Reduce malnutrition in Sub-Saharan Africa

John Hoddinott, Cornell University

Summary[20]

Reducing malnutrition in Africa has both intrinsic and instrumental value. Better nourished populations are more economically productive. Children better nourished during the first 1000 days (*in utero* and the first two years of life) will be more productive as adults, increasing country GDP. Interventions that prevent malnutrition are excellent investments; for the median African country in our sample, the Benefit: Cost Ratio (BCR) for investments that reduce chronic undernutrition in children is 13.6.

Background

Nutrition has always been important to development. Good nutrition allows for healthy growth and development of children, inadequate nutrition is a major contributing factor to child mortality and obesity leads to poor health and premature death. Put simply, improving nutrition is intrinsically valuable. A large and growing body of evidence now shows that good nutrition is also important for economic development.

Malnutrition encompasses both undernutrition (see Box 1) and overweight/obesity.[21] While there have been improvements since 2000, undernutrition in sub-Saharan Africa remains pervasive. Across Africa, 58 million (31 percent) of children under the age of 5 are chronically undernourished and as of 2013, no country had a stunting prevalence of less than 13 percent (WHO, 2017). More than 14 million are acutely undernourished (6.1 percent) (WHO, 2017). Micronutrient deficiencies in children under five are also widespread: 41 percent of children are Vitamin A deficient; 40 percent are iodine deficient; 20 percent suffer from iron deficient anemia; and 24 percent are zinc deficient (Black et al, 2013).

Africa's future economic success lies in increasing human capital – schooling, knowledge and skills that will allow Africans to compete and thrive in a global economy. Human capital is an important determinant of labour productivity; raising labour productivity lies at the heart of raising incomes across Africa. In debates regarding African economic development strategies, it had long been assumed that increasing human capital comes about through investments in the formal education system, but this is only partially true. Investments in nutrition – particularly in the nutrition of very young children – are equally important.

To understand the economic effects of malnutrition, consider chronic undernutrition in the first 1000 days (pregnancy and the first two years of life). There is abundant evidence that this has long term adverse consequences. One manifestation of these is attained stature in adulthood. Data from several countries including Senegal, South Africa and Zimbabwe (Stein et al, 2010; Alderman et al, 2006) show that growth failure in the first 24 months of life is associated with reduced stature in adulthood. The economic consequences are captured by evidence showing associations between height and outcomes in the labor market.

Box 1: What do we mean by undernutrition?

Undernutrition reflects inadequate intake of nutrients: calories, proteins and micronutrients. There are two manifestations of undernutrition: anthropometry (height and weight); and micronutrient deficiency. The World Health Organization (WHO) has developed and validated anthropometric standards for children. One important measure pertains to chronic

[20] This paper draws heavily on text found in Hoddinott (2016) but provides updated BCR calculations. I thank Bjorn Larsen and an anonymous reviewer for helpful comments on an earlier draft.

21 While the prevalence of obesity across much of sub-Saharan Africa is low, there are places and groups (such as adult women in southern Africa) where it is rising rapidly (Ng et al, 2014).

undernutrition. A child is considered chronically undernourished, or stunted, if - relative to WHO reference standards for healthy, well-nourished children - a child is too short given her age and sex. A second is acute undernutrition. A child is considered acutely undernourished, or wasted, if – again relative to WHO reference standards for healthy, well-nourished children – she is too thin given her height. The human body needs approximately 20 different micronutrients of which four – iodine, Vitamin A, iron and zinc – are especially important.

More importantly, chronic undernutrition has neurological consequences that lead to cognitive impairments – see Box 2. These cognitive impairments result in children starting school later, dropping out earlier and attaining fewer grades of schooling. Longitudinal studies that have followed individuals for several decades show that, in adulthood, those persons who were chronically undernourished as pre-schoolers scored poorly on tests of cognitive ability. They earned lower wages and, for women, had more children (Hoddinott et al, 2013b).

These links – poor nutrition to damaged cognitive abilities to poorer schooling outcomes to poor cognitive abilities in adulthood to lower economic productivity – are the economic rationale for investing in efforts to reduce malnutrition.

Do economic benefits justify investments that reduce undernutrition?

How strong is the economic case for investments that reduce undernutrition? There are three complementary ways of answering this question: Measuring the cost of doing nothing in terms of lost GDP; measuring the benefits of working towards the World Health Assembly targets for nutrition; and by calculating BCRs associated with investments in nutrition.[22] This requires:

- Identifying a set of interventions that have been demonstrated to reduce dimensions of undernutrition
- Costing these interventions
- Calculating the economic benefits derived from their implementation
- Comparing the ratio of benefits to costs

Box 2: How does chronic undernutrition affect cognitive abilities, schooling and wages?

Undernutrition in early life damages children's brains. Early life malnutrition damages the hippocampus by reducing dentrite (branch like structures, which receive signals sent along axons) density. This adversely affects spatial navigation and memory formation. In severely malnourished children, dentrites in the occipital lobe (responsible for the processing of visual information) and in the motor cortex are damaged, leading to delays in the evolution of locomotor skills. Malnutrition results in reduced myelination of axon fibers thus reducing the speed at which signals are transmitted. The cognitive impairments experienced in early life have long-term effects on children's ability to learn. Two studies – one in Guatemala and one in Zimbabwe – have traced children from infancy (when their nutritional status was first measured) to adulthood. In both countries, a one standard deviation increase in Height-for-Age z (HAZ) scores increases grade attainment by approximately 0.75 grades; in Zimbabwe, shifting a child from being stunted to being well-nourished would increase schooling by 1.25 grades. In Guatemala, a one standard deviation increase in HAZ increases *adult* test scores for reading and nonverbal cognitive skills by 0.28 and 0.25 SDs respectively.

Work by Bhutta et al (2013) has identified 10 interventions that will significantly reduce undernutrition. The logic behind these is that well-nourished children require well-nourished mothers and so measures to reduce

22 Seven African governments estimated the costs of hunger and malnutrition in terms of GDP lost because of illness, avertable mortality, grade repetition, school dropout and reduced productivity (see costofhungerafrica.com). The median estimate was a loss of 7.7 percent of GDP. Hoddinott (2016) calculates the cumulative addition to GDP associated with accelerating investments to meet the World Health Assembly 2025 target for stunting reduction for 15 African countries over the period 2035 – 2060, finding that of these targets were met, GDP would increase by $83 Billion (2016) US.

undernutrition should focus primarily on these two groups. The interventions they identify are:

1. Universal salt iodization
2. Multiple micronutrient supplementation during pregnancy
3. Calcium supplementation during pregnancy
4. Energy protein supplementation during pregnancy
5. Vitamin A supplementation during childhood
6. Zinc supplementation during childhood
7. Breastfeeding promotion
8. Complementary feeding education
9. Complementary food supplementation
10. Management of severe acute malnutrition

Bhutta et al (2013) estimate that scaled up at 90 percent coverage, this package of interventions would reduce severe acute undernutrition by 61 percent, stunting by 20 percent and, globally, would save nearly one million deaths per year.

The per-child cost of this package is currently estimated to be $130; see Appendix 1 for details. What about the economic benefits? In this note, we focus on chronic undernutrition. The best estimate of its malign economic impact comes from Hoddinott et al (2013b) who show that in adulthood, per capita incomes of individuals who were not stunted at age 2y were 66 percent higher compared to individuals who were stunted at age 2y. This increase comes about through the impact of improved nutrition on income through higher schooling, better cognitive skills, greater height, reduced fertility and other channels (Hoddinott et al, 2013b). But this package of interventions only reduces stunting by 20 percent and coverage is estimated to be 90 percent. So, on average, implementing this package would raise incomes by 11.8 percent.

Now consider the following. Suppose a country, say Senegal, were to fully implement this package over time; specifically, that the package is scaled up gradually over a nine-year period (see Appendix 1 for details). As instructed, we use as a base year 2018. We assume the beneficiaries of this package, children under the age of two, enter the labour force in 2037. Median per capita income in Senegal in 2037 is projected to be $2,874. (See Appendix 1 for full details on these calculations.) If this package were implemented, median incomes would be 11.8 percent higher. This implies a gain of $258; in present value (2018) terms using a five percent discount rate, this is an increase of $134. However, we adjust this number to account for the gradual scale up of coverage so for 2037, the present discounted value of the gain is $7 (because coverage in the first year that the package is implemented is assumed to be only 5%). Adding these up from 2037 to 2063 yields an increase in income of $2,374. Given a cost of $130, the benefit cost ratio is 18.3.

Note that the calculation of this BCR is sensitive to the discount rate, the costing of the 10 interventions, assumptions regarding the magnitude of the impact on incomes, how quickly these programs are scaled up and the duration over which benefits are calculated.[23] Generally, these calculations are constructed so as to be conservative: the cost of the interventions has been raised relative to the data described in Bhutta et al (2013), a relatively high discount rate is used and we only count these benefits until middle age. These estimates do not account for additional monetary benefits that certain components of the package generate. For example, universal salt iodization and iron supplementation have direct effects on economic productivity (through improved cognition and work effort respectively) which are not accounted for here. Further, no monetary value is ascribed to reduced morbidity or mortality that results from these interventions.

Table 1 shows BCR calculations for 15 African countries with a total population of 515 million people. The BCR for the median country is 13.6.

Any investment with a benefit: cost ratio that exceeds one is a good investment. By this standard, investments to reduce chronic

23 For example, using a more conservative income gain and a longer period to scale up interventions, Galasso and Wagstaff (2019) come up with a population weighted BCR estimate of 9.

undernutrition are excellent investments. Even under conservative assumptions –the benefit: cost ratios are high.[24] These economic benefits derive largely because averting chronic undernutrition gives children greater capacity to learn, learning is rewarded in the labour market with higher wages.

TABLE 1: BENEFIT: COST RATIOS ASSOCIATED WITH REDUCTION IN STUNTING IN 15 AFRICAN COUNTRIES

Country	Benefit: Cost ratio
Benin	14.0
Chad	18.6
Ethiopia	14.6
Lesotho	9.3
Madagascar	5.1
Malawi	6.0
Mali	12.2
Niger	14.8
Nigeria	14.5
Rwanda	9.9
Senegal	18.3
Togo	13.6
Uganda	15.0
United Republic of Tanzania	12.0
Zambia	10.9
Median BCR	13.6

Source: Author's calculations.

References

Alderman H., Hoddinott J. and Kinsey B., 2006. Long term consequences of early childhood malnutrition. *Oxford Economic Papers* 58, 450-474.

Black, Robert E., et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet* 382.9890 (2013): 427-451.

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

Diofasi, A. and N. Birdsall, 2016. The World Bank's Poverty Statistics Lack Median Income Data, So We Filled In the Gap Ourselves, http://www.cgdev.org/blog/world-bank-poverty-statistics-lack-median-income-data-so-we-filled-gap-ourselves-download-available accessed June 30, 2019.

Galasso, E. and A. Wagstaff, 2019. The aggregate income losses from childhood stunting and the returns to a nutrition intervention aimed at reducing stunting. *Economics and Human Biology.*

Hoddinott, J., 2016. The economics of reducing malnutrition in sub-Saharan Africa. Global Panel on Agriculture and Food Systems for Nutrition working paper.

Hoddinott, J., H. Alderman, J. Behrman, L. Haddad and S. Horton, 2013a. The economic rationale for investing in stunting reduction, *Maternal and Child Nutrition*, 9(Suppl 2): 69-82.

Hoddinott, J., J. Maluccio, J. Behrman, R. Martorell, Paul Melgar, Agnes R. Quisumbing, Manuel Ramirez-Zea, Aryeh D. Stein, and Kathryn M. Yount, 2013b. Adult consequences of growth failure in early childhood, *American Journal of Clinical Nutrition*, 98: 1170-1178.

Ng, M. et al, 2014. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 384(9945): 766-781.

Stein A. D., Wang M., Martorell R., Norris S.A., Adair L.S., Bas I.et al., 2010. Growth patterns in early childhood and final attained stature: Data from vive birth cohorts from low- and middle-income countries. *American Journal of Human Biology* 22, 353-359.

[24] Note that these BCRs differ slightly from those found in Hoddinott et al (2013a) and in Hoddinott (2016) because of some technical changes in the assumptions used to generate them, most notably the switch to basing these on median (and not mean) per capita incomes and the use of a different scale up period.

World Health Organization (WHO). 2017. *Nutrition in the WHO African Region*. Brazzaville: World Health Organization.

Appendix 1:

Estimating Benefit: Cost Ratios associated with reduction in stunting:

These benefit: cost ratios (BCRs) focus on the economic benefits associated with the reduction of stunting created by investing in nutrition-specific interventions. Calculating these requires the following information and assumptions:

- What is the time frame over which these calculations are made?
- How much does the intervention cost?
- What percent of the population will it reach?
- How effective is the intervention?
- By what percent does it increase income?
- What is the counterfactual – what would incomes be in the absence of this intervention?
- Because benefits accrue in the future, what discount rate is used to estimate the present value of these benefits?

What is the time frame over which these calculations are made?

Following the instructions provided by the Copenhagen Consensus Center, these calculations are based on a cohort of individuals born in the year 2018. It is assumed that they enter the workforce in 2037. I calculate benefits based on their employment in the labour force until the year 2063. Allowing benefits to accrue over a longer period will increase the BCRs; reducing the time period would reduce them.

How much does the intervention cost?

The 10-item intervention package described in Bhutta et al (2013) is estimated to cost on a per child basis, for African countries, $102.50 in 2013. Hoddinott (2016) assumed that by 2018, because of inflation this cost would increase by 15% to $118. To bring this up to date, it is assumed that this has further increased in cost by 10 percent to $130. Bhutta et al (2013) note that the costs of this package of interventions do not differ across African countries; we adopt their assumption here.

What percent of the population will it reach?

In the work by Bhutta et al (2013), they assume that these interventions, scaled up, would reach 90 percent of children. We assume that the package is scaled up gradually: 5% coverage in the first year; 10% coverage in the second year; 15% coverage in the third year; 20% coverage in the fourth year; 40% coverage in year five; 50% coverage in year six; 60% coverage in year seven; 70% coverage in year eight before reaching 90% coverage in the ninth year.

How effective is the intervention?

Bhutta et al (2013) estimate that this package of interventions would reduce stunting by 20 percent if coverage was 90%.

By what percent does it increase income?

Hoddinott et al (2013b) show that switching someone from being stunted at age 24 months to being not stunted at age 24 months raises their per capita consumption in adulthood (consumption is a proxy for income; it is less susceptible to measurement error and is a less volatile measure) by 66 percent. But recall that the implementation of this intervention package reduces the prevalence of stunting by only 20 percent and that coverage in practice is estimated to be 90 percent. Thus, the implementation of this package raises incomes by (66% x 0.20 x 0.90) = 11.8%.

What are counterfactual incomes?

We begin with a current estimate of per capita incomes, specifically median per capita incomes reported in PPP dollars as calculated by Diofasi and Birdsall (2016) for countries where current estimates (2010 or later) are available. Earlier work (Hoddinott et al, 2013a) used mean per capita incomes but this is problematic for countries with significant levels of inequality as it overstated the benefit streams from investing in nutrition. The median tells us how much the "typical" African earns (or consumes) in a year. These data are reported in PPP dollars; the PPP conversion factors reported in the World Bank development indicators database to convert the median per capita incomes to nominal US dollars.

Next, recall that the individuals benefitting from these interventions do not start working until the year 2037. What will their incomes be in that year in the absence of these interventions? We begin by taking these median per capita incomes and applying the projected economic growth rates for Africa for the period 2037-2063. This growth rate, calculated by the IMF and World Bank (and used on other projection exercises such as those associated with climate change projections), is 3.5 percent per year. Using this growth rate, we estimate per capita median income in 2037. As an example, for Senegal we estimate that per capita median income in 2037 will be $2,874.

What would their incomes be in that year if these interventions were implemented? Based on the estimated impact of investing in this package of interventions, they raise incomes by 11.8 percent. So if these interventions in Senegal took place, per capita median income in 2037 would be ($2,874 + ($2,874 x 11.8%)) = $3,199. The increase in income is $339.[25] (Note that when we do our calculations, we need to adjust this so that it is expressed in present value terms and that we need to take into account that coverage of the package of interventions in the first year is only 5%). We calculate these increases in income for every year from 2037 to 2063.

What discount rate is used?

Following the instructions provided by the Copenhagen Consensus Center, these calculations are based on setting the discount rate at 5%. Discounting is done back to 2018 so all monetary figures are expressed in 2018 US dollars.

Which countries can this increase be calculated for?

These calculations require data on median per capita consumption dated 2010 or later, data on population size and projected population growth and data on the prevalence of stunting dated 2010 or later. Twenty African countries meet these criteria. However, for several countries there are reasons to expect that these median incomes are not a good guide either because of subsequent health crises (Ebola in Guinea), civil unrest (Democratic Republic of Congo; Guinea-Bissau) or because the economy is heavily reliant on mining (South Africa, Namibia). This leaves the following countries: Benin; Chad; Ethiopia; Lesotho; Madagascar; Malawi; Mali; Niger; Nigeria; Rwanda; Senegal; Togo; Uganda; United Republic of Tanzania; and Zambia.

[25] Note in the accompanying spreadsheet, the income gains reported adjust for the gradual increase in coverage.