastructure-tf.net/attachments/library/aicd-background-paper-9-irrig-invest-summary-en.pdf

- water and sanitation with BCRs in the range of 2-3 for the sub Saharan region overall (WHO 2012), and
- road infrastructure in urban Kenya with BCRs of 11-61 (UNEP 2010)

Figure 6: Benefit Cost Ratios for Investing in Stunting Reduction



The economic rationale for investing in stunting reduction. John Hoddinott, Harold Alderman, Jere R. Behrman, Lawrence Haddad and Sue Horton. April 2013

Second, design programmes in supporting areas that attack the underlying causes of malnutrition: in agriculture, social welfare, education, women's empowerment and water, sanitation and hygiene.

Finally, develop an enabling environment to advocate for and support these interventions and to hold various actors accountable for the quality of their nutrition relevant actions.

If we don't act, our failure to prevent undernutrition in young children represents the most blatant squandering of human potential imaginable.