ALL HANDS ON DECK

Reducing Stunting through Multisectoral Efforts in Sub-Saharan Africa

WORLD BANK GROUP

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Abbreviations, Acronyms

AFDM	African Flood and Drought Monitor
BO	Blinder-Oaxaca
CCT	Conditional Cash Transfer
CDF	Cumulative Density Function
CLM	Agency in Charge of the Fight against Malnutrition
CRECER (To Grow)	National Strategy for Combating Poverty and Chronic Child Malnutrition in Peru
CSO	Civil Society Organization
DDS	Dietary Diversity Score
DHS	Demographic and Health Surveys
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GNI	Gross National Income
HAZ	Height-for-age Z
HFIAS	Household Food Insecurity Access Scale
IDA	International Development Association
IHP	International Hydrological Program
JMP	Joint Monitoring Program
LPM	Linear Probability Model
LSMS-ISA	Living Standards Measurement Study-Integrated Surveys on Agriculture
MAD	Median Absolute Deviation/Minimum Acceptable Diet (context-specific)
MDS	Ministry of Social Development and Fight Against Hunger
MPA	Multiphase Programmatic Approach
NEP	Nutrition Enhancement Program
PBF	Performance-based Financing
PCE	Per Capita Expenditures
PDF	Probability Density Function
PPP	Purchasing Power Parity
RCT	Randomized Control Trial
s. d.	Standard Deviation
SDG	Sustainable Development Goal
SPI	Standardized Precipitation Index

SSA	Sub-Saharan Africa
SUN	Scaling-Up Nutrition
UCT	Unconditional Cash Transfer
UNICEF	United Nations Children's Fund
UQR	Unconditional Quantile Regression
USAID	U. S. Agency for International Development
WASH	Water, Sanitation, and Hygiene
WFP	World Food Programme
WHO	World Health Organization

Executive Summary

Motivation

In 2014, 171 million children under the age of five had stunted growth, meaning that they were excessively short for their age.[1] In Africa, specifically, the scale of undernutrition is staggering with 58 million children under the age of five being too short for their age (stunted) and 13.9 million weighing too little for their height (wasted) (Global Nutrition Report 2016). Poor diets in terms of diversity, quality, and quantity, together with illness, are linked with micronutrient deficiencies (that is, a lack of important vitamins and minerals linked to growth, development, and immune function, such as iodine, vitamin A, and iron) and contribute to stunting, as well as poor health and development outcomes.

Income poverty and inequalities in access to basic services such as health, water, sanitation, and proper care and feeding practices, in the initial stages of children's lives are associated with delayed child growth and serious costs that are eventually borne by the rest of society. Inequities in access to *the underlying determinants* of good nutrition and long-term well-being are associated with immediate costs in child welfare: no access or access to inadequate levels of the drivers of nutrition is associated with an increase in the incidence of undernutrition and diarrheal disease. But there are also important consequences in the long term—both to the individual and society—associated with the chronic undernutrition of children: a high risk of stunting, impaired cognitive development, lower school attendance rates, reduced human capital attainment, and a higher risk of chronic disease and health problems in adulthood (Victora et al. 2010; Black et al. 2013; Hoddinott et al. 2013). Thus, inequities in access to services early in the life of a child also contribute to the intergenerational transmission of poverty.

The negative outcomes later in life are numerous, and some can even be quantified in economic terms. Recent World Bank estimates suggest that the per capita income penalty a country incurs for not having eliminated stunting when today's workers were children is around 7 percent of gross domestic product (GDP) per capita, on average. In Sub-Saharan Africa and South Asia, these figures rise to about 9–10 percent of GDP per capita (Galasso et al. 2017).

The conceptual framework developed by UNICEF highlights the basic and underlying determinants of undernutrition that include environmental, economic, and sociopolitical factors, with income poverty, and inequalities in access to services having a central role. An emphasis on policies aimed at accelerating economic development and shared income growth is generally effective at reducing undernutrition but the speed at which undernutrition declines with economic growth varies from country to country and from region to region. Thus, although growth is a necessary condition for the reduction of stunting, it is not a sufficient condition, especially in the region of Sub-Saharan Africa (SSA), where cross-country time series data suggest that the strength of the relationship between growth in real GDP and stunting is weaker in comparison to other regions in the world (World Bank 2017a).

Much of the effort to date has focused on the costing, financing, and impact of nutrition-specific interventions delivered mainly through the health sector, for the purpose of reaching the global nutrition targets for stunting, anemia, and breastfeeding and interventions for treating wasting (Shekar et al. 2016; Horton et al. 2010). However, an acceleration of the progress toward reducing stunting in the African region requires enlisting more sectors in addition to the health sector, such as agriculture; education; social protection; and water, sanitation, and hygiene in the effort to improve nutrition. Large scale '*nutrition sensitive*' interventions in these sectors will have to be able not only to address the key underlying determinants of nutrition effectively but also to intensify the role of '*nutrition-specific*' interventions (Black et al. 2013).

In recent years, there has been a significant increase in the number of initiatives at the international as well as at the country level, aiming to scale up nutrition-sensitive interventions. One prominent initiative is the Scaling-Up Nutrition (SUN) movement, whose framework is by now endorsed by 59 developing countries, the majority of which are in Africa. Also, the 'Investing in the Early Years' initiative, started in 2016, takes a holistic approach to the nature of interventions needed for the healthy physical and cognitive development of children. The initiative aims to facilitate children reaching their full potential through an increased emphasis on the good nutritional status of mothers, expecting mothers, and children, especially in their first 1,000 days of life (including 9 months in utero); exclusive and continued breastfeeding; health care; and immunization, as well as proper feeding accompanied by good hygiene practices, the role of early stimulation and age appropriate learning opportunities, and the role of nurturing care and social protection that provides buffers from poverty and stress.[2] All these initiatives are based on the premise that the determinants of undernutrition are multisectoral and that the solution to undernutrition requires multisectoral approaches.

The effectiveness and ultimate success of multisectoral approaches toward reducing stunting depends on having a more holistic view of the inequities and gaps in access to adequate levels of the underlying determinants (drivers) of nutrition, that is, care; food security; health; and water, sanitation, and hygiene (WASH). The complex interdependence *among* the underlying determinants of nutrition is usually beyond the consideration of any given sector. The targeting of communities or the integration of nutritional considerations in existing interventions of the agricultural sector, for example, is unlikely to take into consideration the status of WASH services and facilities in the communities where these agricultural interventions are being considered. In consequence, the extent to which such nutrition-sensitive interventions can ultimately accelerate or enhance the impact of nutrition-specific interventions on key nutrition outcomes can be impeded considerably by the absence of adequate WASH facilities. On the other hand, the impact of agricultural interventions on child nutrition could be enhanced considerably if they were to be accompanied by simultaneous improvements in the water and sanitation facilities in the same communities. Thus, a more holistic approach to the targeting and the 'nutrition-sensitivity' of interventions is likely to be better able to address the key underlying determinants of nutrition effectively, as well as reinforce the impacts of nutrition-specific interventions through the health sector.

This report lays the groundwork for more effective multisectoral action on reducing stunting by analyzing and generating empirical evidence useful for informing the joint targeting and, if necessary, the sequencing of sector-specific interventions in countries in SSA. The analysis in the report offers new insights on how data can be used to inform allocation decisions of different sectors that can strengthen multisectoral efforts aiming to reduce stunting. These insights are derived from widely used surveys such as the Demographic and Health Surveys (DHS) and provide a more holistic view of the multiple deprivations experienced by children with respect to the underlying drivers of nutrition and the prevalence of stunting. The analysis is based on 33 recent DHS from the Africa Region. Except for Angola, all 32 countries are part of the global SUN initiative.[3] The main selection criterion for inclusion into the group of countries analyzed is that the survey had to be quite recent, that is, collected in 2010 or later. DHS contain rather limited information on the components of food security and child care. However, this shortcoming is compensated by the availability of child anthropometric measures in all countries covered and the information on the joint distribution of access (or lack of access) to adequate levels for some of the other underlying determinants of nutrition such as access to improved water and improved sanitation (WASH) and access to health services, according to internationally accepted standards.[4]

Information about the joint distribution of the underlying drivers of nutrition is essential for identifying particularly important gaps in access to the underlying drivers of nutrition that, if addressed through joint targeting by the different sectors, can serve to strengthen the impacts of nutrition initiatives. A univariate analysis carried out independently by any given sector, such as agriculture, for specific determinants of undernutrition (for example, food security and dietary diversity) without taking into consideration other determinants of undernutrition typically in the purview of another sector (for example, water and sanitation), is unable to provide much guidance on the geographic areas where the interventions in the agriculture sector are likely to be less or more effective in terms of their effect on undernutrition. In contrast, a multivariate analysis of the simultaneous (or lack of) access to adequate food security and water and sanitation services is able to provide a more holistic view and pinpoint better the groups of children and the geographic areas where these inadequacies are prevalent, thus enabling the joint prioritization of operations, and improved cost efficiency of interventions aimed at contributing to the reduction of undernutrition in the agricultural and water and sanitation sectors.

The report also provides a fresh perspective on the relationship between household wealth and income and child undernutrition. Income is a basic determinant of nutrition underpinning much of the demand for the underlying drivers of nutrition. Specifically, two different dimensions of income are investigated: income level and income variability. A multisectoral approach aiming to increase access to the underlying determinants of nutrition needs to be cognizant of the fact that household constraints faced at different points in time may interact with utilization and behavior. The implication worthy of serious policy consideration is that multisectoral interventions against undernutrition may be more effective if accompanied by broader development policies that mitigate the impacts of weather-related risks affecting income generation.

Specifically, this report provides data-driven answers to the following questions:

1. **What is the extent to which children have inadequate access to the underlying determinants of nutrition?** Information available at the child level from the DHS allows one to get a better sense about the joint distribution of the various determinants (or drivers) of undernutrition. Information about the joint distribution of inadequate access to the drivers of nutrition is essential for better targeting and more effective programs in the context of budgetary constraints.
2. **What is the association of stunting (or low height-for-age), at any given point in time, with inadequate food and care practices, inadequate WASH, and inadequate health?** Is simultaneous access to adequate level of one or more of the underlying determinants of nutrition associated with lower stunting? Empirical evidence confirming that simultaneous access to adequate levels of two or more nutrition drivers is associated with lower stunting validates the importance of the joint targeting of interventions by different sectors in the geographic areas and populations therein where stunting is prevalent.
3. **If a multisectoral approach is not feasible, what is the sequencing of sector-specific interventions that could have the greatest impact on stunting?** For example, if budgetary constraints prevent the joint coverage of geographic areas (and/or populations within these areas) with high prevalence of stunting by sectors such as agriculture, health care, and WASH, in which sector should the limited resources be allocated?
4. **What is the role of income growth and income variability on child stunting and how does income interact with the underlying drivers of nutrition?**

The findings of this regional report are intended to stimulate and provide a blueprint for further analytic work that is operationally useful for the design of more effective multisectoral sectoral interventions on stunting at the country level in SSA. The main findings of the report are based on data on children pooled across 33 countries, thus reflecting relationships that prevail on average among stunting and access to the drivers of nutrition by children residing in different countries. The advantage of pooling data on children across many countries, based on common definitions and thresholds is not only in terms of total sample size but also in that pooling increases number of observations on children with access to adequate levels to different combinations of nutrition drivers. This advantage, however, comes at some costs. Applying definitions and using thresholds that are common across all countries tends to minimize the role of country-specific factors. As a consequence, the relationship between stunting and access to nutrition drivers derived from the sample of children pooled across countries may not necessarily reflect the relationship that may prevail within any given country. In view of these considerations, Chapter 6 of the report provides an example applying the same methodology based on data from only one country, Tanzania. In addition, a separate annex accompanying this report includes a brief for each of the 33 countries used in the report, summarizing access to the determinants of nutrition and their components as well as the simple correlation between stunting and the number of determinants. In addition, appendix C of the report presents the country-specific estimates summarizing the relationship between stunting and access to different combinations of nutrition drivers.[5]

Design and Methods

The analysis in the report is guided by the insights provided by the UNICEF conceptual framework. The UNICEF framework, first proposed in 1990 (UNICEF 1990), was one of the first attempts at emphasizing food security, environment, health, and child care practices as the main underlying determinants of child undernutrition in developing countries. A fundamental premise of this conceptual framework is that increases in access to adequate services in any one of the drivers of undernutrition, say for example, food security alone, cannot substitute for inadequate levels of access to the other drivers. While there is widespread acknowledgment of the role of the underlying determinants of nutrition, there is limited quantitative information on the size and direction of the interdependence among adequate (or inadequate) access to food security and care practices, environment, and health.

For each child, an indicator for each of the subcomponents of food security, care, WASH, and health is constructed based on available data in the DHS in the 33 countries in SSA analyzed in this report. Next, for each indicator a binary variable identifying 'adequacy' is defined using thresholds based on accepted international standards. In consideration of the complexity of the links between the underlying determinants of undernutrition and the economic situation of the family, the analysis is also carried out separately for urban and rural households and for wealthier households (top 20 percent of the asset distribution) and poorer (bottom 20 percent of the asset distribution) households. Thus, a more holistic view is provided of the extent to which adequate levels of the drivers of nutrition— adequate food and care, access to health services, and a safe and hygienic environment at the household and community level—on their own as well as in combination are associated with better nutrition as measured by HAZ scores and stunting rates.

Results

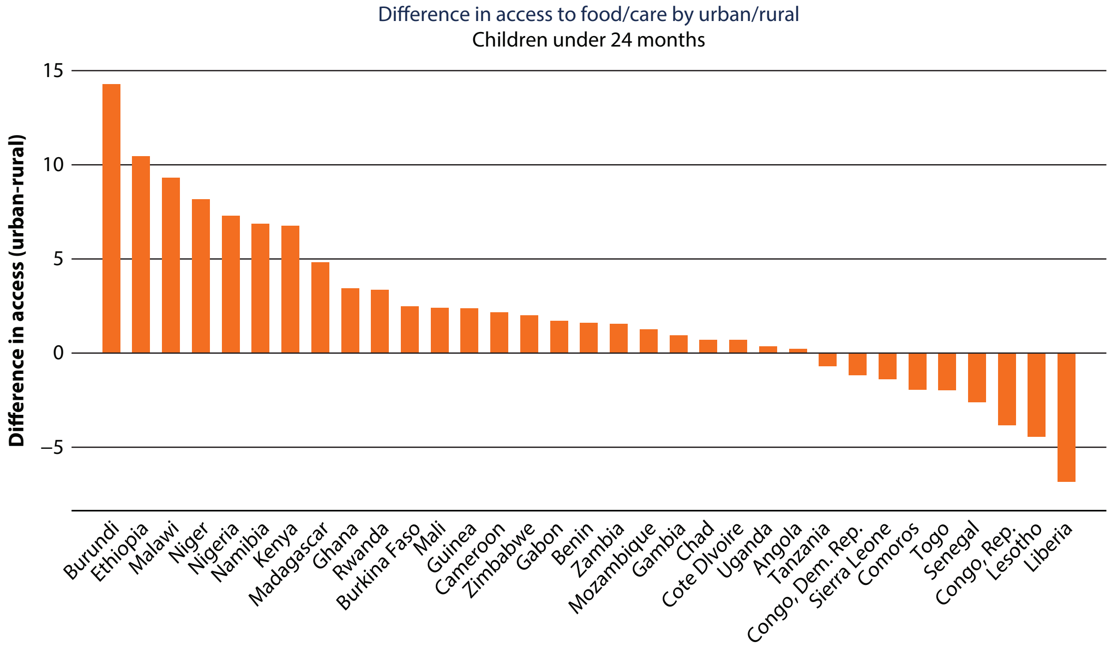
Substantial inequalities within countries in access between rural and urban areas, and between poorer and wealthier households are prevalent in SSA (Figure ES.1–Figure ES.3). The differences in access to adequate food/care[6] are in general small across rural and urban households (see Figure ES.1). In Liberia, children in rural areas are more than 5 percentage points more likely to have access to adequate food/care than children in urban areas. In Burundi, Ethiopia, Malawi, Niger, Nigeria, Namibia, and Kenya, urban children are more than 5 percentage points more likely to have access to adequate food/care than rural children. However, there are greater differences in access to adequate food and care by wealth category. Over one-third of the sample has more than 5 percentage point difference between the two wealth quintiles (Figure ES.1b).

Regarding access to adequate WASH,[7] in nine countries, the difference in access to WASH between urban and rural children is more than 30 percentage points (see Figure ES.2a). In 24 countries, children from the top wealth quintile (T20) are more than 30 percentage points more likely to have access to WASH than children from the bottom wealth quintile (B20) (Figure ES.2b). In Namibia, Senegal, and Niger the difference is more than 70 percentage points.

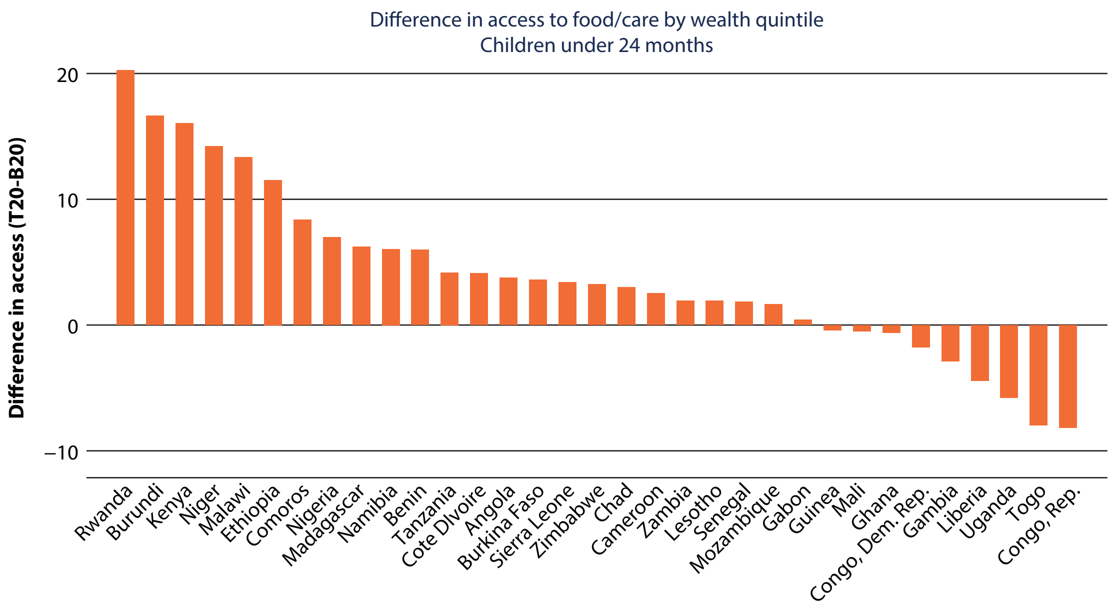
Urban children are always more likely to have access to adequate health[8] than rural children and children from richer households are more likely to have access than children from poorer households. In 11 of the countries the difference in access to adequate health between urban and rural children is more than 30 percentage points (Figure ES.3a). In 14 countries children from the richest households are

Figure ES.1 Differences in access to adequate food and care between rural and urban areas and top and bottom wealth quintiles in SSA

a) Food and care by rural versus urban



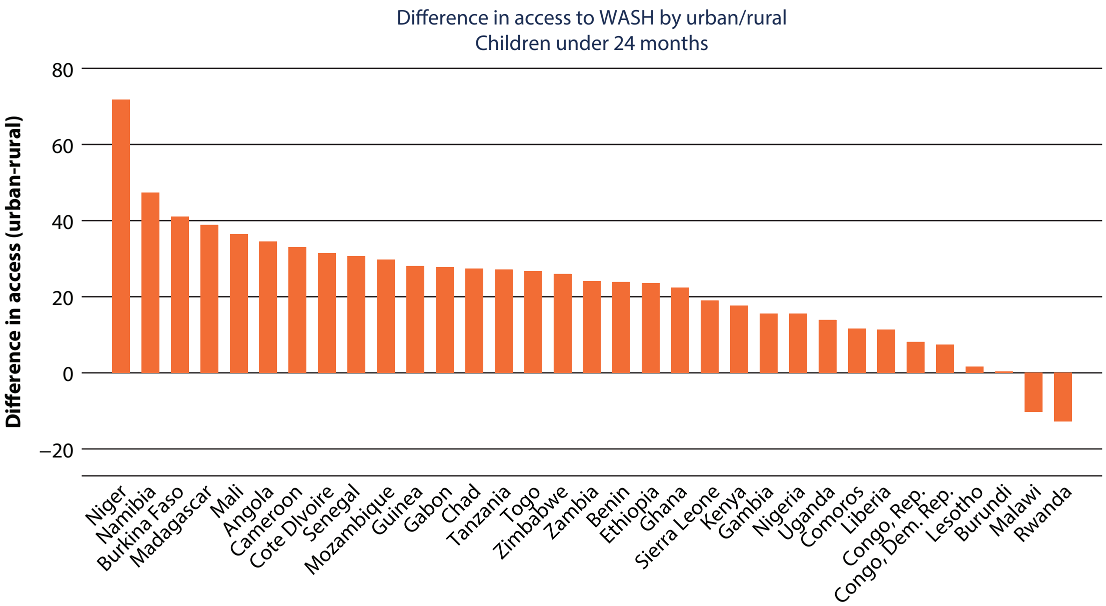
b) Food and care by wealth quintile



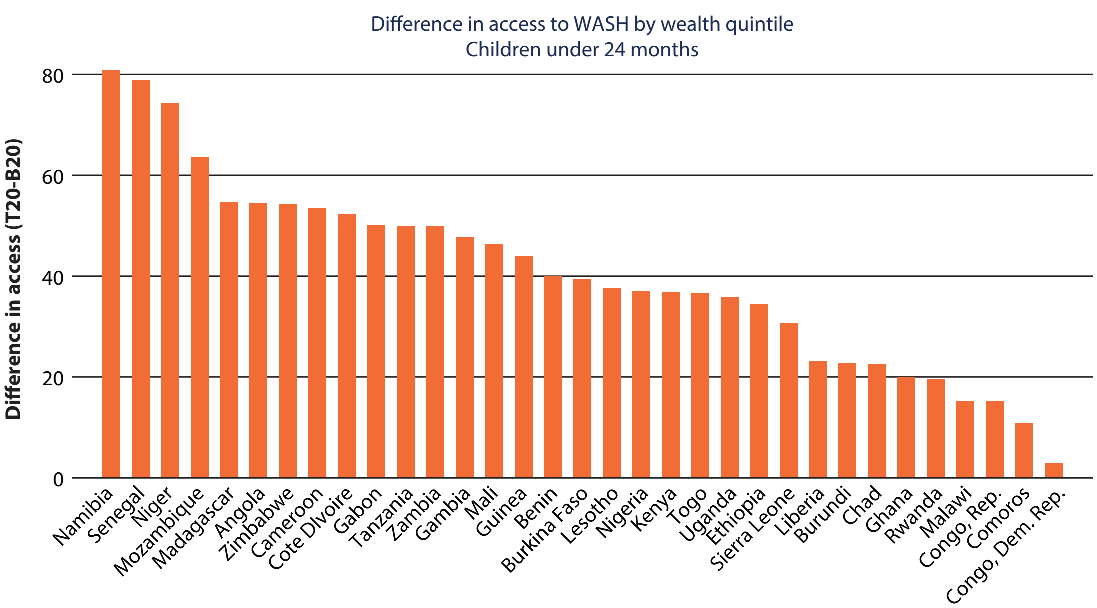
Source: World Bank staff estimates based on pooled DHS data from 33 countries in SSA.
Note: Wealth quintiles calculated by the authors.

Figure ES.2 Differences in access to adequate WASH between rural and urban areas and top and bottom wealth quintiles in SSA

a) Environment by rural versus urban



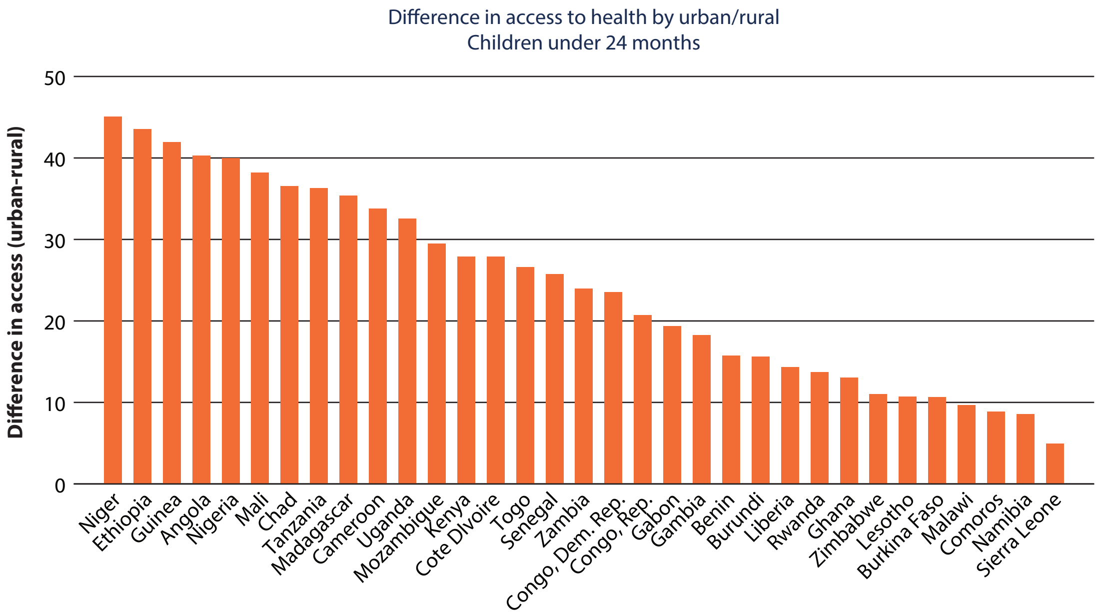
b) Environment by wealth quintile



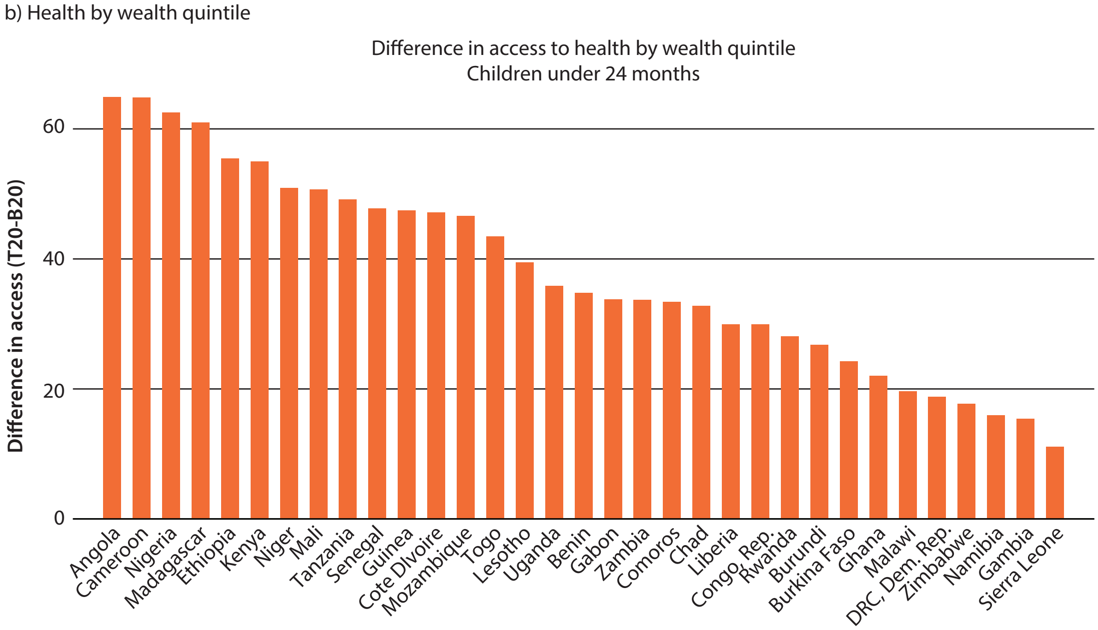
Source: World Bank staff estimates based on pooled DHS data from 33 countries in SSA.
Note: Wealth quintiles calculated by the authors.

Figure ES.3 Differences in access to adequate health between rural and urban areas and top and bottom wealth quintiles in SSA

a) Health by rural versus urban

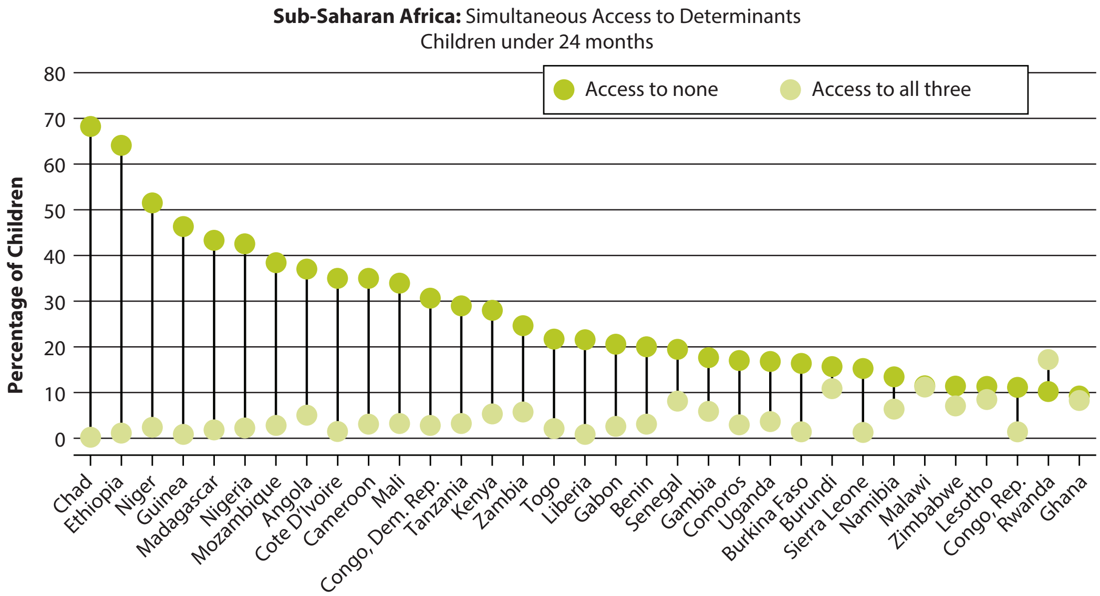


b) Health by wealth quintile



Source: World Bank staff estimates based on pooled DHS data from 33 countries in SSA.
Notes: Wealth quintiles calculated by the authors.

Figure ES.4 Simultaneous access to the drivers of nutrition



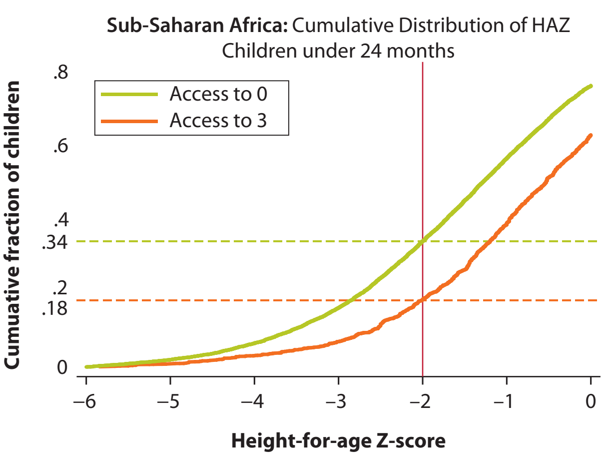
Source: World Bank staff estimates based on pooled DHS data from 33 countries in SSA.

more than 40 percentage points more likely to have access to adequate health than children from the poorest households (Figure ES.3b).

Very few children have access to adequate levels of all three drivers of nutrition at the same time (Figure ES.4). Figure ES.4 gives a sense of the inequities in joint/simultaneous access to the drivers of nutrition. Many children do not have access to any of the three determinants of nutrition. In three countries—Chad, Ethiopia, and Niger—more than half of the children do not have access to even one of the determinants. The countries with the highest fraction of children with simultaneous access to all three determinants are Rwanda, Malawi, and Burundi—where more than 10 percent of the children have access to all three determinants.

The prevalence of stunting among children with simultaneous access to adequate levels of all three nutrition drivers is significantly lower than children who do not have access to adequate level in any of the nutrition drivers. The prevalence of stunting among children who do not have access to adequate level in any of the three drivers of nutrition (access to 0) is 34 percent (Figure ES.5). In contrast, the prevalence of stunting among children with access to adequate level of all three of the drivers of nutrition (access to 3) is 18 percent, much lower than the prevalence among children with access to none. In addition, as the cumulative distribution function of the HAZ scores for children less than 24 months of age highlights significant reductions in severe stunting rates—children more than 3 s. d. below the median height-for-age—are also prevalent.

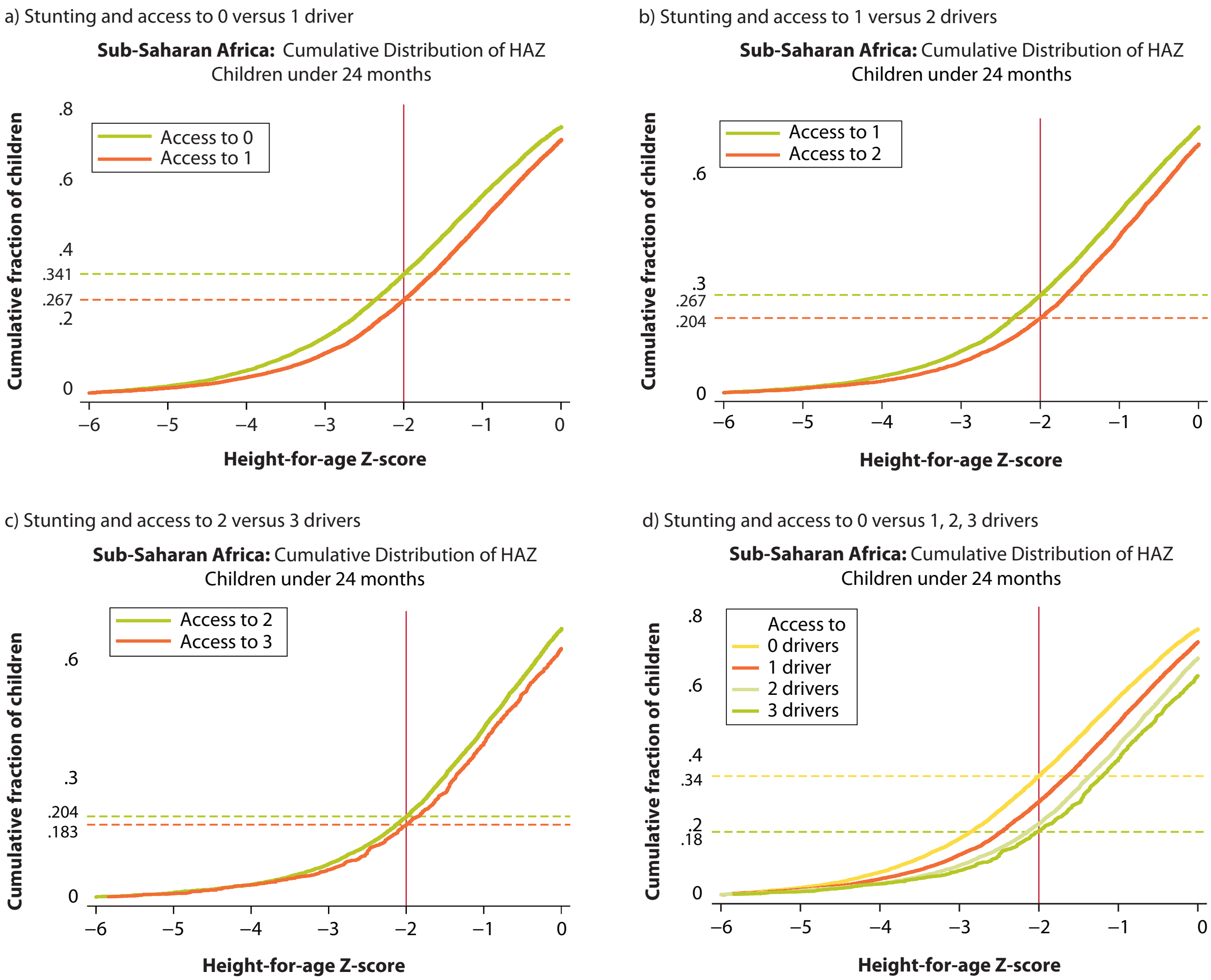
Figure ES.5 Prevalence of stunting and simultaneous access to the drivers of nutrition



Source: World Bank staff estimates based on pooled DHS data from 33 countries in SSA.

The greatest reductions in stunting are associated with increases in access from none (0) to any 1 nutrition driver and from any 1 driver to simultaneous access to any 2 drivers.[9] For example, the stunting rate among children with access to adequate level in any one nutrition driver is 26.7 percent compared to the stunting rate of 34.1 percent prevailing among children with access to none (see Figure ES.6a). Lower

Figure ES.6 Prevalence of stunting and simultaneous access to the drivers of nutrition



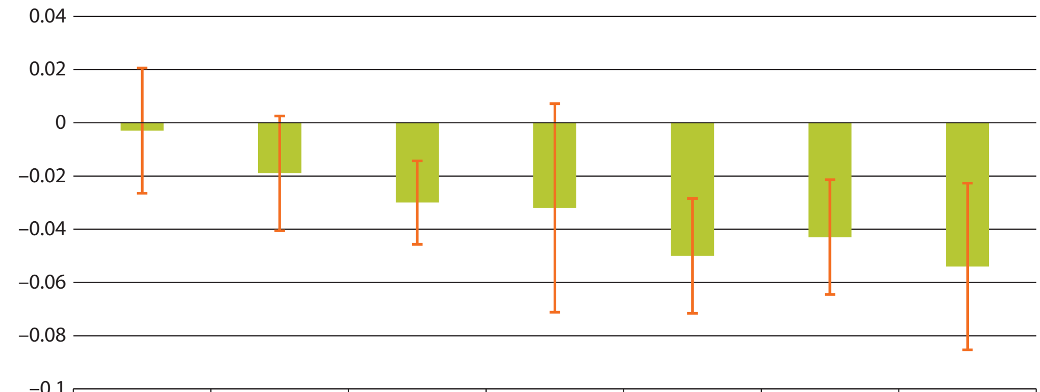
Source: World Bank staff estimates based on pooled DHS data from 33 countries in SSA.

stunting rates are also prevalent among children with simultaneous access to any two of the drivers (20.4 percent) compared to the stunting rates prevalent among children with access to any one of the drivers (26.7 percent) (see Figure ES.6b). However, the marginal decline (gain) in the stunting rate is smaller than that associated with a change in access from none (0) to any one of the drivers. Finally, even lower stunting rates are prevalent among children with simultaneous access to all three of the drivers (18.3 percent) compared to the stunting rates prevalent among children with access to any two of the drivers (20.4 percent) (see Figure ES.6c).

The marginal effect on the probability of a child being stunted from access to adequate health only is greater than the marginal effect from access to adequate food and care only or access to adequate WASH only. Controlling for child, parental, and household characteristics as well as for the geographic location of the household within a country, the probability of stunting associated with having access to adequate health only decreases by 3.0 percentage points (Figure ES.7).

The estimates also reveal similar marginal effects on stunting of complementing health interventions with simultaneous access to adequate food/care or with simultaneous access to adequate WASH. Controlling for child, parental, and household characteristics, as well as for the geographic location of the household within the country of residence, the decrease in the probability of stunting associated with

Figure ES.7 Marginal effects on the probability of stunting: Access to adequate levels of combinations of the underlying drivers of nutrition



	F/C	W	H	F/C & W	F/C & H	W & H	All 3
Estimates	–0.003	–0.019	–0.03	–0.032	–0.05	–0.043	–0.054

Source: World Bank staff estimates based on 33 recent DHS from Africa. See Table 2.1 for the list of countries and years.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2) controlling for country-strata fixed effects and child, parental, and household characteristics, consisting of the following variables: dummy variables for age, gender, multiple births and birth order, the age of the mother (in years), the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5, and whether the household lives in an urban/rural area. Robust standard errors corrected for correlation at the cluster level.
FC = Food and care only; W = WASH only; H = Health only; FC_W = Food and care and WASH only; FC_H = Food and care and health only; W_H = *W*ASH and health only; All 3 = Food and care and WASH and health.

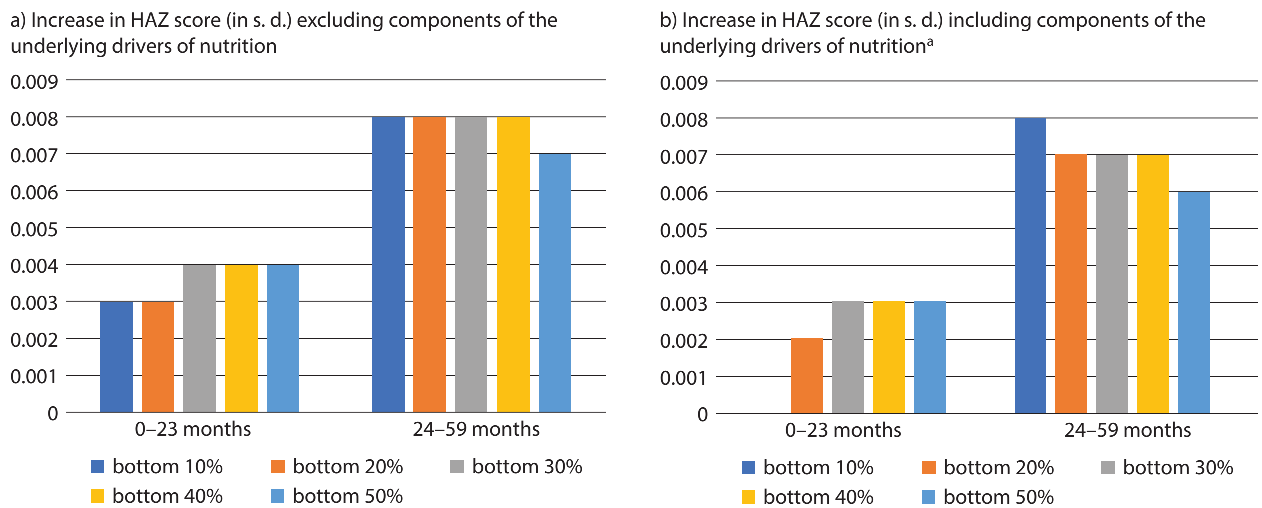
having simultaneous access to adequate health *and* adequate WASH or adequate health *and* adequate food/care ranges from 4.3 to 5.0 percentage points (Figure ES.7).

In the context of budgetary constraints, these results have important implications for the targeting and the sequencing of sector-specific interventions in target areas (or target populations). These are elaborated in this summary as well as in the body of the report.

The report also provides new evidence on (a) the contribution of wealth in reducing stunting by using household assets/wealth as a measure of living standards (in place of income) and (b) the effects of weather-related shocks on stunting. Building on recent evidence supporting the use of the wealth (or asset) index as a valid predictor of child nutrition outcomes (Sahn and Stifel 2003; Krishna et al. 2015), an analysis is carried out of the relationship between child HAZ scores and the percentile ranking of households in the national wealth index distribution within each of the 33 countries in the report.[10] To unpack the role of wealth as a determinant of growth faltering among children, separate estimates are presented for younger (0–23 months) and older children (24–59 months). Income or wealth may have what appears to be a small positive impact on the HAZ score of children in their first two years of life, but these small positive effects compound as the child ages, resulting in larger differences in HAZ scores that are more apparent later in life. The analysis demonstrates that increased wealth has a significant effect on child HAZ scores among both younger children (0–23 months) and older children (24–59 months) (Figure ES.8). For example, an increase in the ranking of the wealth index value of the household by 10 percentage points is associated with a 0.03 s. d. increase in HAZ score for younger children at the median (50th quantile) of the HAZ distribution.[11] For older children at the median of the HAZ distribution, the same 10 percentage point increase in the ranking of the wealth index of the household is associated with an increase in the HAZ score by 0.06 s. d. (see Figure ES.8b).[12] In addition, income appears to have a significant 'direct' effect on child nutrition (HAZ score) aside from that captured by the components of food and care, WASH, and health (compare panels a and b in Figure ES.8), (that is, even after controlling for the components of the underlying drivers of nutrition).

Country-specific estimates of the impacts of rainfall shortfalls during the growing season on the probability of stunting underline the importance of programs that decrease the vulnerability of household income from weather-related shocks. A shortfall in rainfall by 1 s. d. from the normal mean-precipitation

Figure ES.8 The relationship between HAZ scores and percentile of household wealth among older and younger children



Source: World Bank staff estimates based on children 0–23 and 24–59 months old from 33 country DHS from SSA. See Table 1 for the list of countries and years.
Notes: Unconditional quantile regression (UQR) estimates including country fixed effects. Detailed estimates available upon request. Both sets of regressions include child, parental, and household characteristics containing the following variables: dummy variables for age (months), gender, and birth order; multiple births; mother's education in years; marital status (married, never married, or other); mother's height; mother's age; wealth dummy (poorer, middle, richer, richest); number of children under 5 years of age; number of household members; and household is in a rural or an urban area.
a. The components of the underlying drivers of nutrition include the following: whether a child had immediate skin-to-skin contact at birth, had age appropriate breastfeeding, the child's mother had 4 or more prenatal care visits, the child delivery was assisted by the trained professional, child has been to at least one postnatal care visit, child received all the vaccinations, child sleeps under mosquito net, the household has access to improved water, the household has access to improved toilet, handwashing facilities, disposal of stools, and if the majority of households in the community (75%) use some sort of a sanitation facility. For 24–59-month-old children, the components of the underlying drivers of nutrition do not include the following variables (not collected for older children): whether a child had immediate skin-to-skin contact at birth, had age appropriate breastfeeding, the child's mother had 4 or more prenatal care visits, the child delivery was assisted by the trained professional, and child has been to at least one postnatal care visit.

during the most recently completed growing season is associated with a 4.08 percentage point increase in the probability of being stunted across all children age 0–60 months in Benin, a 3.59 percentage point increase in the Democratic Republic of Congo, a 1.67 percentage point increase in Mozambique, and 2.71 percentage point and 2.50 percentage point increases in Nigeria and Rwanda, respectively. These estimates confirm that policies and programs that decrease the vulnerability of household income from weather-related shocks can significantly contribute to the decline of stunting and should be considered as components of any multisectoral effort.

Policy Considerations

The analysis in the report offers new insights on how data can be used to inform allocation decisions of different sectors that can strengthen multisectoral efforts aiming to reduce stunting. In practice, however, there is little assurance that involving multiple sectors in the effort to reduce undernutrition will produce the desired outcomes.

The history of multisectoral initiatives on nutrition contains many nonperforming projects (IEG 2009; World Bank 2014). Multisectoral nutrition planning was favored by the international development community in the 1970s, but it quickly became apparent that it was overly ambitious and too dependent on other sectors that were reluctant to be coordinated (Levinson and Balarajan 2013). A more recent example is the case of multisectoral AIDS projects in Africa, where a number of sectors such as health, WASH, and education were involved. When budgets, governance, and accountability structures are driven mainly by sector-specific considerations within country ministries as well as within international organizations, 'multisectoral' initiatives tend to reduce clarity and specificity on the role and responsibility of each sector (IEG 2009).

Yet, in recent years there have been a few countries, such as Peru, Senegal, and Brazil, that have been quite successful in reducing undernutrition significantly through multisectoral approaches tailored to their needs and circumstances. This section synthesizes the main findings of this report with the lessons offered from these successful country cases to identify the key ingredients of a multisectoral strategy in the reduction of undernutrition that maximizes the potential to produce the desired outcomes in practice.

The Joint Targeting of Interventions by Different Sectors

One fundamental ingredient of a successful strategy is the scale-up of interventions by agriculture (food security), health, care, and WASH that are *jointly* targeted to geographic areas (or populations within these areas) with high prevalence of stunting.[13] The primary purpose of these jointly targeted operations is to increase access to the underlying determinants of nutrition as envisioned by the UNICEF conceptual framework underpinning this report. For sector-specific investments to contribute to the reduction of stunting and to speed up progress toward the Sustainable Development Goals (SDGs), the prevalence of stunting needs to be considered as an additional criterion when prioritizing and allocating scarce resources at the country and subnational level. The very high proportions of children with inadequate access to all 3 drivers of nutrition (Figure ES.4) suggest that the strategy of joint targeting would apply almost to all countries in SSA.

This requires taking stock of the sectors operating in the target areas (or target population groups) and redirecting operations of the missing sectors to the target areas. The absence of some key sector from the target areas, such as agriculture, WASH, or social protection, may also act as a deterrent for the sector (or sectors) already operating in the target areas to be the 'first mover' in terms of adopting nutrition-sensitive interventions. The descriptive statistics on access to adequate WASH in the 33 countries covered by the report (Chapter 3) in combination with the recently completed WASH Poverty Diagnostic of the Water and Poverty and Equity Global Practices (World Bank 2017b) confirm the limited coverage by the WASH sector in the rural areas where stunting is prevalent. The same also applies to the fraction of the population covered by social protection schemes (Del Ninno, Coll-Black, and Fallavier 2016). For example, the Productive Safety Net program of Ethiopia, one of the largest in SSA, covers only 10 percent of the population (World Bank 2012).

This report provides country authorities with a holistic picture of the gaps in access to the drivers of nutrition within countries that is critical for the formulation of a more informed, evidence-based, and balanced multisectoral strategy against undernutrition in their countries. Much work remains to be done in terms of coordinating the targeting of service delivery in areas with stunting if all key sectors are to contribute jointly in the reduction of stunting. While there is a broad correlation between monetary poverty and children's health at the country level, the targeting of stunted children is not as simple as distinguishing between urban and rural areas or using 'poverty maps' identifying the poor and non-poor regions. Not all children in poor households or in rural areas are undernourished, and, in many countries, not all children in non-poor households or in urban areas are well nourished. The 33 country-specific notes attached as a separate annex to this report are a first step in this direction.

With limited budgetary resources, the greatest decline in stunting can be accomplished by targeting the scarce resources to children who do not have adequate access to any of the three nutrition drivers (see Chapter 5). If the same resources were to be allocated at increasing access to an additional nutrition driver among children who already have access to one driver, the consequent decline in stunting is likely to be smaller.

The estimates can also provide policy guidance useful for the sequencing of sector-specific interventions in target areas (or target populations).

- **First, if budgetary or other considerations allow for interventions covering deprived children by only one sector, this sector should be health.** Thus the 'biggest bang for the buck' in reducing stunting is through expanded coverage by the health sector addressing the immediate causes of undernutrition (Figure ES.7). The findings also empirically validate the sequencing of integrated approaches to improving nutrition outcomes such as the one currently in process for Madagascar and in preparation for other 1st wave countries. As soon as other sectors succeed in redirecting their operations to the target areas, an acceleration in the reductions in stunting is very likely to follow.
- **Second, if a target area is already covered by the health sector, the decision of whether to cover the same target area by sectors such as WASH or agriculture should be based mainly on costs rather than**

benefits. This is because the benefits in terms of reductions in stunting through simultaneous coverage by WASH or agricultural (food/care) operations appear to be similar. However, country-specific analyses would need to be carried out to confirm that the regional relationship holds nationally.

Increased access to adequate levels of the underlying drivers of nutrition coordinated across different sectors should not be considered in isolation from programs increasing incomes and minimizing income variability in rural areas, both important determinants of household demand for better nutrition (see Chapter 7)**.** Instead, programs and interventions aimed at increasing the level *and* stability of income among populations where stunting is prevalent should be considered as indispensable components of a 'multisectoral' approach to reducing undernutrition in SSA. Household constraints faced at different points in time may interact with the utilization of services. Thus, multisectoral interventions against undernutrition are likely to be more effective when accompanied by broader development policies and programs that mitigate the impacts of risks.

There is an increasing policy emphasis on adaptive social protection and climate-smart agriculture programs that provide the basis for increasing the level and decreasing the variability of incomes in rural areas. (Lipper et al. 2014; Tirado et al. 2013; Wheeler and von Braun 2013; Del Ninno, Coll-Black, and Fallavier 2016; Del Ninno and Mills 2015). These programs serve not only as useful instruments to respond ex post to the incidence of droughts, floods, and other natural disasters but also help households build their resilience before shocks hit. Drought-resistant seeds for maize, for example, have the potential of increasing both the level and the stability of income from agricultural activities in African countries. Cash transfer programs can redistribute income to the poorer segments of the population and allow households to invest in human capital and in child nutrition, to build assets and diversify their livelihood strategies. Public works programs can help households and communities to reduce their vulnerability to shocks while improving community infrastructure and the opportunities for new and improved livelihoods. In parallel or in combination, increased access to insurance products and credit markets can ensure better and more efficient use of resources by eliminating the incentive to adopt low-risk/low-return crops and production methods and alleviate inter-temporal distortions on human and productive capital investment such as cutting down on food consumption and health services or withdrawing children from school.

The experience of Peru highlights the contribution of income growth in reducing stunting. Between 2007 and 2012, the prevalence of stunting declined by 21.4 percentage points, from 54.7 percent to 33.3 percent, in the districts targeted by the CRECER strategy (World Bank 2012; Levinson and Balarajan 2013). The contemporaneous income growth and poverty reduction in Peru during the same period had a critical facilitating role in the success of the multisectoral efforts at decreasing undernutrition. Specifically, the poverty rate between 2004 and 2011 decreased by 31 percentage points (from 58.8 percent to 27.8 percent and extreme poverty from 16.7 percent to 6.3 percent). Although the declines in stunting cannot be exclusively attributed to economic growth and poverty reduction in Peru, it is important for policy makers in SSA countries to consider income growth and reduced income variability as necessary but not sufficient conditions for the reduction of child stunting.

More research is needed on the extent to which sector-specific nutrition-sensitive interventions have any measurable impact on stunting over and above the impact from access and utilization (or the targeting) of the services provided by the normal operations of sector-specific programs. Nutrition-sensitive interventions are believed to be essential for achieving adequate access to the underlying determinants of nutrition by improving or redirecting or adding marginal changes to normal sector operations to enhance the coverage and effectiveness of nutrition-specific interventions through the health sector. Recent reviews of the evidence available on the nutritional effects of nutrition sensitive interventions (Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013; Galasso et al. 2017), as well as the review in Annex E of this report, confirm that there is a strong potential but very little in terms of solid evidence. For example, the evidence of the nutritional effect of agricultural programs is inconclusive, mainly because of poor quality evaluations. There is also a scarcity of evidence on the nutritional effect of social safety net programs, while combined early child development and nutrition interventions show promising synergies in child development and in some cases nutrition. Moreover, future evaluations of nutrition-sensitive intervention should take into serious consideration the possibility that the impacts of nutrition-sensitive interventions are likely to depend on the scale of coverage by other sectors as well as on the extent to which the other sectors implement nutrition-sensitive interventions.[14]

Attention to the Incentive Structure

The adoption of a governance and accountability structure that provides the right incentives to all actors involved is the other fundamental ingredient of a successful multisectoral strategy. A common feature of all countries with successful multisectoral projects against stunting is the importance of a coordination system that is supported by high levels of government. The Nutrition Enhancement Program (NEP) of Senegal, for example, involving the Ministries of Health and Education, was coordinated by a unit attached to the Prime Minister's office (Agency in Charge of the Fight against Malnutrition [CLM]) (IEG 2016). Along similar lines, the CRECER strategy in Peru was placed not in a line ministry but directly under the Prime Minister's Office. In Brazil, a new ministry, the Ministry of Social Development and Fight Against Hunger (MDS) was created to provide a platform for coordination with other ministries, such as the Ministry of Education administering the National School Food Program and the Ministry of Agricultural Development involved in the Food Acquisition Program.

In the development community, aside from the impetus generated by the SDGs, there is a confluence of factors that contribute toward a more solid foundation for multisectoral projects aiming to reduce undernutrition. This foundation allows for operations that are better structured, better performing, and potentially much more effective than in the past. All but Angola of the 33 countries analyzed in this report are members of the SUN movement whose framework is by now endorsed by 59 developing countries and over a hundred partners and nearly 3,000 civil society organizations (CSOs) that are members of SUN. All members of SUN are prioritizing nutrition as an investment in their growth and recognizing nutrition as an investment in economic and social development to strengthen its nation.

The renewed emphasis on eliminating extreme poverty and boosting shared prosperity has also provided the incentive for different sectors to reevaluate their country engagement strategy. The recent WASH Poverty Diagnostic Initiative, for example, generated new insights on how data can be used to inform allocation decisions to reduce inequalities and prioritize investment in WASH to boost human capital.[15] Also, new models of operational engagement with client countries such as the Multiphase Programmatic Approach (MPA) offer the opportunity to improve coherence across interventions and strengthen the strategic focus of operations within client countries. The MPA approach is ideally suited for long-term engagement with multiple sectors as in the case of nutrition. In addition, the MPA separates engagements into phases, which facilitates greater learning and adaptation. Combined with performance-based financing (PBF) with disbursement-linked targets, the MPA program has the potential to give the proper incentives to the local authorities implementing the program. In the case of Peru and Brazil, for example, the use of specific targets has been associated with highly positive results in terms of generating proactive initiatives and encouraging local ownership and accountability at subnational levels.

This report contributes to the analytical foundations of a more effective multisectoral approach and as such constitutes only one component of a much broader effort aimed at improving the results of multisectoral projects toward the reduction of undernutrition. It is imperative that the renewed efforts yield the desired results especially in SSA countries.

Endnotes

1. This 2014 figure is agreed upon by the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Bank. In statistical terms, a child is stunted if his/her height-for-age Z (HAZ) score is more than 2 standard deviations (s. d.) below the median height of a healthy reference population (that is, HAZ < –2).
2. Along parallel lines, initiatives aim to foster knowledge exchange and cross-sectoral collaboration and coordination at the project level for improving nutrition (Secure Nutrition Knowledge Platform, World Bank).
3. More information on the SUN initiative and the countries participating in the SUN initiative can be found at: http://scalingupnutrition.org/sun-countries/about-sun-countries/.

4. In contrast, other surveys such as the Living Standards Measurement Surveys (LSMS) contain more information on food and non-food consumption and other dimensions of food security, and sometimes repeated observations (panel data) on the same children and households, but at the expense of more limited country coverage, lack of information on anthropometric measurements, or insufficient information for the construction of measure of WASH and health based on internationally accepted standards.
5. The Annex of the country-specific notes can be accessed at: http://documents.worldbank.org/curated/en/467711529406437446/
6. A child is considered adequate in food and care if he/she meets the age-appropriate criterion for minimum acceptable diet and at least one of the following care giving measures: (a) early initiation of breastfeeding and (b) age-appropriate breastfeeding (see Chapter 4).
7. A child/household is defined to have access to adequate WASH, if at least 3 of the following components are satisfied: (a) has improved water facilities; (b) has improved sanitation (based on the WHO/UNICEF Joint Monitoring Program);(c) less than 25 percent of the households in the community revert to open defecation; (d) has adequate handwashing facilities with water and soap or detergent, as observed by the interviewer; and (e) the child's stools are disposed of into an improved sanitation facility. For all countries in the analysis, information is available to at least construct the first three components and, except for the Republic of Congo and Gabon, at least one of the other two components are also available.
8. A child is defined to have access to adequate health if at least 3 of the following components are satisfied: (a) mother had 4 prenatal visits; (b) birth was assisted by a health care professional; (c) the child was seen in a postnatal checkup visit; (d) child is immunized according to schedule; and (e) child sleeps under a mosquito net (when applicable). For all countries information on prenatal visits, assisted birth and immunizations are available. For four countries, no information is available on postnatal checkup (Cameroon, The Gambia, Mozambique, and Rwanda) and for two countries (Ethiopia and Lesotho) on mosquito nets, and for these countries the index is constructed without considering the unavailable data.
9. The analysis in Chapter 5 of this report confirms that the same patterns hold for the marginal effect of access to one or more drivers on the probability of a child being stunted (after controlling for country-level effects and a variety of child, parental, and household characteristics). The same pattern also holds in different groups of countries, in urban and rural areas, and for children in the bottom 20 percent (B20) and top 20 percent (T20) of the distribution of wealth in each country.
10. The standard of living of households is usually measured by household per capita expenditures (PCE) or income. Household surveys with detailed household PCE *and* child anthropometric measures (such as height and weight) in the same survey are scarce. For example, among the 9 Living Standards Measurement Study- Integrated Surveys on Agriculture (LSMS-ISA) currently available and most likely to collect PCE and child height, it was possible to confirm that only 5 of the 9 surveys had information on both PCE and measures of child height.
11. The estimates in the figures reflect the effect of a 1 percentage point increase in the ranking of the wealth index value of the household in the HAZ score.
12. The same patterns also prevail among children in urban and rural areas, by mother's educational attainment and by mother's autonomy in decision making at home. Estimates are also provided for countries in the 1st wave of the Investing in Early Years initiative and in countries in the Sahel region and compared to countries not in the 1st wave or not in the Sahel region, respectively, as well as within each of the 33 countries. In Tanzania, for example, the estimates at the median (50 percent) quantile of HAZ suggest that a 10 percentage point increase in the wealth index, which is equivalent to a 17 percent increase in mean consumption per capita, leads to a 0.06 s. d. increase in the HAZ of 24–59-month-old children, an effect comparable to that in Alderman, Hoogeveen, and Rossi (2006) based on PCE (instead of the percentile of the asset index used here).
13. For conceptual clarity, nutrition sensitivity in this report is considered as an add-on component to the normal operations and activities of a sector program, distinct from the targeting of the program or project. Nutrition-sensitive interventions are generally identified with efforts to **redirect**, or improve, or add marginal changes to normal sector operations to enhance the coverage and effectiveness of nutrition-specific interventions through the health sector (for example, see Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013).
14. This also has important implications for the design of randomized control trials of nutrition-sensitive interventions, if the findings of the impact evaluation are to have any external validity for scaling up.
15. The synthesis report and the country-specific studies of the WASH Poverty Diagnostic can be accessed at http://www.worldbank.org/en/topic/water/publication/wash-poverty-diagnostic.

CHAPTER 1

Introduction and Motivation

In 2014, 171 million children under the age of five had stunted growth, meaning that they were excessively short for their age.[1] In Africa, specifically, the scale of undernutrition is staggering with 58 million children under age five being too short for their age (stunted), and 13.9 million weighing too little for their height (wasted) (Global Nutrition Report 2016). Poor diets in terms of diversity, quality, and quantity, together with illness are linked with micronutrient deficiencies (that is, a lack of important vitamins and minerals linked to growth, development, and immune function, such as iodine, Vitamin A, and iron) and contribute to stunting, poor health, and development outcomes.

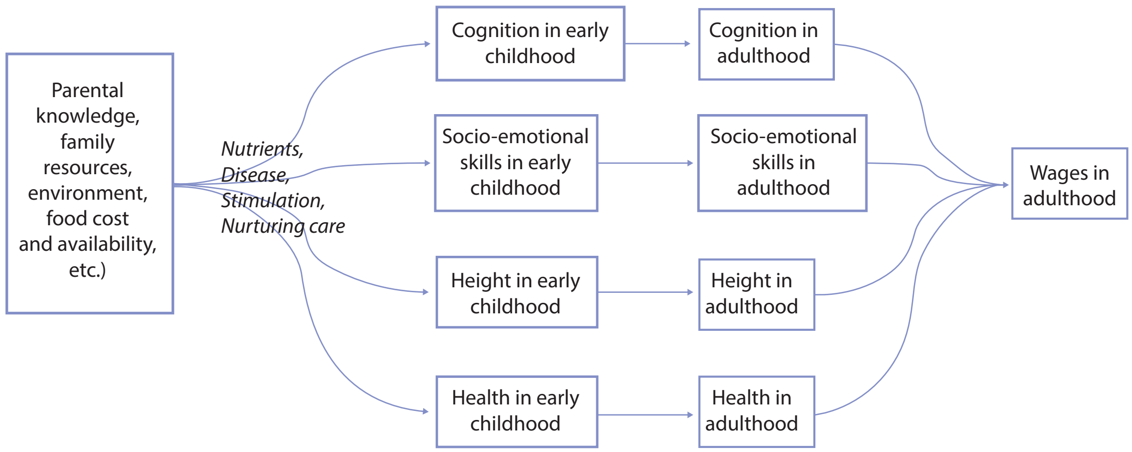
Income poverty and inequalities in access to basic services such as health, water, sanitation, and proper care and feeding practices, in the initial stages of children's lives are associated with delayed child growth and serious costs that are eventually borne by the rest of society. Inequities in access to *the underlying determinants* of good nutrition and long-term well-being are associated with immediate costs in child welfare: no access or access to inadequate levels of drivers of nutrition is associated with an increase in the incidence of undernutrition and diarrheal disease. But there are also important consequences in the long term—both to the individual and society—associated with the chronic undernutrition of children: a high risk of stunting, impaired cognitive development, lower school attendance rates, reduced human capital attainment, and a higher risk of chronic disease and health problems in adulthood (Victora et al. 2010; Black et al. 2013; Hoddinott et al. 2013). Thus, inequities in access to services early in the life of a child also contribute to the intergenerational transmission of poverty.

The negative outcomes later in life are numerous, and some can even be quantified in economic terms (see Figure 1.1). Recent World Bank estimates suggest that the per capita income penalty a country incurs for not having eliminated stunting when today's workers were children is around 7 percent of gross domestic product (GDP) per capita, on average. In Sub-Saharan Africa and South Asia, these figures rise to about 9–10 percent of GDP per capita (Galasso et al. 2017).

The conceptual framework developed by UNICEF highlights the basic and underlying drivers of undernutrition that include both environmental, economic, and sociopolitical factors with income poverty and inequalities in access to services having a central role. A focus on policies aimed at accelerating economic development and shared income growth is generally effective at reducing undernutrition but the speed at which undernutrition declines with economic growth varies from country to country and from region to region. Thus, although growth is a necessary condition for the reduction of stunting, it is not a sufficient condition, especially in the region of Sub-Saharan Africa (SSA), where cross-country time series data suggest that the strength of the relationship between growth in real GDP and stunting is weaker in comparison to other regions in the world (World Bank 2017a).

Much of the effort to date has focused on the costing, financing, and impact of nutrition-specific interventions delivered mainly through the health sector to reach the global nutrition targets for stunting, anemia, and breastfeeding and interventions for treating wasting (Shekar et al. 2016; Horton et al. 2010). However, an acceleration of the progress toward reducing stunting in the African Region requires enlisting more sectors, in addition to the health sector, such as agriculture; education; social protection; and water, sanitation, and hygiene (WASH) in the effort to improve nutrition. Large-scale '*nutrition sensitive*' interventions in these

Figure 1.1 Causes, correlates, and consequences of stunting



Source: Galasso et al. 2017.

sectors will have to be able not only to address the key underlying determinants of nutrition effectively but also intensify the role of '*nutrition-specific*' interventions (Black et al. 2013) (see Box 1.1).

In recent years there has been a significant increase in the number of initiatives at the international as well as at the county level aiming to scale up nutrition-sensitive interventions. One prominent example is the Scaling-Up Nutrition (SUN) movement, launched in April 2010, whose framework is by now endorsed by 59 developing countries and over a hundred partners and nearly 3,000 civil society organizations (CSOs) that are members of SUN. A number of countries are prioritizing nutrition as an investment in their growth and recognizing nutrition as an investment in economic and social development to strengthen its nation. Along parallel lines, initiatives within the World Bank and other development agencies and research institutions aim to foster knowledge exchange and cross-sectoral collaboration and coordination at the project level for improving nutrition (Secure Nutrition Knowledge Platform, World Bank). Also, the 'Investing in the Early Years' initiative, started in 2016, takes a holistic approach to the nature of interventions needed for the healthy physical and cognitive development of children. The initiative aims to facilitate children reaching their full potential through an increased emphasis on the good nutritional status of mothers, expecting mothers, and children especially in their first 1,000 days of life (including 9 months in utero); exclusive and continued breastfeeding; health care; and immunization, as well as proper feeding accompanied by good hygiene practices, the role of early stimulation and age appropriate learning opportunities, and the role of nurturing care and social protection that provides buffers from poverty and stress.[2] All these initiatives are based on the premise that the determinants of undernutrition are multisectoral and that the solution to undernutrition requires multisectoral approaches.

The effectiveness and ultimate success of such multisectoral approaches toward reducing stunting, and in furthering progress toward the SDGs, depends on having a more holistic view of the inequities and gaps in access to adequate levels of the underlying determinants of nutrition, that is, care, food security, health, and environment (water, sanitation, and hygiene or WASH). The complex interdependence *among* the underlying determinants of nutrition is usually beyond the consideration of any given sector. The targeting of communities or the integration of nutritional considerations in existing interventions of the agricultural sector, for example, is unlikely to take into consideration the status of WAS) services and facilities in the communities where these agricultural interventions are being considered. In consequence, the extent to which such nutrition-sensitive interventions can ultimately accelerate or enhance the impact of nutrition-specific interventions on key nutrition outcomes can be impeded considerably by the absence of adequate WASH facilities. On the other hand, the impact of agricultural interventions on child nutrition could be enhanced considerably if they were to be accompanied by simultaneous improvements

Box 1.1 Nutrition-Specific and Nutrition-Sensitive Interventions

Nutrition-specific interventions address the immediate determinants of fetal and child nutrition and development—adequate food and nutrient intake, feeding, caregiving and parenting practices, and low burden of infectious diseases. Examples include adolescent, preconception, and maternal health and nutrition; maternal dietary or micronutrient supplementation; promotion of optimum breastfeeding; complementary feeding and responsive feeding practices and stimulation; dietary supplementation; diversification and micronutrient supplementation or fortification for children; treatment of severe acute undernutrition; disease prevention and management; nutrition in emergencies.

Nutrition-sensitive interventions and programs address the underlying determinants of fetal and child nutrition and development—food security; adequate caregiving resources at the maternal, household, and community levels; and access to health services and a safe and hygienic environment—and incorporate specific nutrition goals and actions. Examples include agriculture and food security; social safety nets; early child development; maternal mental health; women's empowerment; child protection; schooling; water, sanitation, and hygiene; health and family planning services.

Nutrition-sensitive interventions are believed to be essential for achieving adequate access to the underlying determinants of nutrition by redirecting, improving, or adding marginal changes to normal sector operations to enhance the coverage and effectiveness of nutrition-specific interventions through the health sector (Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013). It is important to point out that this definition conflates coverage of normal operations (or targeting) with the improvement or the addition of marginal changes enhancing the effectiveness of normal operations. Thus, the 'nutrition sensitivity' of a sector-led project can be enhanced simply by improving its targeting to geographic areas and populations therein with high stunting prevalence.

For conceptual clarity, nutrition sensitivity in this report is considered an add-on component to the normal operations and activities of a sector program, distinct from the targeting of the program. Based on this distinction, nutrition-sensitive operations by a sector in a specific geographic area can be implemented only if a sector carries out normal operations in the targeted areas. Annex E contains a more detailed discussion of the different types of nutrition-sensitive interventions possible through the different sectors along with a review of the literature on the impacts of such interventions on child stunting.

Sources: Adapted from Ruel, Alderman, and the Maternal and Child Nutrition Study Group (2013), and World Bank (2013).

in the water and sanitation facilities in the same communities. Thus, a more holistic approach to the targeting and 'nutrition sensitivity' of interventions is likely to be better able to address the key underlying determinants of nutrition effectively, as well as reinforce the impacts of nutrition-specific interventions through the health sector.

This report lays the groundwork for more effective multisectoral action on reducing stunting by analyzing and generating empirical evidence useful for informing the joint targeting of nutrition-sensitive interventions in countries in SSA. The report takes stock of the available data that are useful at applying some of the fundamental concepts of the UNICEF conceptual model for nutrition. These include the critical role of the underlying drivers of nutrition, such as care, food security, health, and WASH, underpinned by the basic determinants of nutrition such as income and the education level of the mother, among others. In the process, some important data limitations are identified, especially in relation to the availability of information on the different dimensions of food security and care in surveys that contain child anthropometric measures such as height and weight. Despite these data limitations, the analysis in the report serves to highlight the fact that a lot of useful information can be extracted from the existing surveys such as the Demographic and Health Surveys (DHS) in terms of getting a more holistic view of the multiple deprivations experienced by children and the prevalence of stunting. Information about the joint distribution of the underlying drivers of nutrition is essential for identifying particularly important gaps (or binding constraints) that, if addressed through joint targeting, can serve to strengthen the impacts on nutrition.

With this background in mind, the key questions addressed by this report include the following:

1. What is the extent to which children have inadequate access to the underlying determinants of nutrition? Information available at the child level from the DHS allows one to get a better sense about the joint distribution of the various determinants (or drivers) of undernutrition. Information about the joint distribution of inadequate access to the drivers of nutrition is essential for better targeting and more effective programs in the context of budgetary constraints.
2. What is the association of stunting (or low height-for-age), at any given point in time, with inadequate food and care practices, inadequate WASH, and inadequate health? Is simultaneous access to adequate level of one or more of the underlying determinants of nutrition associated with lower stunting? Empirical evidence confirming that simultaneous access to adequate levels of two or more nutrition drivers is associated with lower stunting validates the importance of the joint targeting of interventions by different sectors in the geographic areas and populations therein where stunting is prevalent.
3. If a multisectoral approach is not feasible, what is the sequencing of sector-specific interventions that could have the greatest impact on stunting? For example, if budgetary constraints prevent the joint coverage of geographic areas (and/or populations within these areas) with high prevalence of stunting by sectors such as agriculture, health, care, and WASH, in which sector should the limited resources be allocated?
4. What is the role of income growth and income variability on child stunting and how does income interact with the underlying drivers of nutrition?

The findings of this regional report are intended to stimulate and provide a blueprint for further analytic work that is operationally useful for the design of more effective multisectoral sectoral interventions on stunting at the country level in SSA. The main findings of the report are based on data on children pooled across 33 countries, thus reflecting relationships that prevail on average among stunting and access to the drivers of nutrition by children residing in different countries. The advantage of pooling data on children across many countries based on common definitions and thresholds is not only in terms of total sample size but also in that pooling increases number of observations on children with access to adequate levels to different combinations of nutrition drivers. This advantage, however, comes at some costs. Applying definitions and using thresholds that are common across all countries tends to minimize the role of country-specific factors. As a consequence, the relationship between stunting and access to nutrition drivers derived from the sample of children pooled across countries may not necessarily reflect the relationship that may prevail within any given country. In view of these considerations, Chapter 6 of the report provides an example applying the same methodology based on data from only one country, Tanzania. In addition, a separate annex accompanying this report includes a brief for each of the 33 countries used in the report, summarizing access to the determinants of nutrition and their components as well as the simple correlation between stunting and the number of determinants. Also, appendix C of the report presents the country-specific estimates summarizing the relationship between stunting and access to different combinations of nutrition drivers.[3]

The report is structured as follows. Chapter 2 describes the methodology and the data used in the analysis, along with the caveats and the value added of this study. Chapter 3 provides descriptive statistics on the prevalence of stunting in SSA countries as well as differences in the prevalence of stunting among children in urban and rural areas and children living in richer and poorer households within the countries studied. Chapter 4 describes the empirical measures of the components of the underlying drivers of nutrition and presents descriptive statistics on the extent to which children have access to adequate levels of one or more of the underlying determinants of nutrition one (Question 1). Chapter 5 contains a detailed investigation of the relationship between stunting and access to one or more of the underlying determinants of nutrition, the effects of access to different combinations of the drivers of nutrition (Questions 2 and 3). Chapter 6 provides an application of the same methodology used in Chapters 2–5 of the report, using data from only one country, Tanzania. Chapter 7 focuses on the complex relationship of the basic determinants of nutrition such as income growth, income stability, and parental education with child stunting (Question 4). Finally, Chapter 8 synthesizes the main findings of this report with the lessons offered from successful country-level multisectoral initiatives on nutrition, to identify the key ingredients of a multisectoral strategy to the reduction of undernutrition that maximizes the potential to produce the desired outcomes in practice.

Endnotes

1. This 2014 figure is agreed upon by the United Nations Children's Fund (UNICEF), the World Health Organization (WHO), and the World Bank. In statistical terms, a child is stunted if his/her height-for-age Z score (HAZ) is less than 2 standard deviations (s. d.) from the median height of a healthy reference population (that is, HAZ < - 2).
2. Along parallel lines, initiatives aim to foster knowledge exchange and cross-sectoral collaboration and coordination at the project level for improving nutrition (Secure Nutrition Knowledge Platform, World Bank).
3. The Annex of the country-specific notes can be accessed at: http://documents.worldbank.org/curated/en/467711529406437446/

CHAPTER 2

Methodology and Data

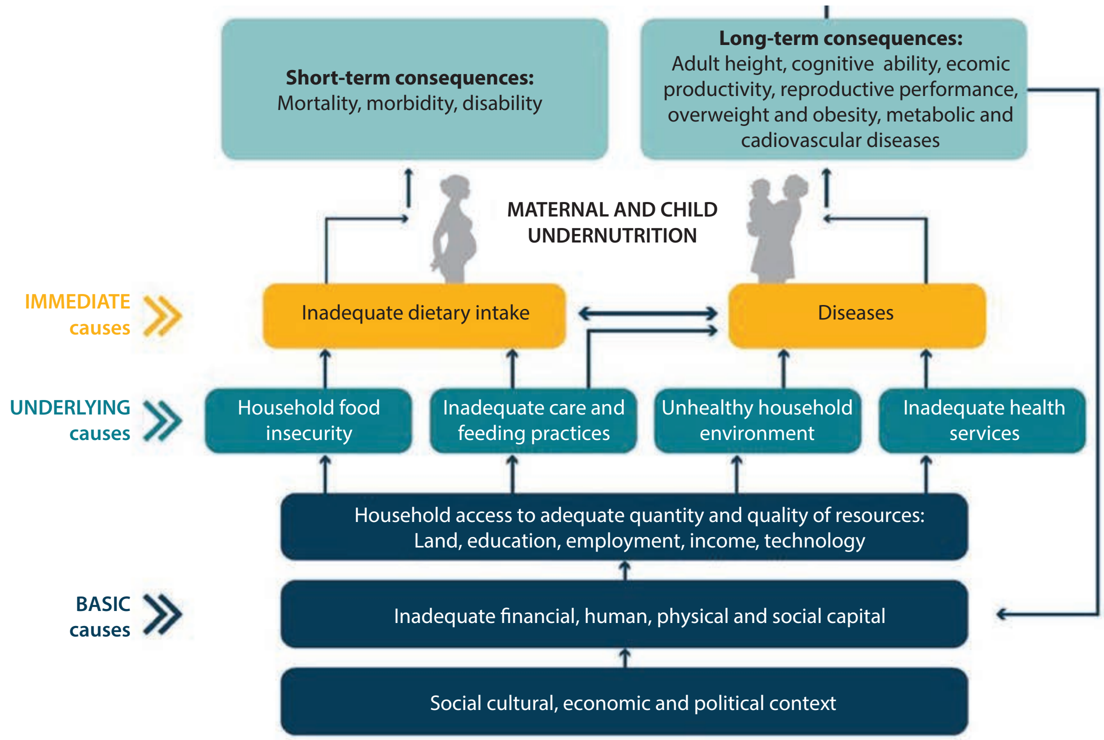
The UNICEF Conceptual Framework

The conceptual framework summarized in Figure 2.1 models undernutrition as the consequence of a variety of interlinked and interrelated factors. The causes of undernutrition are classified into three hierarchical categories: (a) the immediate causes, (b) the underlying causes, and (c) the basic causes of undernutrition. In any given context, identification of the *immediate* causes of undernutrition (disease or inadequate dietary intake) is useful for guiding policy actions, especially in situations of crises. However, disease and inadequate dietary intake are typically consequences of a variety of underlying drivers that are interrelated. For conceptual simplicity, the *underlying* causes of undernutrition are themselves grouped into the four clusters which manifest themselves mainly at the household level: (a) inadequate household food security, (b) inadequate care and feeding practices, (c) unhealthy household environment, and (d) inadequate health services. The *basic* causes of undernutrition summarize the social, cultural, economic, and political context and the prevailing inequalities in the distribution of resources in the society. In combination, these contextual or structural factors play a fundamental role in the extent to which there are inequalities among households and their members in having adequate food security, care, and feeding practices, healthy environment and adequate health services (that is, the underlying causes of undernutrition).

Since its conception, this conceptual framework has been revised and extended in various dimensions. Various international organizations have adopted this framework as well. For example, FAO (2011) discusses adaptation of this framework for nutrition analysis of the Food and Agriculture Organization (FAO). U. S. Agency for International Development - Food and Nutrition Technical Assistance (USAID—FANTA) also adapted this framework (Riely et al. 1999). World Food Programme (WFP) refers to it as the Food and Nutrition Security Conceptual Framework in its Emergency Food Security Assessment Handbook (WFP 2009, 25).

The latest reincarnation of the original UNICEF framework is the framework for actions to achieve optimum fetal and child nutrition and development from the Lancet Maternal and Child Nutrition Series (2013) (Black et al. 2013). This updated framework distinguishes between parental care 'practices' (or behaviors) and parental care 'resources', with the former being considered as an important component of the nutrition-specific interventions delivered primarily through the health system to address the immediate determinants of fetal and child nutrition and development and latter being considered as part of the nutrition-sensitive interventions delivered through the other sectors (other than health) (see Figure 2.2). In contrast, in the original version of the UNICEF model, the distinction between care practices/behavior and care resources is not prominent, with care practices (and care resources) being considered jointly as underlying determinants of child undernutrition. Regardless of the adaptations and the extensions to the original framework, the underlying determinants of nutrition consisting of food security, environment and health, and care, have remained at the core.

Figure 2.1 Determinants of child nutrition

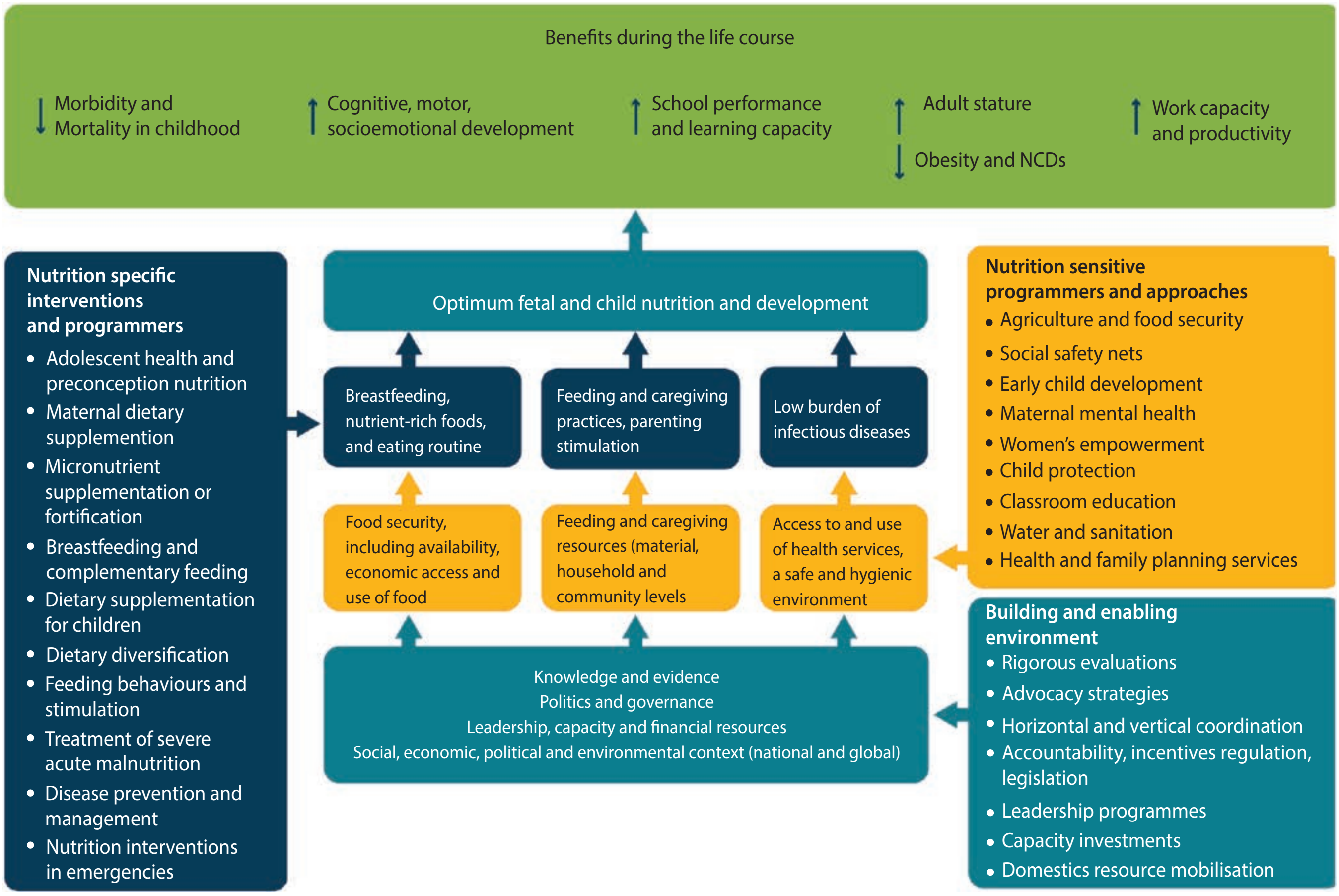


Source: An adaptation of UNICEF 1990.

With this background in mind, this report focuses primarily on the underlying determinants or drivers of nutrition as an entry point to a more systematic analysis of how different sectors can contribute to the declined in undernutrition not only in theory but also in practice.

The first underlying driver of nutrition is adequate food security at the household level. The 'ideal' measure of food security consists of four broad dimensions: availability, access, utilization, and stability (over time) (Barrett 2009). Availability is associated with the supply side of food either at the national (or regional or village or local market) level and it is measured based on agricultural production relative to the size of consumption. Access, on the other hand, is associated with the demand side: conditional on what is available in the local market and the price at which it is available, what is the range of food choices that are open to households given their incomes? Conceptually, it is this dimension of food security that has the strongest resonance with poverty and vulnerability not only because of its direct relationship with income but also because of its links to broader issues of social and political enfranchisement. Food security of individual household members, for example, hinges on their social standing within the household almost as much as it does on the household's overall ability to procure enough food (vulnerable groups within the household may include children, daughters, daughters-in-law, the elderly). The utilization dimension brings to bear the quality dimension of the accessed food. Do households make good use of the food they are able to access? Are diets diverse enough to provide all the micro and macronutrients necessary for healthy physiological and cognitive growth? Are cooking methods sanitary and healthy enough to preserve the nutritional attributes of the eaten food? Finally, stability in some ways cuts through the other three themes and captures how robust availability, access, and utilization are to seasonal patterns prevailing through the agricultural production cycle (planting versus harvesting season) or in the event of unexpected shocks such as political, economic, or climate/weather related.

Figure 2.2 Framework for actions to achieve optimum fetal and child nutrition and development



Source: Black et al. 2013.

The second driver of nutrition is access to adequate care. This driver summarizes the ability of the primary caregiver to provide a safe and appropriate environment for the child to grow and develop. Ideally, it should be measured based on the child's caregivers' (1) knowledge, practices, and beliefs regarding childcare; (2) health and nutritional status; (3) mental health, stress level, and self-confidence; (4) autonomy and control of resources; (5) workload and time constraints; and (6) social support received from family members and the community (Engle, Menon, and Haddad 1999).

The third driver is access to a healthy environment, summarized by the WASH services and conditions prevailing in the household or in the community. This driver summarizes the child's exposure to pathogens in the physical environment where they live and is measured based on the definitions adopted by the WHO/UNICEF Joint Monitoring Program (JMP) and as part of monitoring the Sustainable Development Goals (SDGs). Its components include (1) access to improved drinking water, (2) access to improved sanitation, (3) adequate handwashing practices, and (4) adequate disposal of child's feces. Given that it is not only the child's immediate environment, that is, the facilities at the dwelling unit, but also those in the immediate neighborhood which affect the degree of exposure to pathogens, community-wide access to improved sanitation is a fundamental component.

The fourth driver is access to adequate health care. This driver summarizes the child's access to skilled medical care to minimize the effects of illness and preventively address health issues, especially those linked with undernutrition, such as diarrheal diseases. The measure encompasses the availability and use of health care services for prenatal, birth, and postnatal care.

Caveats and the Contributions of this Study

While the conceptual framework outlined above represents a useful way for thinking about the variety of determinants of child nutrition, it is also important to bear in mind the constraints encountered in quantifying and measuring its components.

Smith and Haddad (2015) is one of the first econometric applications of the UNICEF conceptual model of the underlying and basic determinants of nutrition based on data from 116 developing countries collected over 1970–2012. The analysis in this report builds on this earlier study with the difference that the focus of this study is at the child level in countries in the African Region rather than at the country level. The discussion in the following paragraphs outlines the value added of carrying out the analysis at the child level.

The analysis in this report relies on recent DHS. The next section provides a more detailed description of the specific *components* of care, health, environment, and food security that can be constructed based on the data available in a typical DHS. While the data available in these surveys are far from being able to cover the full spectrum of factors considered as important determinants of nutrition for the factors that are available, such as the few components of care or food security, it is not possible to distinguish between practice (or utilization) and availability or accessibility of the resource available. This is because the data collected in these types of surveys reflect only utilization (or behavior), which is conditional on the availability of the relevant resource. For example, the information that a child was immunized reveals that the mother took the child to the available health center for the shots. If the child were not immunized this does not imply that there is no health center in the community. In fact, there are two possibilities: first, it is possible that there is a health enter in the community (that is, mother had access) but she faced constraints that prevented her from immunizing her child; second, it is possible that there is no health center within reasonable distance from the community (no access). Thus, coverage of stunted communities or stunted children by a given sector and therefore the extent to which sector-specific interventions are targeted toward stunted children can be identified only if there was reported utilization of the sector service or facility by anyone in the community.[1]

Considering all the preceding qualifications and caveats, one question concerns the value added of this report in terms of its additions to the stock of knowledge and its implications for operations. First, the primary benefit derived from the proposed analysis is the fact that in spite of the shortcomings associated with data sources such as the DHS in relation to measuring or categorizing the various components of the determinants of undernutrition, the information available at the child level in these surveys allows one to get a better sense about the joint distribution of the variety of determinants of undernutrition. Information about the joint distribution of these determinants is essential for identifying particularly important gaps (for example in water and/or sanitation) which may affect the impact of other nutrition-related interventions.

As emphasized in the literature of multidimensional poverty, the 'joint distribution' of deprivations (or the lack of access to an adequate level of the various determinants of undernutrition) contains more information than the 'marginal distribution' of deprivations (Atkinson 2003; Bourguignon and Chakravarty 2003; Alkire and Foster, 2011a, 2011b; and Duclos, Sahn, and Younger 2006). For example, a univariate analysis carried independently by any given sector, such as agriculture, for specific determinants of undernutrition (for example, food security and dietary diversity), *without taking into consideration other determinants* of undernutrition typically in the purview of another sector (for example, water and sanitation), is unable to provide much guidance on the geographic areas where the interventions in the agriculture sector are likely to be less or more effective in terms of their effect on undernutrition. In contrast, a multivariate analysis of the simultaneous (or lack of) access to adequate food security *and* water and sanitation services is able to provide a more holistic view and pinpoint better the groups of children and the geographic areas where these inadequacies are prevalent. This enables the joint prioritization of operations and improved cost efficiency of interventions aimed at contributing to the reduction of undernutrition in the agricultural and water and sanitation sectors. In addition, one of the potential contributions of this study is to highlight the shortcomings in the availability of data necessary for tracking the components of adequate food and care, health, and WASH.

Second, the availability of child anthropometric measures together with information on the joint distribution of access (or lack of access) to adequate levels for some of the key determinants of nutrition can shed light on the extent to which the underlying components are substitutes or complements among each other. Based on a strict interpretation of the original UNICEF conceptual framework of the factors considered as important for child nutrition (Figure 2.1) or of the actions necessary to achieve optimal fetal and child nutrition and development (see Figure 2.2), all of the components of the underlying determinants of nutrition, or the actions needed, appear to be strict complements. However, the extent to which specific components are complements or substitutes is mainly an empirical question that seems to have received very little attention in the field of nutrition.

Third, the report also reevaluates the role of household income in child nutrition. Income is a basic determinant of nutrition that underpins much of the demand for the underlying drivers of nutrition. Specifically, two different dimensions of income are investigated: income level and income variability. A multisectoral approach aiming to increase access to the underlying determinants of nutrition needs to be cognizant of the fact that household constraints faced at different points in time may interact with utilization and behavior. The implication worthy of serious policy consideration is that multisectoral interventions against undernutrition may be more effective if accompanied by broader development policies that mitigate the impacts of weather-related risks such as crop and/or weather insurance policies.

The analysis is based on 33 recent DHS from the Africa Region. Of the 33 countries, 32 are part of the global SUN initiative.[2] The main selection criterion for inclusion into the group of countries analyzed is that the survey had to be quite recent, that is collected in 2010 or later.[3] DHS contain rather limited information on the components of food security and child care. However, this shortcoming is compensated by the availability of child anthropometric measures in all countries covered and the information on the joint distribution of access (or lack of access) to adequate levels for some of the other underlying determinants of nutrition, such as access to improved water and improved sanitation (WASH), and access to health services, according to internationally accepted standards. In contrast, other surveys such as the Living Standards Measurement Surveys (LSMS) contain more information on food and non-food consumption and other dimensions of food security, and sometimes repeated observations (panel data) on the same children and households but at the expense of more limited country coverage, lack of information on anthropometric measurements, or insufficient information for the construction of measure of WASH and health internationally accepted standards.

The 33 countries were also categorized into different groups for the purpose of making some useful and interesting comparisons. Each country is categorized as having high or low gross national income (GNI) per capita, high or low-income inequality, and high or low average tariff rates on primary products. In addition, 1st wave, landlocked, and countries or subnational regions comprising the Sahel region are identified. Within the set of countries that are designated as fragile, the countries are characterized by their degree of fragility.

Table 2.1 lists the 33 countries included in the report along with their different groupings: high and low GNI per capita countries based on the most recent GNI per capita and inequality index (Gini) for the country in the World Development Indicators.[4] The 33 countries in the study are divided into two groups, with 16 countries categorized as high GNI per capita or high Gini countries and 17 countries as low GNI per capita or low Gini countries. The measure of income used is the purchasing power parity (PPP) GNI per capita. The high GNI per capita countries have per capita GNI ranging from 1,950 PPPs in Chad to 16,720 PPPs in Gabon. The low GNI per capita countries have GDP per capita ranging from 700 PPPs in Liberia to 1,920 PPPs in Zimbabwe. The Gini coefficients in the high-income inequality countries range from 43 (Nigeria) to 61 (Namibia). The Gini coefficients in the low- income inequality countries range from 31.5 (Niger) to 42.8 (Ghana).

Landlocked countries are those within the sample which do not border either the Atlantic Ocean or the Indian Ocean. There are 12 landlocked countries and 21 non-landlocked countries. Landlocked countries are determined by their lack of access to either the Atlantic Ocean or the Indian Ocean. The landlocked countries are Burkina Faso, Burundi, Chad, Ethiopia, Lesotho, Malawi, Mali, Niger, Rwanda, Uganda, Zambia, and Zimbabwe. High and low tariff countries are based on weighted average tariff on primary

Table 2.1 Characterization of countries included in the study

Country	*DHS year*	*GNI (latest)*	*Gini (latest)*	*Tariff (latest)*	*Starch in diet*	*Landlocked*	*Sahel*[a]	*1st Wave*	*Fragile*
Angola	2015–16	High	Low	High	Low				
Benin	2011–12	High	High	High	High				
Burkina Faso	2010	Low	Low	High	Low	√	√	√	
Burundi	2016–17	Low	Low	Low		√			High
Cameroon	2011	High	High	Low	Low		√[a]	√	
Chad	2014–15	High	High	High	Low	√	√		Low
Comoros	2012	Low	High	Low					Low
Congo, Rep.	2011–12	High	High	High	Low				
Côte d'Ivoire	2011–12	High	High	High	High			√	High
Congo, Dem. Rep.	2013	Low	Low	High					High
Ethiopia	2016	Low	Low	Low	High	√	√[a]	√	
Gabon	2012	High	Low	High	Low				
Gambia, The	2013	Low	High	High	Low				Low
Ghana	2014	High	Low	High	Low				
Guinea	2012	Low	Low	High	Low				
Kenya	2014	High	High	Low	Low				
Lesotho	2014	High	High	High	High	√			
Liberia	2013	Low	Low	Low	High				High
Madagascar	2008–09	Low	Low	Low	High			√	High
Malawi	2015–16	Low	High	Low	High	√		√	
Mali	2012–13	High	Low	High	High	√	√	√	High
Mozambique	2011	Low	High	Low	High			√	
Namibia	2013	High	High	Low	Low				
Niger	2012	Low	Low	High	Low	√	√	√	
Nigeria	2013	High	High	Low	Low		√[a]	√	
Rwanda	2014–15	Low	High	Low	Low	√		√	
Senegal	2015	High	Low	High	Low		√		
Sierra Leone	2013	Low	Low	High	Low				High
Tanzania	2015–16	High	Low	Low	Low			√	
Togo	2013–14	Low	High	Low	High				Low
Uganda	2011	Low	Low	Low	Low	√			
Zambia	2013–14	High	High	Low	High	√			
Zimbabwe	2015	Low	High	Low	Low	√			Low

Note: The data, except for diet composition, were downloaded from http://wdi.worldbank.org/tables, in January 2018. The GNI measure (in PPP) is from Table 1.1, the Gini measure is from Table 2.9, and tariff rates (weighted) from Table 6.6. The degree of fragility is found in Table 5.8. The share of diet from cereals and starchy roots in the national diet come from FAO (http://www.fao.org/3/a-i4175e.pdf). If above 66 percent, the share is considered high.

a. The Sahel region includes the following subnational regions: Centre-Nord, Est, Nord, and Sahel from Burkina Faso; Extrême-Nord, and Nord from Cameroon; Batha, Guéra, Hadjer-Lamis, Kanem, Lac, Ouaddaï, Wadi Fira, Bahr el Gazel, and Sila from Chad; Affar, Amhara, and Tigray from Ethiopia; Kayes, Koulikoro, Sikasso, Segou, Mopti, and Bamako from Mali; all regions except Agadez from Niger; North regions from Nigeria; and all regions except Ziguinchor, Kolda, Kedougou, or Sedhiou from Senegal.

products. Countries with higher tariffs are presumed to have higher food prices on average which could be contributing to child undernutrition, especially in poorer countries. The tariffs in the high tariff countries range from the Democratic Republic of Congo's 11 percent to Chad's 21 percent. In the low tariff countries, tariff rates range from Namibia's 1.1 percent to Togo's 10.3 percent. The share of the diet from cereals and starchy roots in the national diet is used to classify countries as having a high starch diet or a low starch diet. If the share of starches is above 66 percent, then a country is classified as a high starch diet country.[5]

The Sahel region includes the following subnational regions: Centre-Nord, Est, Nord, and Sahel from Burkina Faso; Extrême-Nord, and Nord from Cameroon; Batha, Guéra, Hadjer-Lamis, Kanem, Lac, Ouaddaï, Wadi Fira, Bahr el Gazel, and Sila from Chad; Affar, Amhara, and Tigray from Ethiopia; Kayes, Koulikoro, Sikasso, Segou, Mopti, and Bamako from Mali; all regions except Agadez from Niger; North regions from Nigeria; and all regions except Ziguinchor, Kolda, Kedougou, or Sedhiou from Senegal. The 1st wave countries are those countries designated by the World Bank. Fragile countries are based on the World Bank list of fragile countries in 2015. For this report, the fragile countries are categorized as high or low fragility based on their resource allocation index by International Development Association (IDA).[6]

The asset or wealth index that is publicly available with the DHS data includes WASH-related variables as part of its components. Given the focus of the report on WASH as an underlying determinant of nutrition, a new asset index was estimated excluding WASH from the components of the index, and this author-constructed index is used throughout the report. All households in each country survey are used (and not just households with children) for the construction of this index. Thus, the 'new' asset or wealth index estimated is based on the first principal component of ownership of radio, fridge, bike, motorcycle or scooter, car or truck, and mobile phone; dwelling having electricity; the number of rooms per household member; the type of floor material; the type of wall material; and the type of roof material. In the majority of the regressions, the wealth of the household is represented by five binary variables indicating the quintile of the value of the wealth index of the household in the national distribution of the asset index. In contrast in Chapter 6, where a more detailed analysis is carried out on the association between household income as proxied by the value of household asset index and HAZ scores, the percentile of the value of the asset index is used as a continuous variable. The wealth distribution is determined for each country separately. In some of the figures, the bottom and top quintiles are used to explore differences in stunting and access to the underlying drivers of nutrition by wealth.

Endnotes

1. Also, there is no information available in the DHS on whether there is an ongoing nutrition-specific and/or nutrition-sensitive interventions that children are exposed to.
2. More information on the SUN initiative and the countries participating in the SUN initiative can be found at http://scalingupnutrition.org/sun-countries/about-sun-countries/.
3. An execption is Madagascar, which was included in the study even though the DHS was collected in 2008–09.
4. The data were downloaded from http://wdi.worldbank.org/tables, in January 2017. The GNI measure is from Table 1.1, the Gini measure is from Table 2.9, and tariff rates from Table 6.6. The degree of fragility is found in Table 5.8.
5. Starch shares in the country diet were accessed from FAO http://www.fao.org/3/a-i4175e.pdf.
6. The index considers 16 criteria in peace building and peacekeeping, battle-related deaths, intentional homicides, military expenditure, crime, and informality.

CHAPTER 3

Stunting in Sub-Saharan African Countries

Figure 3.1 presents the stunting rates of younger (0–24 months) and older children (24–59 months) in each of the countries in the study. This figure shows quite clearly that the stunting rates are higher for older children (24–59 months) than for younger children (0–24 months). This pattern is a consequence of the growth faltering that occurs after birth. Growth faltering is the rapid decline in height- and weight-for-age of children in the first two years of life and is common in many developing countries. Growth faltering among children was first documented in a study by Shrimpton et al. (2001) and to a large extent, it is in response to these finding that several global health policy and information campaigns with emphasis on the first 1,000 days window have been initiated (Prentice et al. 2013).

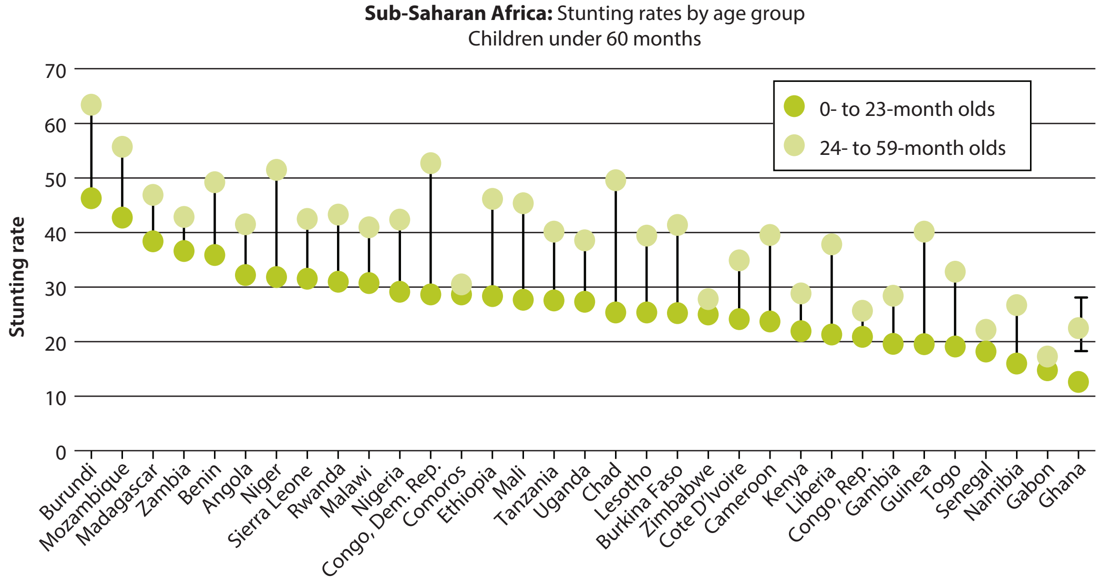
Figure 3.2 presents the cross-sectional age profile of HAZ scores for children between 0 and 59 months of age in the 33 countries from SSA analyzed in this report. As can be seen clearly, HAZ decreases rapidly in the first 21 months of life, continues decreasing at a slower pace after 21 months bottoming out at around 33 months of age, and increasing at a very slow rate afterwards with only minor fluctuations.[1]

Figure 3.3 presents the growth faltering curves for selected groups of countries (1st wave versus others, and Sahel versus others) as well as urban versus rural areas within countries, boys versus girls, and different socioeconomic groups within countries. Growth faltering is slightly faster in 1st wave countries and in countries in the Sahel region, which highlights the urgency for policy action in these groups of countries. Also, the differences in the pattern of child growth faltering with maternal characteristics such as the level of education of the mother or the level of wealth of the household (for example, bottom or top 20 percent of the wealth distribution) attest to the important role of the basic determinants in child stunting and underlines the need to also improve maternal and income conditions of the households with stunted children.

Given the critical importance of intervening earlier in a child's life to prevent growth faltering, most of the analysis and discussion in this report will focus primarily on the prevalence of stunting rate and the underlying determinants of stunting among children between 0 and 23 months of age.

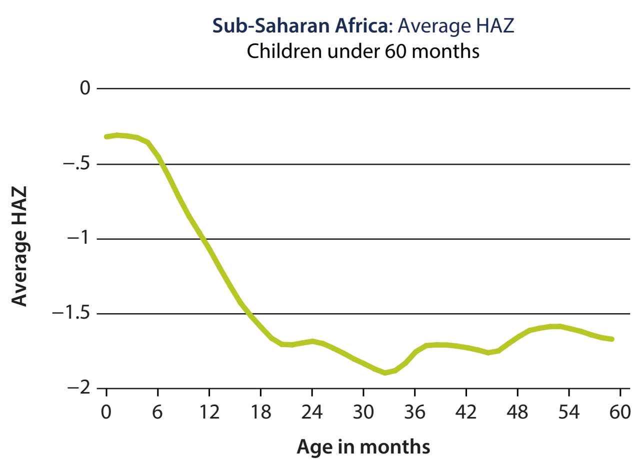
The stunting prevalence among children under 24 months of age in the pooled sample of countries is 28 percent. However, there are differences in the distribution of height-for-age and stunting for different population groups. Figure 3.4 presents the probability density functions (PDFs) of HAZ scores for rural and urban areas in the sample of 33 countries and for different socioeconomic groups. The area under the probability density function to the left of the red vertical line at the HAZ score of –2 provides a visual representation of the fraction of the child population that is stunted. Rural children are more likely to be stunted than urban children (see panel (a) in Figure 3.4). Nearly 31 percent of the rural children are stunted compared with 22 percent of urban children. Both boys and children of mothers with less than seven years of education are more likely to be stunted than girls or children of mothers with at least seven years of education. The largest difference in the distribution of HAZ scores analyzed is by household wealth. Around 34 percent of children from the bottom wealth quintile families are stunted whereas only 17 percent of children from the top wealth quintile families are stunted.

Figure 3.1 Stunting prevalence among younger (0–23 months) and older (24–59 months) children within each country



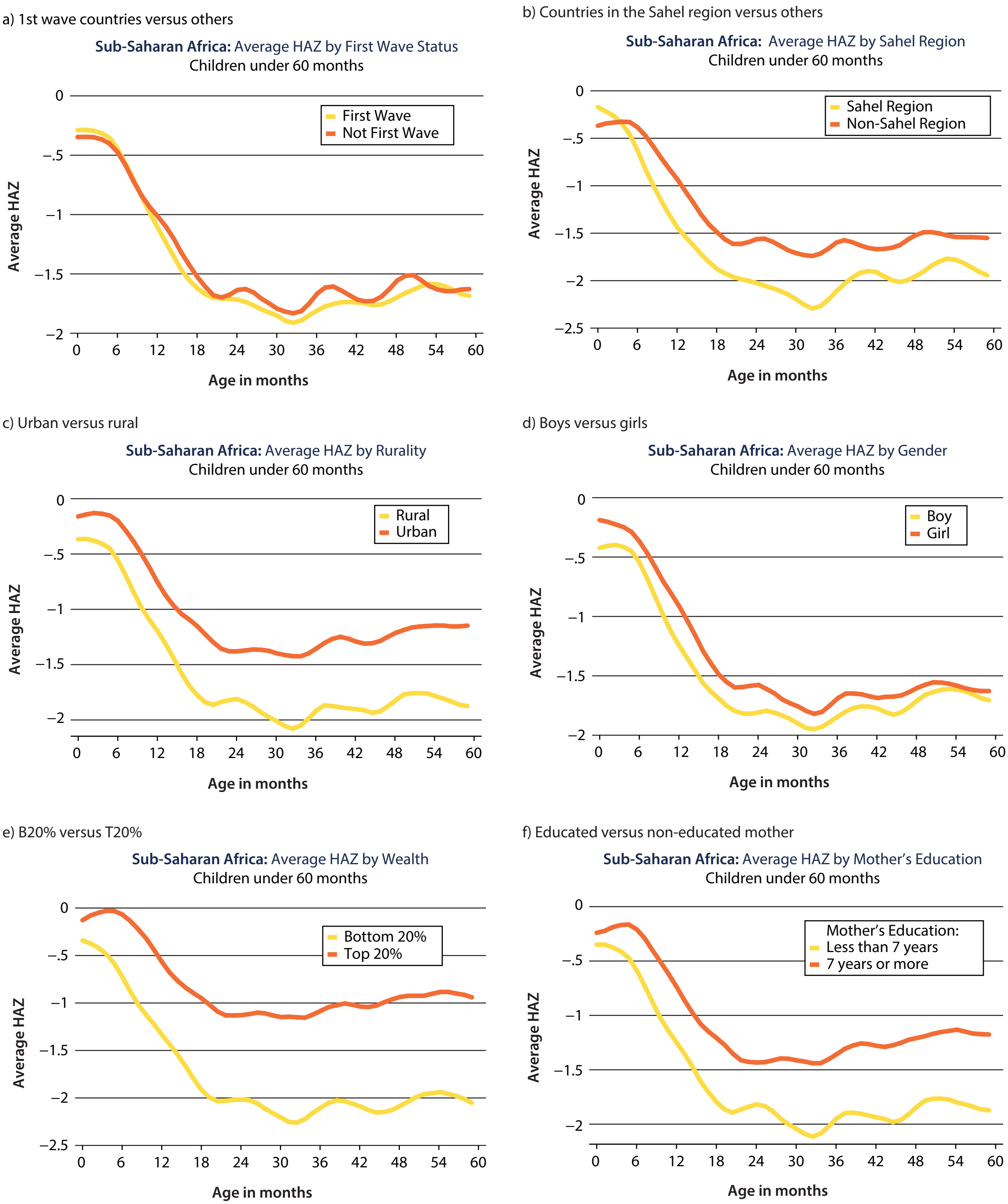
Source: World Bank staff estimates based on children less than 60 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.
Note: Sampling weights were standardized across the 33 DHS following the procedure outlined by DHS. The sampling weight of the mother was multiplied by the ratio of the total number of women 15 to 49 years of age in the surveyed country to the number of women (15 to 49 years of age) surveyed. The total number of women was obtained from the World Population Prospects by the United Nations (2015).

Figure 3.2 Growth faltering in SSA (children 0–59 months)



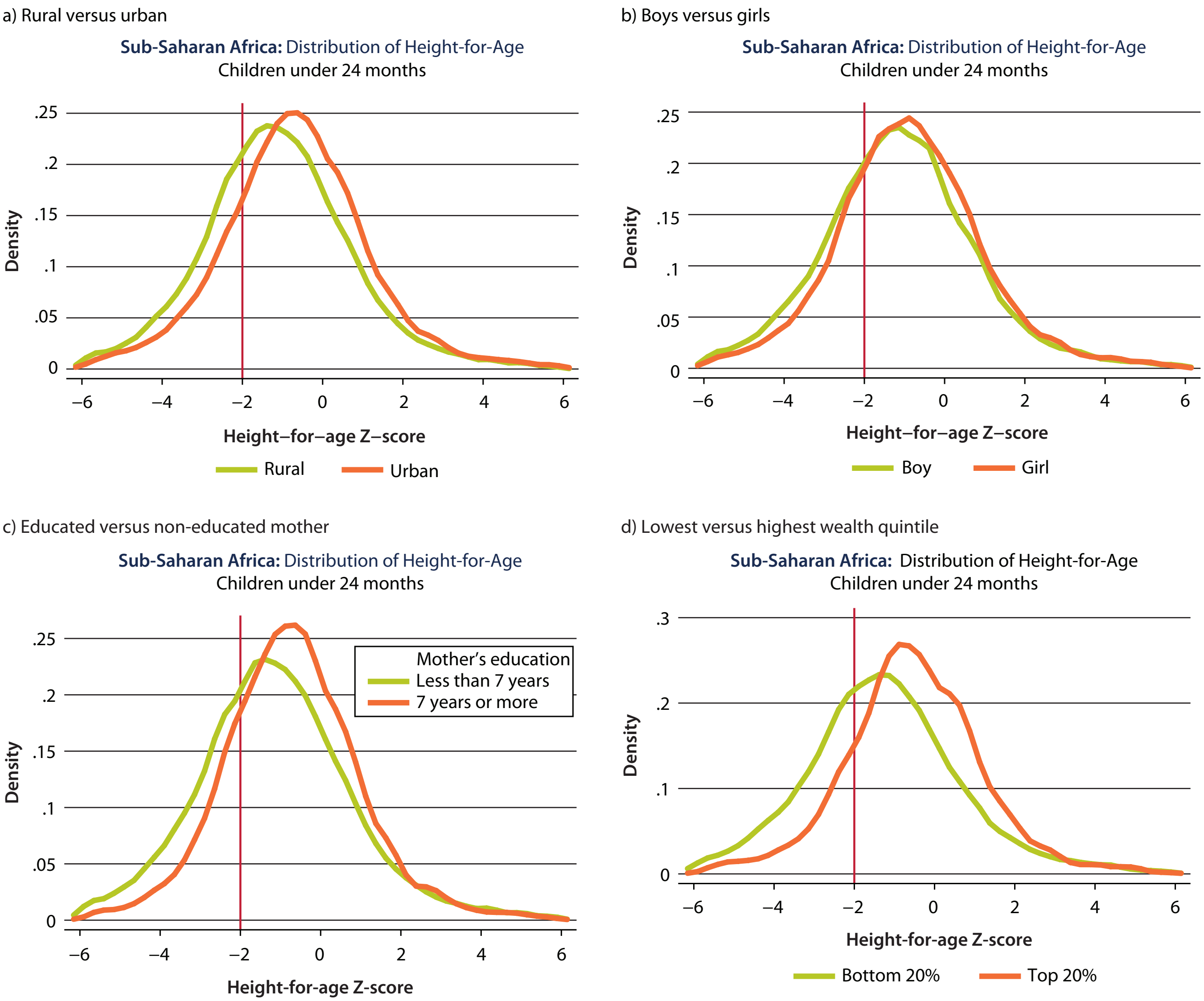
Source/Note: Same as in Figure 3.1: Stunting prevalence among younger (0–23 months) and older (24–59 months) children within each country.

Figure 3.3 Growth faltering in SSA by socioeconomic characteristics (children 0–59 months)



Source/Note: Same as in Figure 3.1: Stunting prevalence among younger (0–23 months) and older (24–59 months) children within each country.

Figure 3.4 Distribution of height-for-age for different populations in SSA

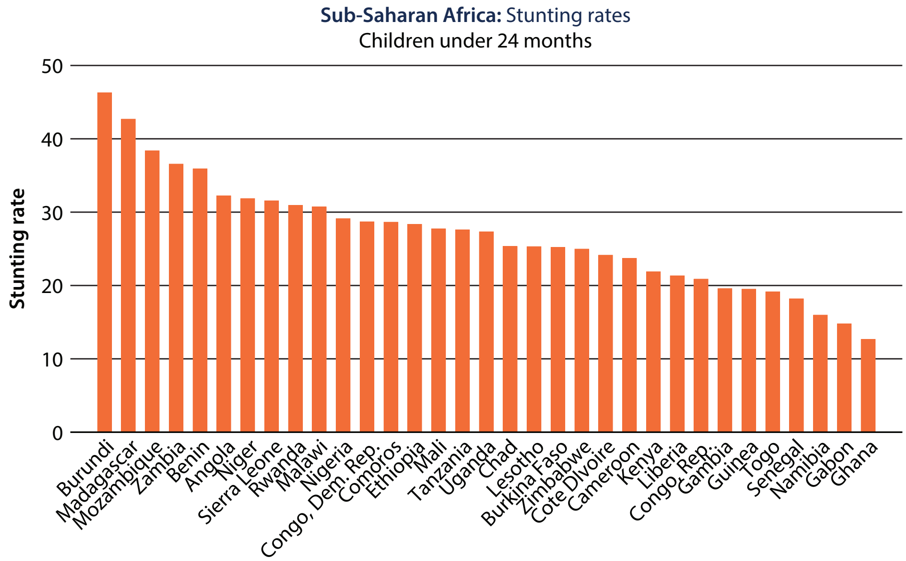


Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.
Note: Sampling weights were standardized across the 33 DHS, following the procedure outlined by DHS. The sampling weight of the mother was multiplied by the ratio of the total number of women 15 to 49 years of age in the surveyed country to the number of women (15 to 49 years of age) surveyed. The total number of women was obtained from the World Population Prospects by the United Nations (2015).

The main patterns summarized above also hold within each of the countries. However, country-specific estimates of stunting prevalence highlight not only the variability in stunting rates between countries but also the large differences *within* countries, particularly in relation to location (rural or urban) and the level of household wealth (B20 versus T20). Stunting among younger children (0–23 months) is high across the region with only Ghana (12.7 percent) and Gabon (14.8 percent) having a stunting rate below 15 percent. Nearly half of the children under 24 months of age are stunted in Burundi (46.3 percent) (see Figure 3.5).

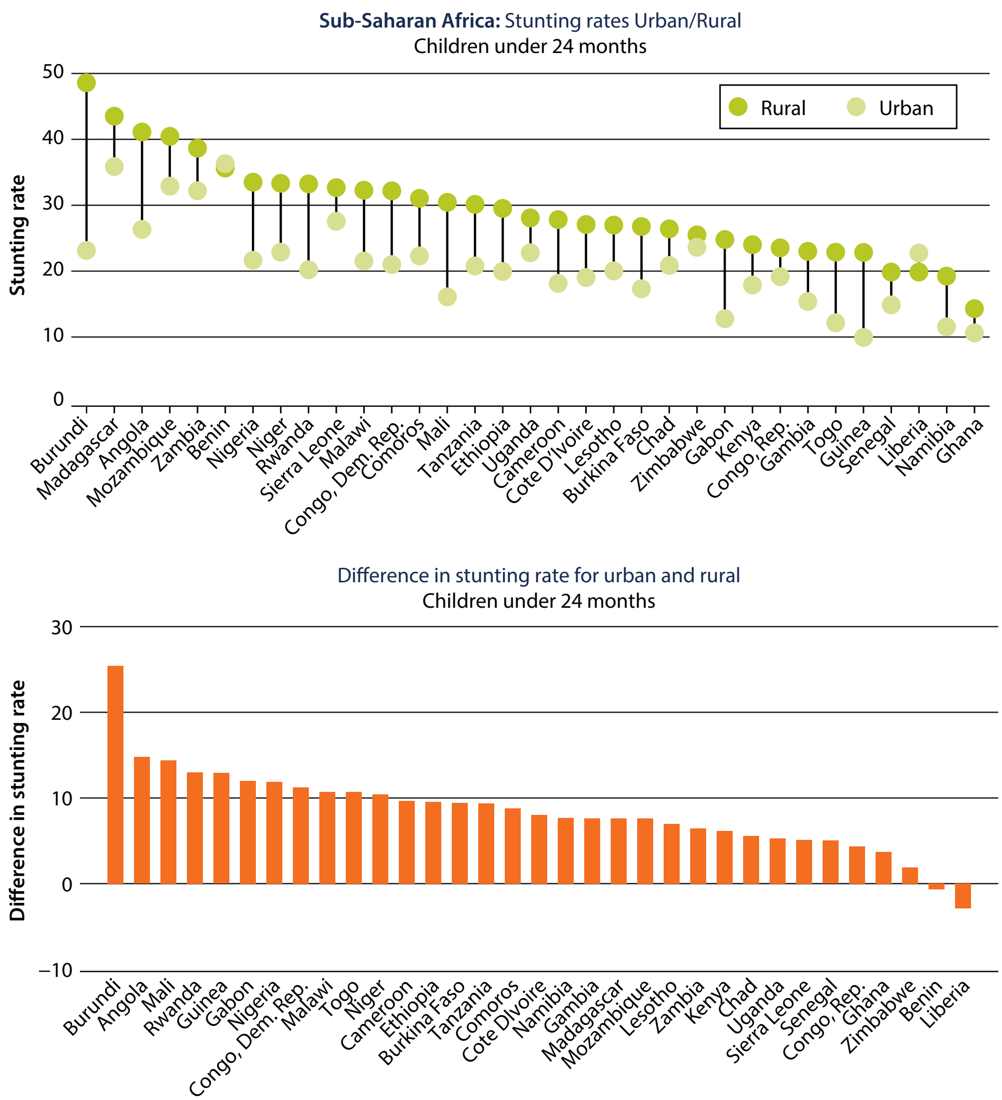
Also, across the countries studied, urban children tend to be less likely stunted than rural children. Liberia and Benin are exceptions; the point estimates for stunting are higher for urban children than for rural children (see Figure 3.6).

Figure 3.5 Stunting prevalence by country (children 0–23 months old)



Source/Note: Same as in Figure 3.4.

Figure 3.6 Stunting prevalence in urban and rural areas within each country (children 0–23 months old)

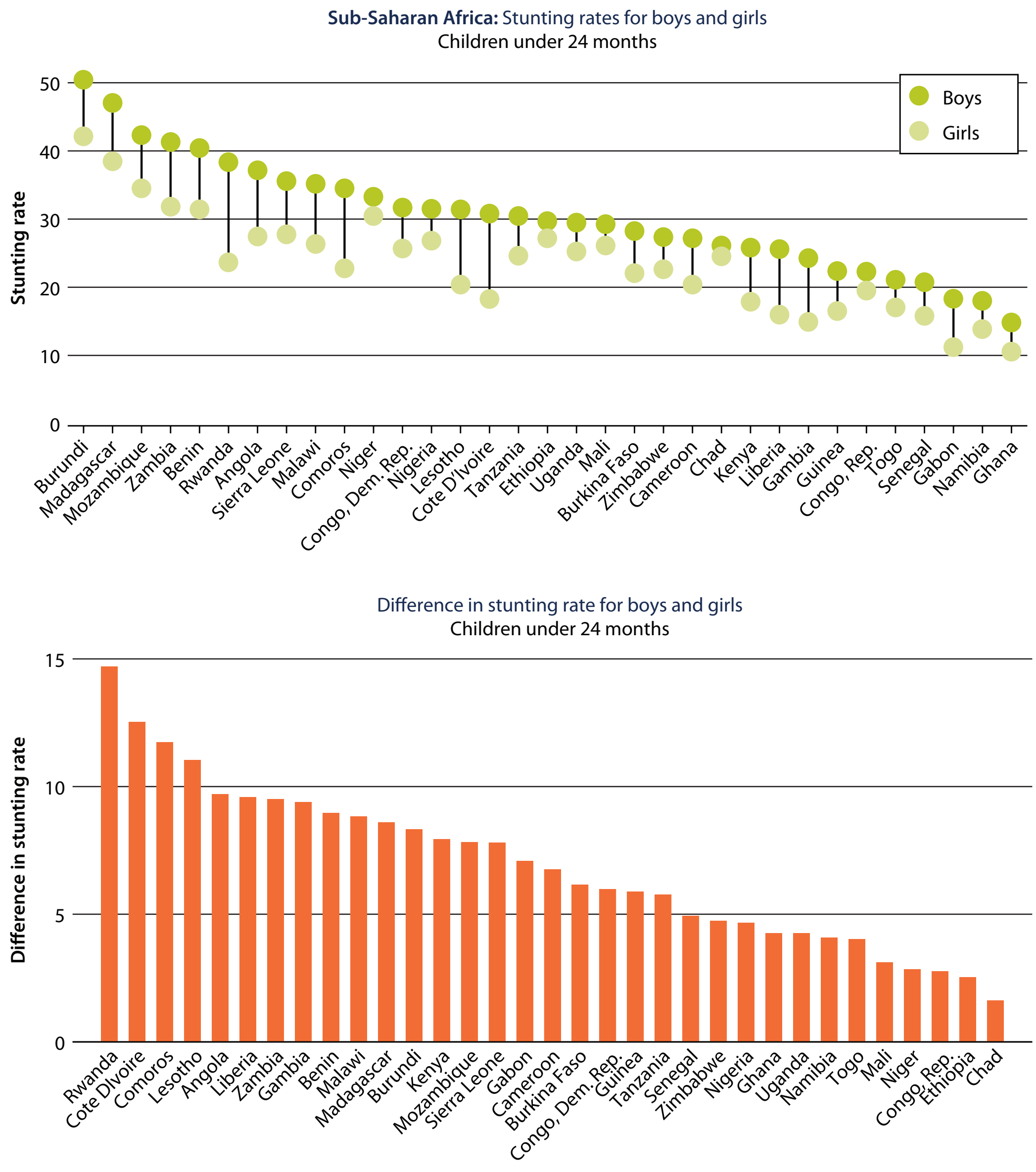


Source/Note: Same as in Figure 3.4.

The prevalence of stunting is higher among boys than among girls (see Figure 3.7), which is generally attributed to genetics though this does not preclude the discrimination in the allocation of household resources in favor of boys rather than girls. The prevalence of stunting is also higher among children in households at the bottom quintile (B20) of the distribution of assets within countries compared to children in households at the top quintile (T20) of the distribution (see Figure 3.8).

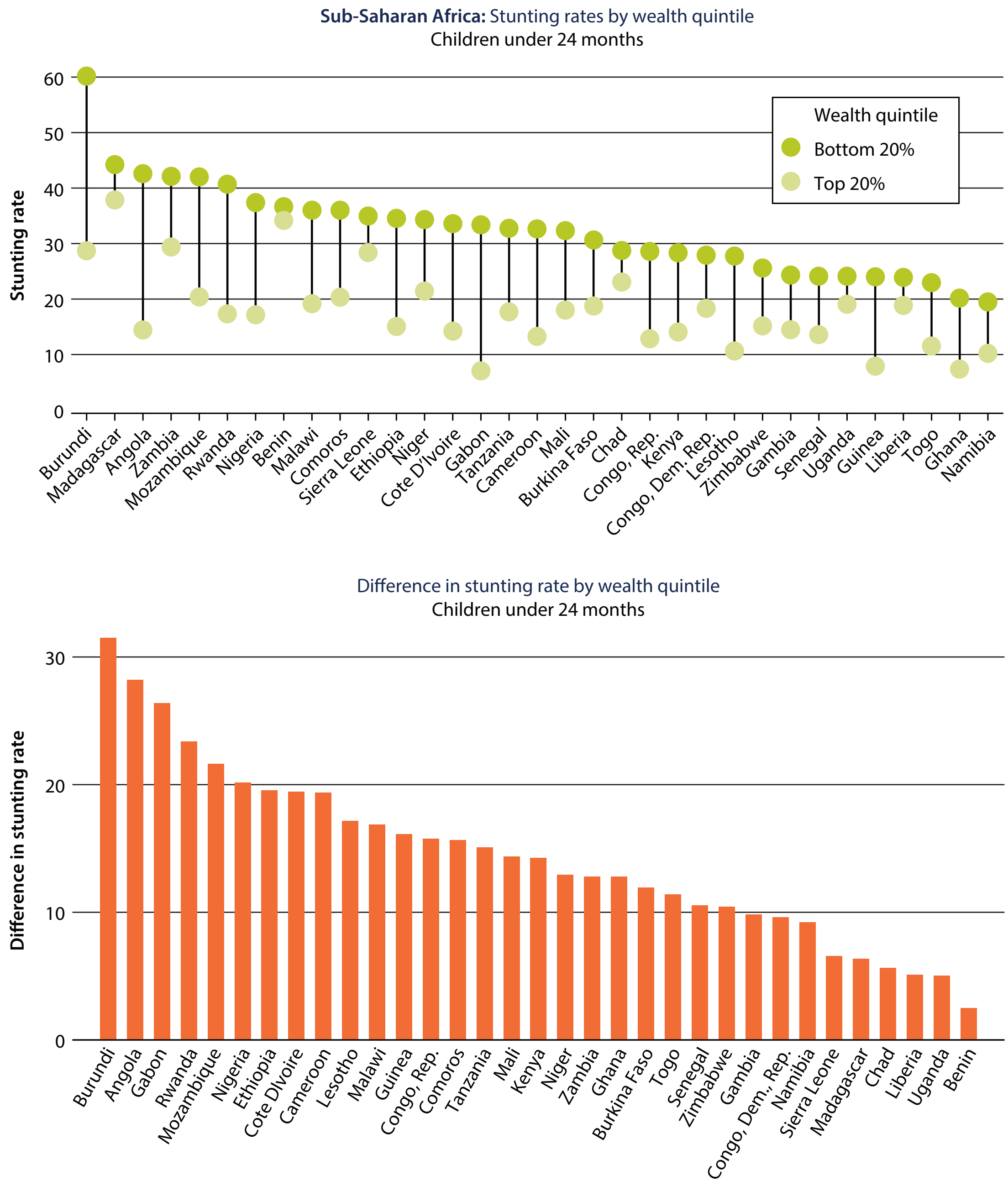
Finally, children whose mothers have less than 7 years of education are more likely to be stunted than children with mothers who have at least 7 years of education (see Figure 3.9). However, again Liberia is an exception where children with more educated mothers are on the average more likely to be stunted than children of mothers who are less educated. Nigeria and Burundi have the largest differences in the probability of being stunted depending on the mother's educational attainment.

Figure 3.7 Stunting prevalence among boys and girls within each country (children 0–23 months old)



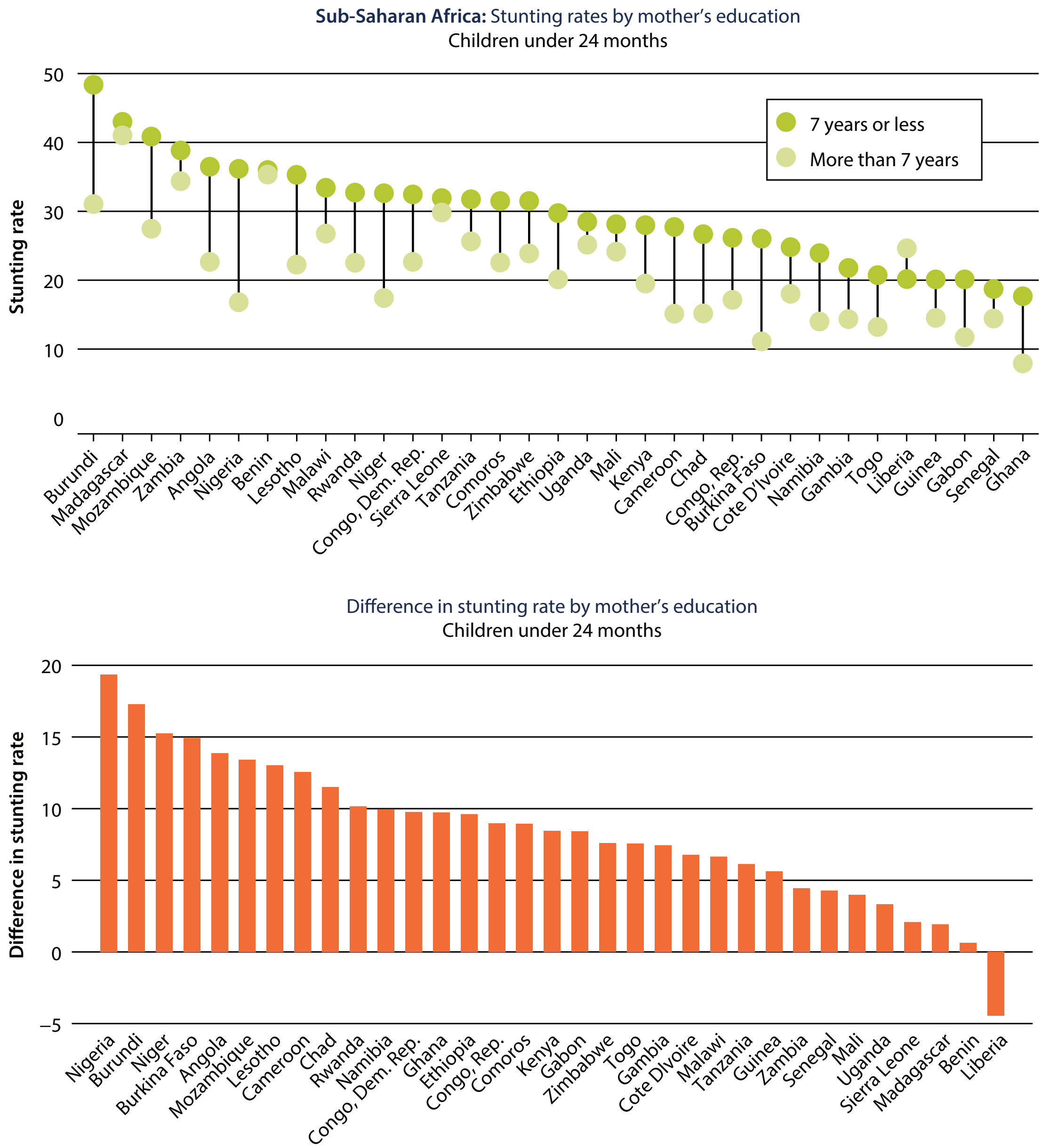
Source/Note: Same as in Figure 3.4.

Figure 3.8 Stunting prevalence by wealth quintile within each country (children 0–23 months old)



Source/Note: Same as in Figure 3.4.

Figure 3.9 Stunting prevalence by mother's education within each country (children 0–23 months old)



Endnotes

1. For a recent cross-country study on the determinants of growth faltering, see Rieger and Trommlevora (2016). The growth faltering curves derived using a local polynomial smooth of HAZ with the Stata command lpoly.

CHAPTER 4

The Underlying Determinants of Nutrition

Measurement is very important for a proper diagnosis of the longer-run constraints to reducing chronic undernutrition in any given context. Each of the three drivers of nutrition is inherently multidimensional, making measurement difficult and costly. This section briefly surveys the ideal measures of the drivers of nutrition and the actual measures used based on the information available in the DHS. The large gaps between the ideal measures and what is actually available in national surveys underlines the urgent need to include in nutrition surveys more and better measures of the different dimensions of food security at the household and ideally at the individual level as well as information on child care practices. In contrast, relatively more data seem to be available for the measurement of some of the components of environment and health, with the latter being measured almost as best as one could hope for. This is probably a reflection of the tradeoffs involved between more complete or better measurement and costs. Given constrained budgets for surveys collecting information on the different dimensions of nutrition, greater emphasis may be placed on collecting information on environment and health and, to some degree, in child care as these are collected at lower cost and perhaps even more reliably compared to the cost of a detailed survey collecting information on food availability, access, and utilization at the household or individual level.

Measures of Food Security and Child Care

Table 4.1 summarizes the various indicators of food security, each capturing different dimensions of the ideal food security measure and the indicators that can be constructed from the DHS in the countries studied. A detailed description of the different indicators of food security is contained in Tiwari, Skoufias, and Sherpa (2013).

The DHS datasets used in this study contain sufficient information to construct a dietary diversity score for the child and the minimum acceptable diet measure but lack information relevant for the other dimensions of food security. The minimum acceptable diet combines dietary diversity, breastfeeding, and meal frequencies whereas the dietary diversity score depends on the age of the child. Both are discussed in more detail below. Considering the absence of more data on different dimensions of food security, it is encouraging that the literature suggests that dietary diversity holds promise as a means of measuring household food security (defined as household energy availability) (Ruel 2002). Hoddinott and Yohannes (2002), for example, find strong associations between dietary diversity and per capita expenditures on food, as well as between dietary diversity and number of calories consumed from non-staples.

Adequate care measures the capacity of the child's caregiver to provide a healthy environment for the child to grow up in. Ideally, the measure is based on information on (1) the caregiver's education, knowledge, and beliefs; (2) the health and nutritional status of the caregiver; (3) the mental health, lack of stress, and self-confidence of the caregiver; (4) the caregiver's autonomy and control of resources; (5) the workload and time constraints of the caregiver; and (6) the social support received by the

Table 4.1 Components of food security measured

Ideal Indicators	*Available*
Children's Dietary Diversity Score (CDDS)	Yes
Mom's Dietary Diversity Score (MDDS)	No
Minimum Acceptable Diet (for children 6–24 months)	Yes
Household Food Insecurity Access Scale (HFIAS)	No
Food Consumption Score (FCS)	No
Relative prices of different food groups	No
Starchy staple ratio or the fraction of household calories derived from starchy staples	No

caregiver from family members and the community. The ideal components of an adequate care measure would include information on

- **Caring behavior: Breastfeeding and complementary feeding, health seeking, hygiene related**
  - Caregiver feeding behavior (observation of one or more eating episodes)
  - Caregiver responsiveness during feeding episodes
  - Frequency of behavior such as feeding, number of spoonfuls, number of touches
  - Breastfeeding practices (for example, exclusive breastfeeding up to 6 months, early initiation of breastfeeding, breastfeeding at 2 years)
  - Introduction of solid/semisolid/soft foods 6–8 months
  - Child feeding index (constructed from DHS data using the following yes/no questions: current breastfeeding, use of bottles, dietary diversity, feeding/meal frequency)
  - Taking a child to a health clinic for treatment of illness
  - Maternal hand-washing with soap
- **Maternal education, knowledge, and beliefs**
  - Years of schooling
  - Literate/illiterate (Self-reported, simple test or existing data)
  - Beliefs and knowledge about initiation of breastfeeding
  - Beliefs about complementary feeding—timing, types, control of intake
- **Workload and time availability of caregiver**
  - Observed time in child care (observed in sample of time or continuously)
  - Recalled time in child care (24-hour recall)
  - Quality of care during work time (characteristics of alternate caregivers, for example. age, gender)
- **Social support for caregiver**
  - Availability of alternate caregivers
  - Community support (assessment of community institutions for child care-feeding programs, child care programs)
- **Psychosocial care**
  - Caregiver/child interactions—naturalistic observation of caregiver and child for a short period (code variables such as delay to respond, type of response, level of vocalization by caregiver and child)
  - Child appearance (rating of appearance either in a public place or over a period of visits)
  - Caregiver's understanding of motor milestones

The DHS contains information only on a few of the caring behaviors, namely some information on breastfeeding and complementary feeding, as well as protective steps taken by the family to reduce susceptibility to mosquito-borne illnesses. Table 4.2 lists the ideal and the available measures. The measure of adequate care used and initial breastfeeding for immediate skin-to-skin contact has to have occurred within the first hour after birth. For children under the age of 6 months, adequate care consists of exclusive breastfeeding. For children 6 to 8 months of age we require complementary feedings. All children

Table 4.2 Components of care

Ideal	*Available*
Workload and time availability of caregiver	No
Social support for caregiver	No
Psychosocial care	No
Caring behaviors: Breastfeeding	Yes
Caring behaviors: Health seeking	No
Caring behaviors: Complementary feeding	Yes
Caring behaviors: Hygiene	No
Caring behaviors: Child feeding index	No

Note: Another important indicator of care is maternal education though there is no consensus on the threshold (or level of education) for adequate nutrition care behaviors.

under 24 months are required to be breastfed. Although the surveys have information on the educational level of the mother, the presumed caregiver, there is no consensus on how to translate that information to a measure of the mother's caregiving abilities and thus this is not included in the measure.

Based on the paucity of data available, the care components are combined into food and health. Although access to adequate food and access to adequate care measure important but different aspects of the nutritional environment that the child is exposed to, the two measures are combined into one for the purposes of this report. The choice is driven by the fact that the care-based measures available from the DHS are food based. Any recommendations toward adequate food (as possible to measure here) would also promote the caring behaviors that can be measured from the surveys. The additional measure of a child sleeping under a mosquito net is also considered a caring behavior by the caregiver to protect the child from malaria. This measure is included as a component of the health determinant given its nexus with illness prevention. These three components do not capture the breadth of the care determinant and thus the three care-based components are 'distributed' into food or health depending on which sector policies could potentially affect these caregiving behaviors.

Therefore, there are three components considered in the food and care determinant. The first is a measure the food quality—minimum acceptable diet. For children under the age of six months, the only acceptable diet considered is exclusive breastfeeding. For children 6 to 23 months of age, it depends on their Dietary Diversity Score (DDS) and meal frequency. The DDS is a measure of the nutritional quality of the food consumed. The WHO (2008) defines the DDS measure for children under 24 months based on the consumption of seven food groups consumed during the past 24 hours. The seven food groups considered are (1) grains, roots, and tubers; (2) legumes and nuts; (3) dairy products; (4) flesh foods including organ meats; (5) eggs; (6) Vitamin A rich fruits and vegetables including orange and yellow vegetables; (7) and other fruits. To have minimum acceptable diet, a child needs to have consumed from at least four of the seven categories. Furthermore, breastfed children 6 to 8 months of age need to be fed at least twice in the past 24 hours and children 9 to 23 months at least thrice. For non-breastfed children from 6 to 23 months of age, the child needs to be fed four times in the past 24 hours.

The other two measures are measures of care practices: early *initiation of breastfeeding* and *age-appropriate breastfeeding*. Early initiation of breastfeeding is measured as breastfeeding initiated within one hour of birth (WHO 2008). *Age-appropriate breastfeeding* is defined as children under 6 months of age being exclusively breastfed and all children 6 to 24 months of age being breastfed and children ages 6 to 8 months receiving complementary foods (WHO 2008).

For children to be considered adequate in the food/care determinant, they must meet the age-appropriate criteria for minimum acceptable diet and at least one of the two care practice measures. Information for the dietary diversity score is relatively consistent across the surveys. However, there is one notable exception, Uganda, where the survey used much more detailed food groupings and, potentially with the extra probing, additional valid data were gathered.

Table 4.3 Components of WASH

Ideal	*Available*
Access to safe water	Yes
Access to improved sanitation	Yes
Community level sanitation	Yes
Handwashing facilities	Yes
Feces disposal	Yes

Measures of WASH

The environmental indicators measure the sanitary and hygienic conditions in the dwelling where the child lives. Components that are considered relate to access to drinking water, access to sanitation, and the disposal of a child's stools. As per JMP classification, improved drinking water source is considered to be one that "protects drinking water from outside contamination, especially from fecal matter" (WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation 2015, 21). An *improved water* source is one that is piped into the dwelling, yard, or plot; comes from a public tap or standpipe; comes from a tube well or a bore well; comes from a protected well or spring; or is rainwater.[1] For most countries, bottled water is considered an unimproved source.

The JMP definition for *improved sanitation* is one "that effectively separates extra from human contact, and ensure that excreta do not re-enter the immediate household environment" (WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation, 2015, 20). Thus, households having access to a flush toilet, a ventilated improved pit latrine, a pit latrine with slab, or a composting toilet are considered to have improved sanitation. Unimproved sanitation facilities include pit latrine without slab, bucket, hanging toilet, or latrine or no facilities. The sanitation is considered improved only if it is not shared with other households.[2]

To capture the general sanitary conditions in the child's immediate surroundings, a measure of *community-level sanitation* is included. The measure is based on the percentage of households in the child's locality (that is, the primary sampling unit or PSU in which the child lives) who do not have access to any type of facility but resort to open defecation.[3] We use a threshold of 75 percent in these analyses. That is, for the community to not be an open defecation community, less than 25 percent of the households in the community use open defecation.

Two additional components are considered: *handwashing facilities* and *disposal of stools*. The household is classified as having appropriate handwashing facilities if such facilities, along with availability of water and soap or detergent, are observed by the interviewer. Child's stool disposal is considered adequate if the child's stools are disposed of into an improved sanitation facility, either as the child used the toilet or improved latrine herself or the stools were disposed of into the toilet or improved latrine.

A child is considered adequate in WASH if s/he meets at least three of the five components. When it is not possible to construct all five components, the possible set of components is reduced to four or three, but nonetheless the child still needs to meet at least three of the conditions for adequacy. For example, in the Republic of Congo where there is not information on handwashing facilities or feces disposal, a child must meet the remaining three conditions—access to improved water, improved sanitation, and community sanitation are required for the child to be considered adequate in WASH.

Measures of Health

The final driver is access to adequate health care. This driver summarizes the child's access to and utilization of skilled medical care to minimize the effects of illness and preventively address health issues, especially those linked with undernutrition, such as diarrheal diseases. The measure encompasses the availability and use of health care services for prenatal, birth, and postnatal care.

Table 4.4: Components of health

Ideal	*Available*
Use of prenatal services	Yes
Birth assisted by a health care professional	Yes
Postnatal checkups	Yes
Age appropriate immunization status	Yes
ORS use for treatment of diarrhea[a]	Yes, for those exhibiting symptoms in the prior 2 weeks.

Note: a. The use of ORS for diarrhea and antibiotics for pneumonia are measures often associated with adequate access to health services. However, given that information on such behaviors is only available for the subset of children with symptoms in the prior two weeks, these are not included.

The first measure considered is the use of prenatal services. The WHO (2007) recommends at least four *prenatal visits* by a pregnant woman and the adequacy measure uses four visits as the threshold. The second measure we explore is *birth assisted by a health care professional*—including birth assisted by a doctor, nurse, birth attendant, or midwife. The third measure considered is *postnatal growth control visit* as is an indicator of the child's health assessment by medical professionals after birth. The fourth component to be considered is *vaccination status*. The measure is based on the WHO's compilation of recommended vaccination schedules for each country.[4] The immunizations which are considered are: BCG, DPT, polio, measles, and yellow fever. In general, the vaccination schedule is as follows: BCG at birth; DPT/pentavalent at 2, 3, and 4 months; oral polio at 2, 3, and 4 months; measles at 9 months; and yellow fever, when part of the schedule, at 9 months. We allow for a three-month leeway in immunization compliance. For example, all infants zero to two months are considered in compliance with BCG regardless of actual vaccination status. Only at three months will a child be considered to be noncompliant with the BCG vaccination. Similarly, we apply the same three-month window to all vaccinations considered. The fifth health component considered is whether the child sleeps under a *mosquito net*.[5]

For a child to be considered as having access to adequate health, s/he must meet at least three of the five requirements. As with adequate WASH, if the survey did not collect information on all five components, then three or four components were considered. However, for adequacy in health, the child must meet three of the requirements.

Empirical Measures of the Underlying Determinants of Nutrition

In previous work, access to adequate level in any one of the nutrition drivers was defined based on a strict rule requiring that the child must have access to adequate level in each and every one of the components of the particular determinant (Skoufias and Vinha, 2017). Here a slightly different, less stringent, approach is followed. A child is considered as having access to adequate level in an underlying driver if he/she meets a certain number of the components. This approach, which is the intermediate case of the *union* and the *intersection* approaches to defining multidimensional poverty discussed in detail Atkinson (2003) and Alkire and Foster (2011a), allows some substitutability among the components of any given nutrition determinant.

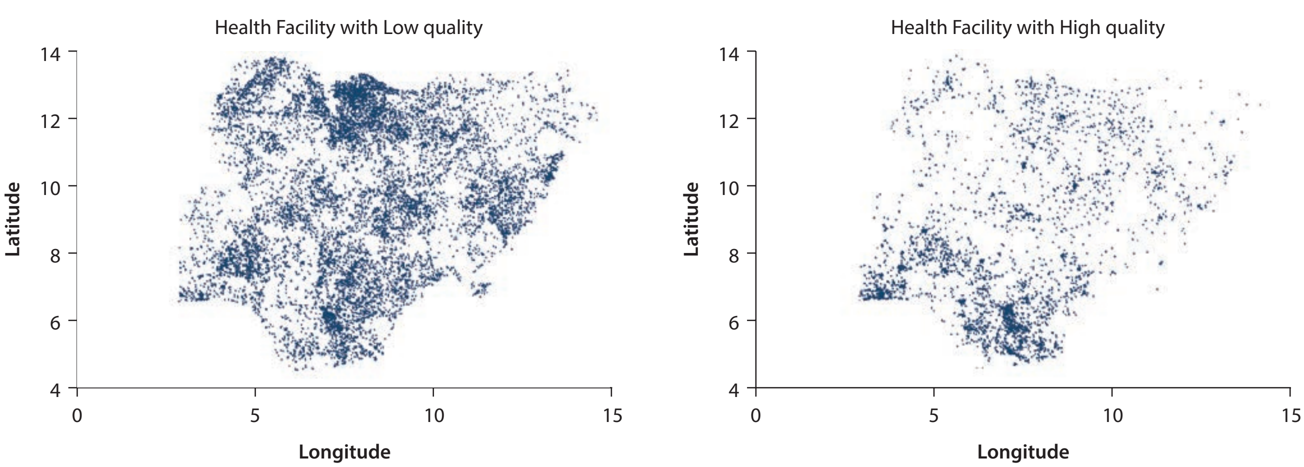
Table 4.5 summarizes some of the components which are not consistent across the different countries. Regarding the health determinant, the table identifies those countries where yellow fever vaccination is part of the vaccination schedule, surveys with information on postnatal visits, and the use of mosquito nets. Regarding the WASH determinant, the table identifies those countries where bottled water is classified as improved because of additional work by the World Bank's WASH sector in determining the common secondary source for those using bottled water as their drinking water source or if the survey had information on secondary source. It also identifies whether information was collected on handwashing facilities and feces disposal and thus included as components of the WASH determinant.

Box 4.1 Access to and/or utilization of the health facilities

In the DHS, it is not possible to distinguish access from utilization of a service. One might argue that utilization is a choice variable whereas access is not under the control of the household. A household may have access to a health facility for reasons beyond its control but not use the services available due to high costs or other constraints. At the same time, one can easily conceive reasons for access being an endogenous variable. Households, for example, may choose to migrate to be able to access a service. Irrespective of whether utilization is a choice variable or not, the placement of clinics is also likely to be non-randomly allocated but rather based on unobserved community characteristics. In that case, the coefficient of access to the service may be biased. For example, as first pointed out by Rosenzweig and Wolpin (1982, 1986), it is possible that clinics are placed in areas with higher incidence of illness. In this case, a simple regression of the incidence of illness on a variable identifying the presence of a clinic in the community with other controls that do not typically include community-level fixed effects is likely to have a biased and negative coefficient, leading to the incorrect inference that access to clinics decreases health. Pitt, Rosenzweig, and Gibbons (1993) demonstrate, with a panel dataset in Indonesia, that controlling for community-level fixed effects removes the bias in the coefficient of interest, thus allowing for the correct inference about the positive effect of access to a clinic on child health.

Figure 4.1, using data from the 2014 Health Census of Nigeria, demonstrates that the placement of health facilities in Nigeria is not random, with low-quality districts rather disproportionately concentrated in the north region of the country, which is the poorest region of the country, and high-quality facilities concentrated in the relatively better-off southern region.

Figure 4.1 The non-random allocation of high- and low-quality health facilities in Nigeria



Source: 2014 Health Census, Ministry Health, Nigeria. The census contains the location of all the health facilities in existence as of 2014 (n = 34,218).
Note: The quality of health facility is determined by the following characteristics: the clinic has (1) improved water supply, (2) improved sanitation, (3) refrigerator/freezer for vaccines, (4) antenatal care service, (5) family planning service, (6) malaria treatment service, (7) emergency transport service, (8) skilled birth attendant, (9) electricity, (10) caesarian-section service, (11) measles vaccination service. A health facility is classified as 'low quality' if the total number of services available out of 11 services is 4 or less. A clinic is categorized as having 'high' quality if the number of characteristics is more than eight.

Box 4.2 Additional questions in surveys for better adequacy measures

Although the DHS collect sufficient information to capture some aspects of all four determinants of nutrition—food security, childcare practices, access to health care, and access to water and sanitation—additional information to build more robust measures would be useful. Given that chronic malnutrition, such as stunting, is the product of a poor nutritional environment during a period, the conditions at the time of the survey may not reflect the historical nutritional experience. Longitudinal data, collecting information from various points in time, would give a richer picture on not only the current nutritional conditions but those that have led up to the current state. Furthermore, longitudinal data on a specific child would also increase the tools available for causal inferences.

There are also specific measures which could complement those already collected for a more robust description of the childís access to nutrition determinants. For food security, the currently available data measure the utilization aspect of food security but not availability or access. Whereas availability measures the national, or regional, conditions of how much food is available for consumption, access is a household-specific measure which could be incorporated into surveys. One measure of access is the Household Food Insecurity Access Scale (HFIAS) which aims to capture the changes in food consumption patterns and reflect the severity of food insecurity faced by households due to lack of or limited resources to access food (Coates, Swindale, and Bilinksy 2007). Some surveys, for example the 2009 Guatemala DHS, already incorporate questions allowing for the partial assessment of householdsí food insecurity. Additionally, questionnaires with expanded food categories reflecting the local cuisine may better capture the true dietary diversity of the child. In Uganda, for example, the questionnaire specifically asked if the child ate a variety of meats not usually included in the description of meat, such as pigeon or duck, or a variety of starches such as specific types of bananas. The resulting average dietary diversity measure was much higher than in countries where the surveys were not as specific, even though in any survey, pigeon or banana could be included in the given categories. It may be that Ugandan children truly have much better access to food diversity or that the additional prompting elicited different information.

Collecting information, on a large scale, of many of the childcare practices—such as caregiver responsiveness during feedings, caregiver and child interactions, observed time in child care, and child appearance in a public place—would be difficult to implement. However, questions could elicit information on the motherís knowledge and beliefs of proper feeding practices and milestones, the motherís access and source of such information, recalled time in child care, and the characteristics of alternative caregivers who are with the child for extended periods.

The access to health care as well as access to sanitation and drinking water are relatively well covered in the surveys used. Apart from collecting information on the location of the closest health care facility to measure the availability of health care or the levels of various pathogens in the household environment to measure the actual exposure risk to illnesses, the information collected in a typical DHS is sufficient for relatively robust measures. For health care, the only potentially easily added measure would be the frequency of growth checkup visits that the child has been to and the quality of feedback from these visits to the mother. Most surveys collect information only on the first postnatal visit that the child had but not on any subsequent follow-up visits specifically focusing on the childís growth and development.

Table 4.5 Inclusion of select health and WASH components

Country	*Yellow fever vaccine*	*Postnatal visit*	*Nets*	*Bottled water improved*	*Handwashing facilities*	*Feces disposal*	*Other Notes*
Angola	√	√	√	√[a]	√	√	
Benin	√	√	√		√	√	
Burkina Faso	√	√	√		√	√	
Burundi		√	√	√	√	√	
Cameroon	√		√	√	√	√	
Chad	√	√	√		√	√	
Comoros		√	√		√	√	
Congo, Rep.	√	√	√				
Côte d'Ivoire	√	√	√		√	√	
Congo, Dem. Rep.	√	√	√	√	√	√	
Ethiopia		√		√[a]	√	√	
Gabon	√	√	√				
Gambia, The	√		√		√	√	
Ghana	√	√	√		√	√	
Guinea	√	√	√		√	√	
Kenya		√	√		√	√	
Lesotho		√				√	
Liberia	√	√	√		√	√	
Madagascar		√	√				
Malawi		√	√	√[a]	√	√	
Mali	√	√	√		√	√	
Mozambique			√		√	√	
Namibia		√	√		√	√	
Niger	√	√	√	√	√		
Nigeria	√	√	√		√	√	
Rwanda			√		√	√	
Senegal	√	√	√	√	√	√	
Sierra Leone	√	√	√		√	√	
Tanzania		√	√	√[a]		√	
Togo	√	√	√		√	√	
Uganda		√	√		√	√	
Zambia		√	√		√	√	
Zimbabwe		√	√	√[a]	√	√	No information on polio at birth

Sources: Latest DHS. See Table 2.1 for specific years.
Note: a. Based on whether secondary source is improved.

Access to Food and Care, Health, and Wash

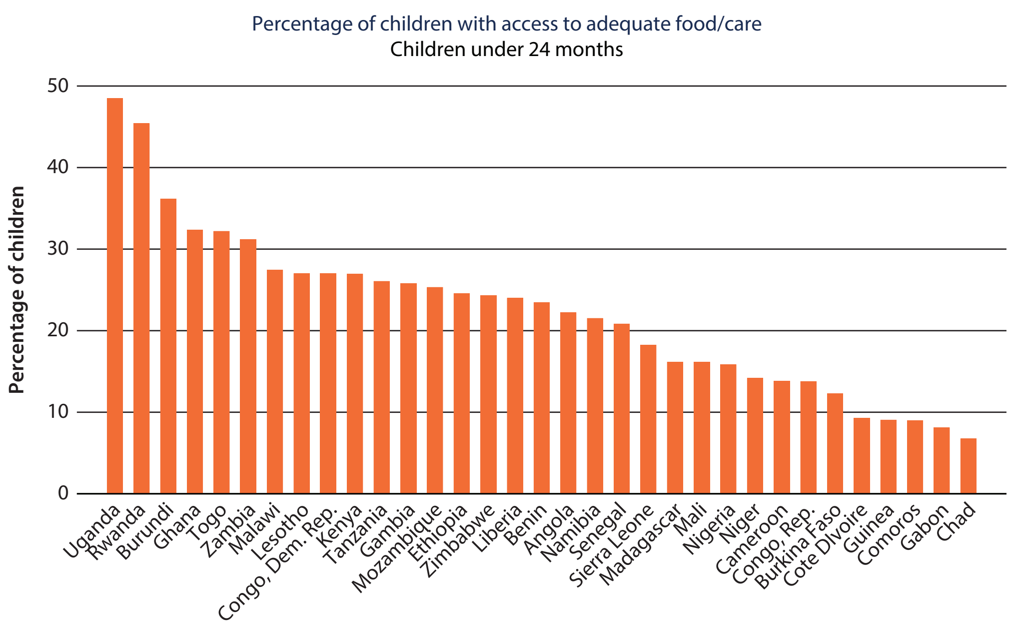
In all countries, the percentage of children with access to adequate food and care ranges between 7 percent and 49 percent (see Figure 4.2). In Uganda, the percentage reaches 49 percent probably in part because the Uganda DHS collects more detailed information on food. The differences in access to adequate food/care are in general small across rural and urban households (see Figure 4.3). In Liberia, children in rural areas are more than 5 percentage points more likely to have access to adequate food/care than children in urban areas. In Burundi, Ethiopia, Malawi, Niger, Nigeria, Namibia, and Kenya, urban children are more than 5 percentage points more likely to have access to adequate food/care than rural children.

There are greater differences in access to adequate food and care by wealth category. One-third of the sample had more than 5 percentage point differences between the two wealth quintiles. However, not all of the differences favor children from the wealthier families. In Guinea, Mali, Ghana, Democratic Republic of Congo, The Gambia, Liberia, Uganda, Togo, and Republic of Congo, children from poorer households are more likely have access to adequate food/care than children from the richest households. In the Gambia, for example, these differences are driven by the higher prevalence of the care components whereas in Liberia by the higher prevalence of access to minimum acceptable diet and age-appropriate breastfeeding in the lower wealth quintile households.

There are large inequalities in access to adequate WASH services across countries. Except for Rwanda and Malawi, less than half of the children have access to adequate WASH in the study countries (see Figure 4.4). Also, Rwanda and Malawi are the only countries where a significantly larger share of rural children than urban children have access to adequate WASH (Figure 4.5a). In nine countries, the difference in access to WASH between urban and rural children is more than 30 percentage points (see Figure 4.5b). In 24 countries children from the top wealth quintile (T20) are more than 30 percentage points more likely to have access to WASH than children from the bottom wealth quintile (B20) (Figure ES.2). In Namibia, Senegal, and Niger the difference is more than 70 percentage points.

In the majority of the countries, at least half of the children have access to adequate health. The notable exception is Ethiopia where only 14 percent of the children under 24 months of age have access to adequate health (Figure 4.6). However, despite the relatively high access to adequate health, there are large disparities in access to adequate health services by household location as well as by

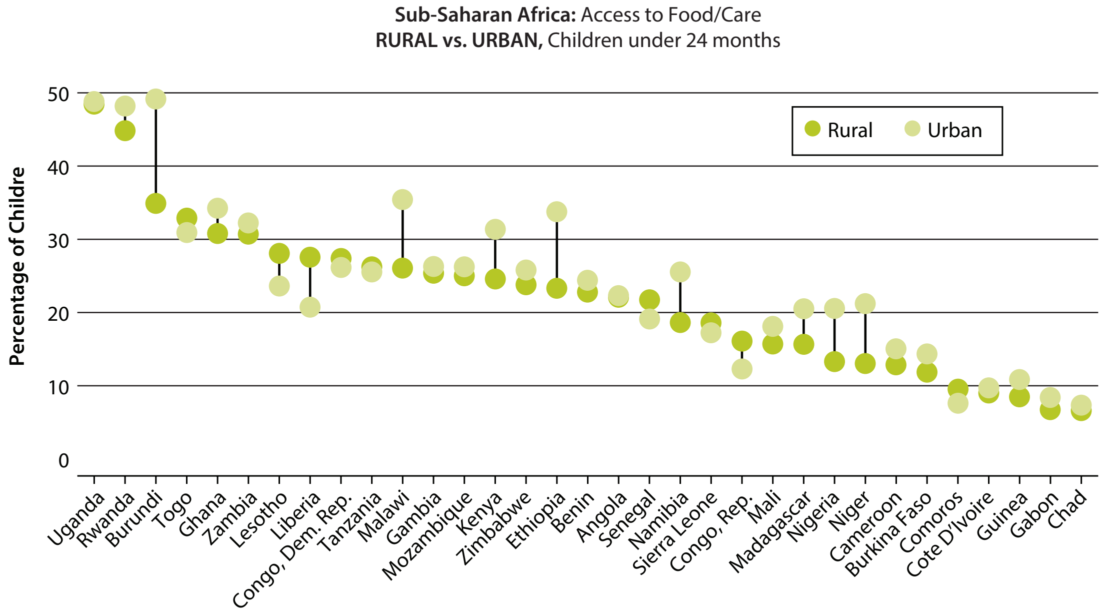
Figure 4.2 Percentage of children with access to adequate food and care within each country (children 0–23 months)



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Figure 4.3 Inequities in access to adequate food and care within each country (children 0–23 months)

a) Urban versus rural: Percentage of children with access to adequate food and care



b) Urban versus rural: Difference in access to adequate food and care

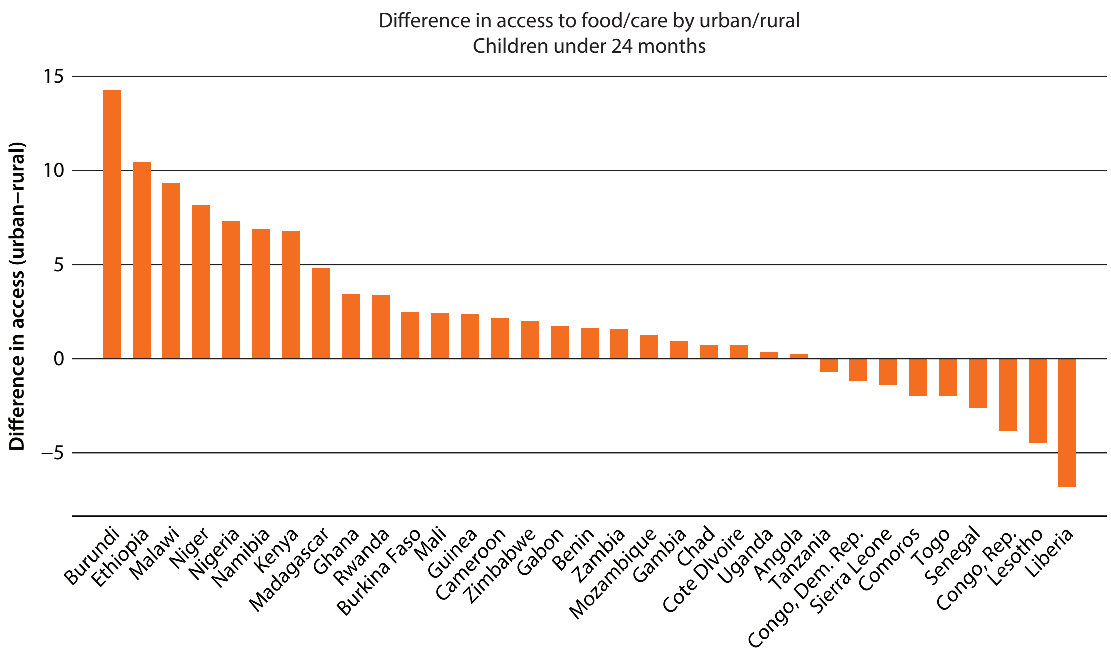
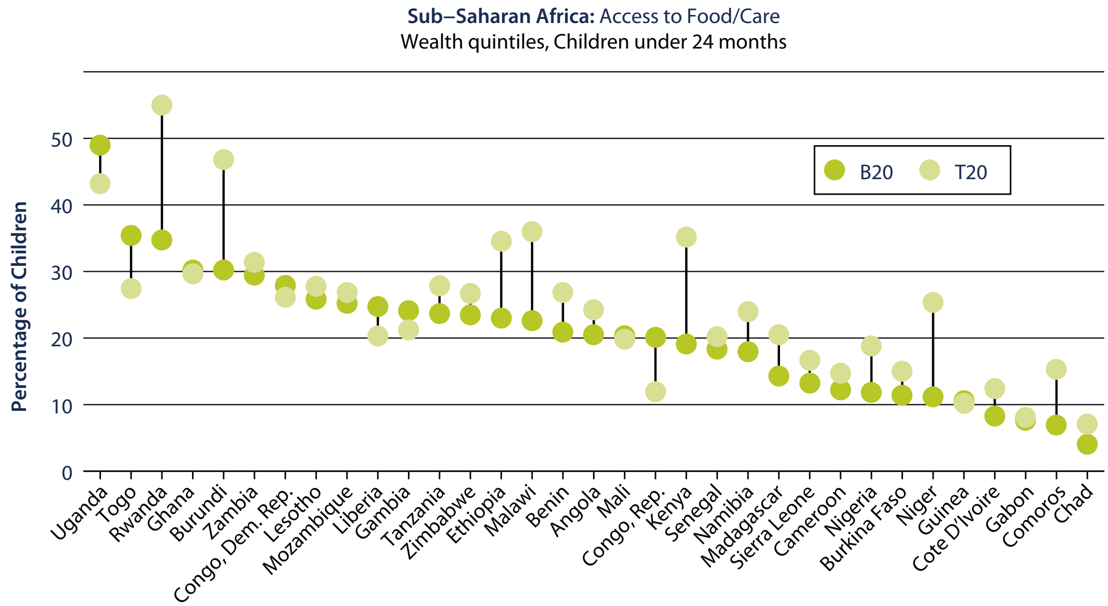
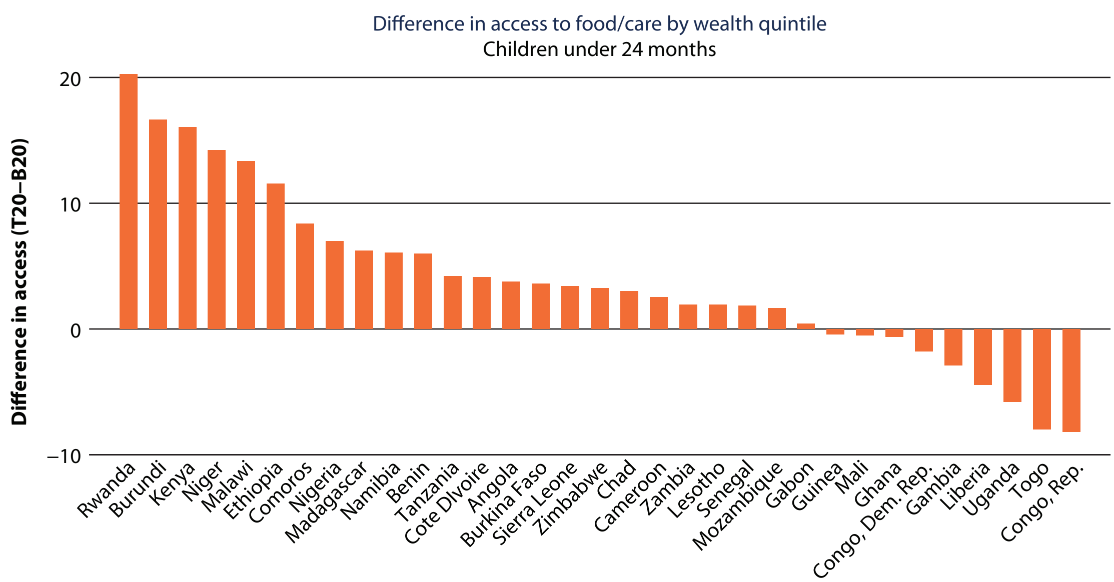


Figure 4.3 Inequities in access to adequate food and care within each country (children 0–23 months) *(continued)*

c) B20 versus T20: Percentage of children with access to adequate food and care

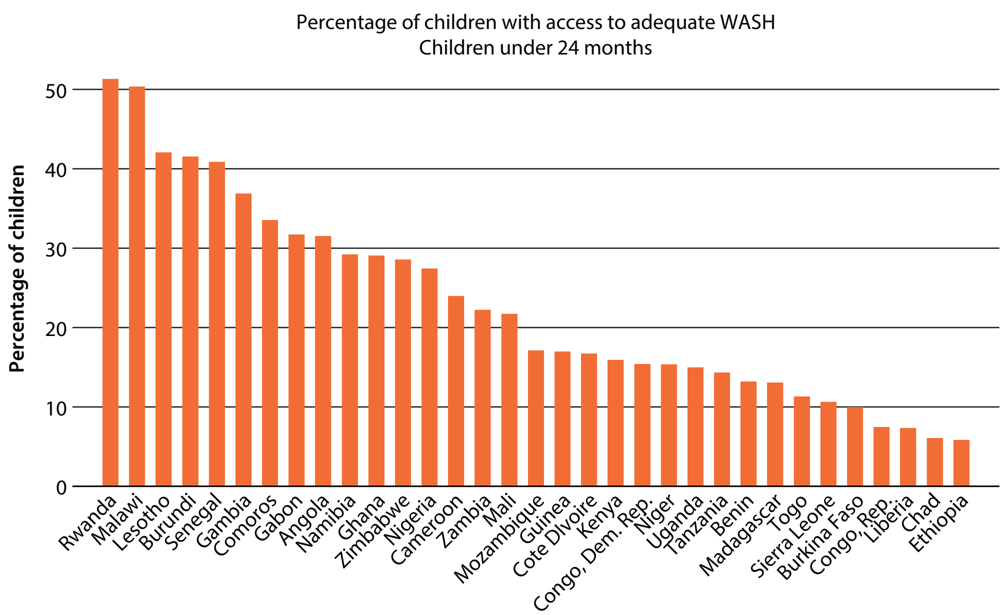


d) B20 versus T20: Difference in access to adequate food and care



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

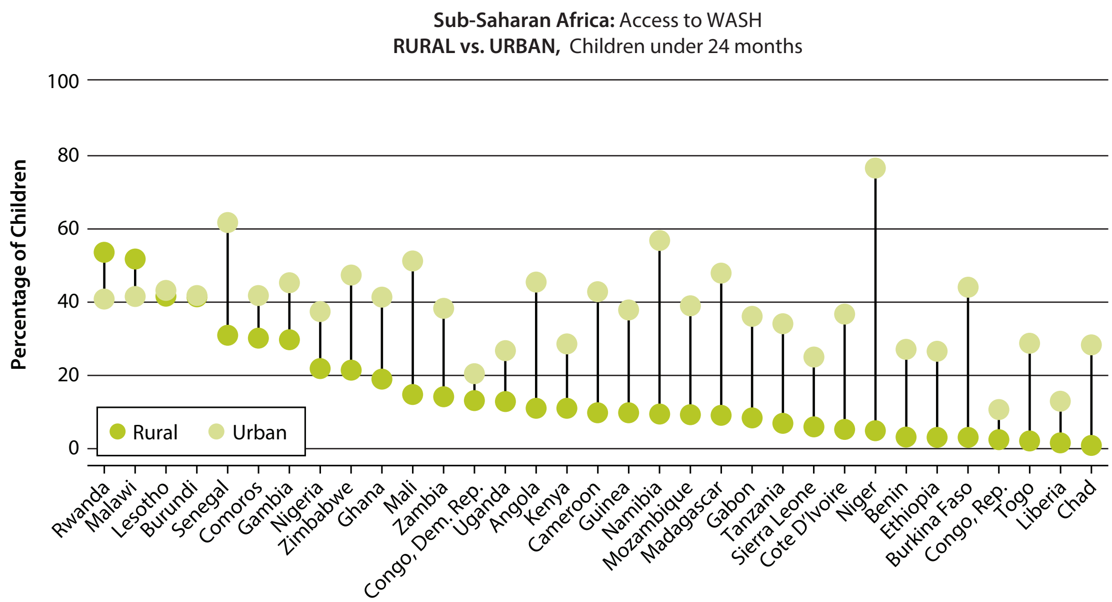
Figure 4.4 Percentage of children with access to adequate WASH within each country (children 0–23 months)



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Figure 4.5 Inequities in access to adequate WASH within each country (children 0–23 months)

a) Urban versus rural: Percentage of children with access to adequate WASH



b) Urban versus rural: Difference in access to adequate WASH

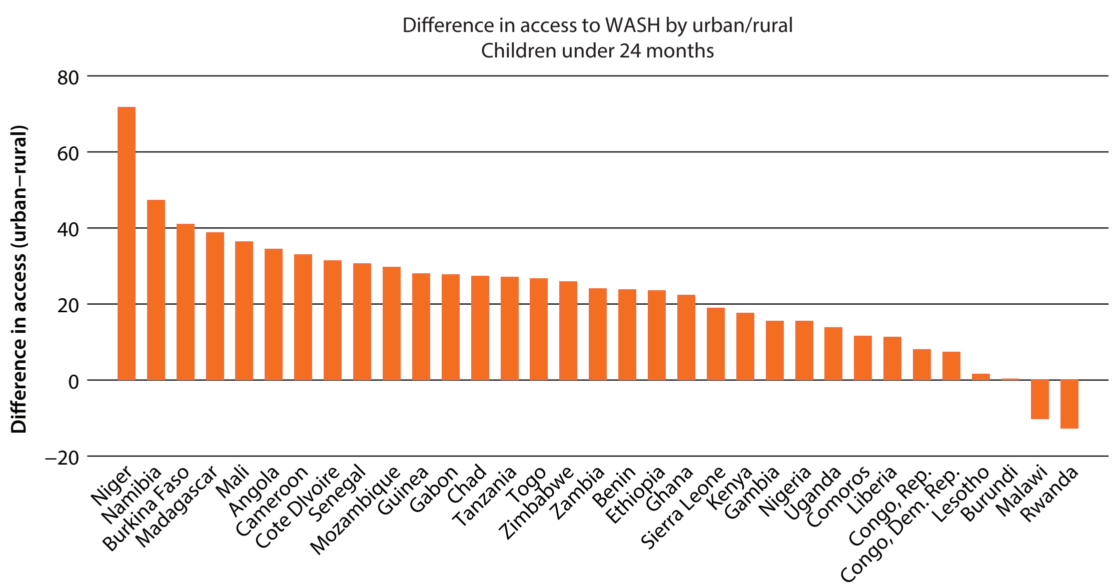


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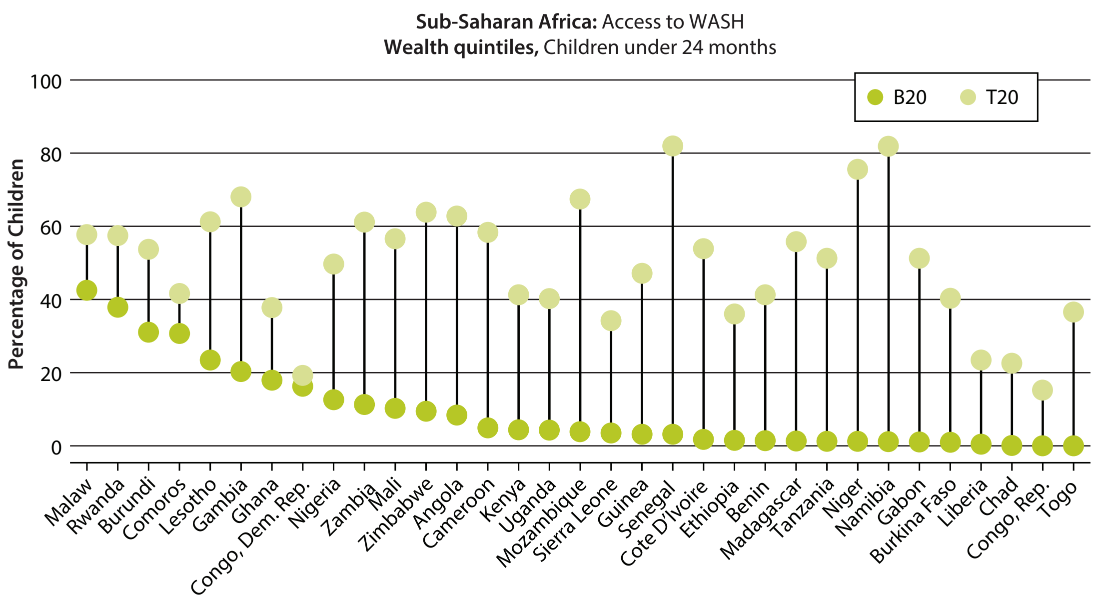
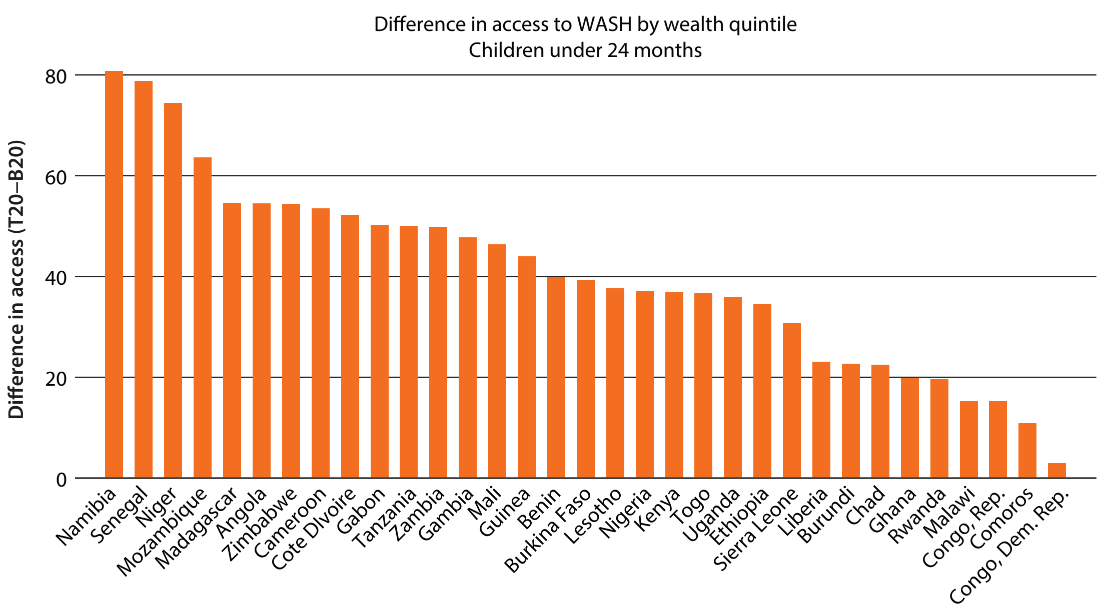
Figure 4.5 Inequities in access to adequate WASH within each country (children 0–23 months) *(continued)*

c) B20 versus T20: Percentage of children with access to adequate WASH

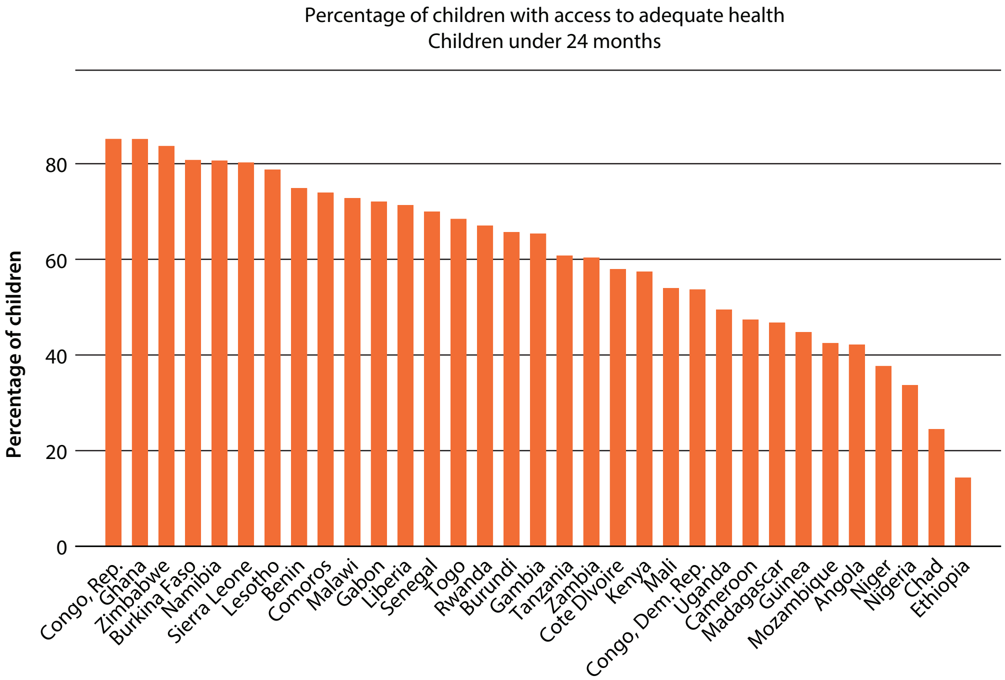


d) B20 versus T20: Difference in access to adequate WASH



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Figure 4.6 Percentage of children with access to adequate health within each country (children 0–23 months)



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

wealth (Figure 4.7). Urban children are always more likely to have access to adequate health than rural children, and children from richer households are more likely to have access than children from poorer households. In 11 of the countries, the difference in access to adequate health between urban and rural children is more than 30 percent (Figure 4.7b). In 14 countries, children from the richest households are more than 40 percentage points more likely to have access to adequate health than children from the poorest households (Figure 4.7d).

Simultaneous Access to the Underlying Determinants of Nutrition

One major advantage offered by using information at the child level from the DHS is the opportunity to get a better sense of the joint distribution of the determinants of undernutrition. Information on the joint distribution of the determinants is essential for identifying particularly important gaps (for example, in water and/or sanitation) which may affect the impact of other nutrition –related interventions.

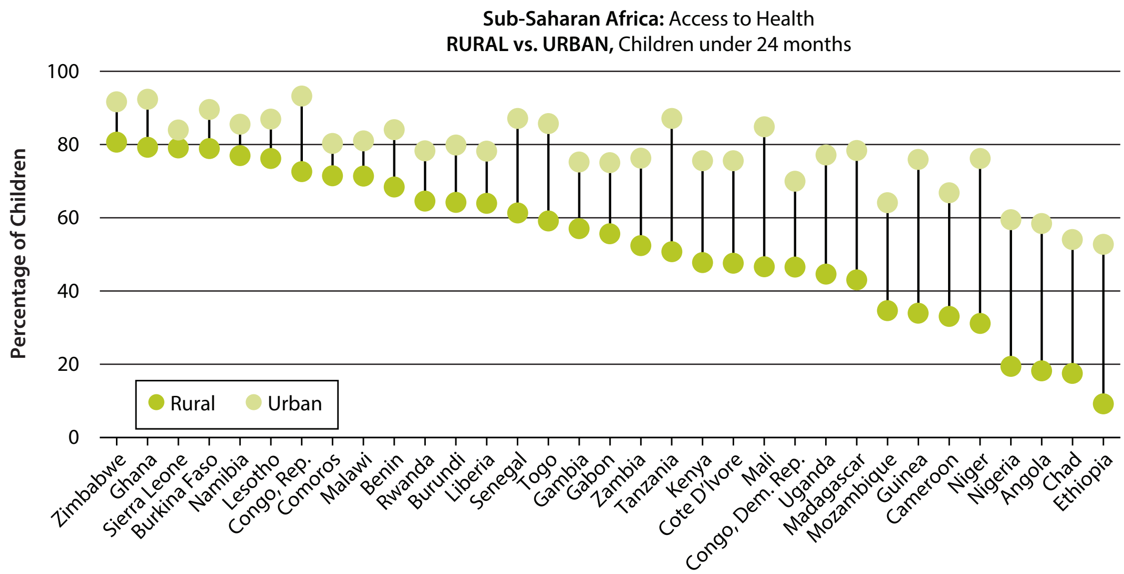
Figure 4.8 gives a sense of the inequities in joint/simultaneous access to the drivers of nutrition. Many children do not have access to any of the three determinants of nutrition. In three countries—Ethiopia, Chad, and Niger—the majority of the children do not have access to even one of the determinants. Simultaneous access to all three determinants is under 20 percent across the region.

Figure 4.9 reveals that simultaneous access to the drivers of nutrition for rural and urban children differs significantly. Rural children are more likely to have access to none (0) of the drivers of nutrition than urban children and, in general, less likely to have access to all three drivers. Rwanda and Lesotho are exceptions since more rural children have access to all three than urban children.

The differences are even larger by wealth (see Figure 4.10). In all countries children from the bottom wealth quintile are more likely to have access to zero (or access to inadequate levels to all three drivers) and less likely to have access to adequate levels to all three drivers than children from the top wealth quintile. In 12 countries, more than half of the children in the poorest households do not have access to any determinant, but in none of the countries studied is this the case for the wealthiest households.

Figure 4.7 Inequities in access to adequate health within each country (children 0–23 months)

a) Urban versus rural: Percentage of children with access to adequate health



b) Urban versus rural: Difference in access to adequate health

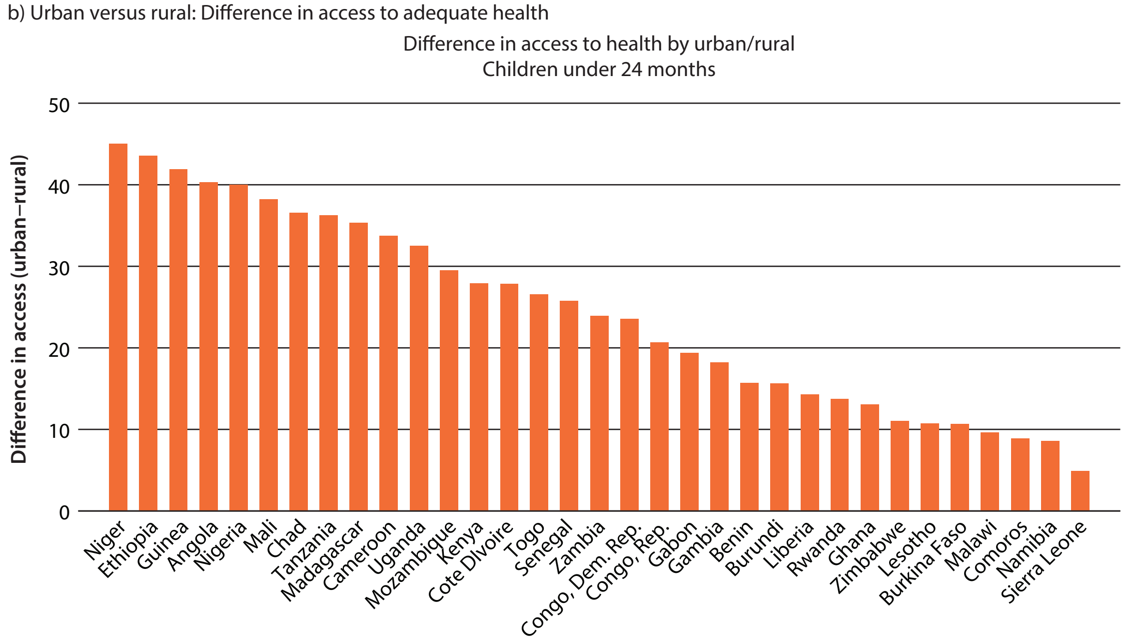
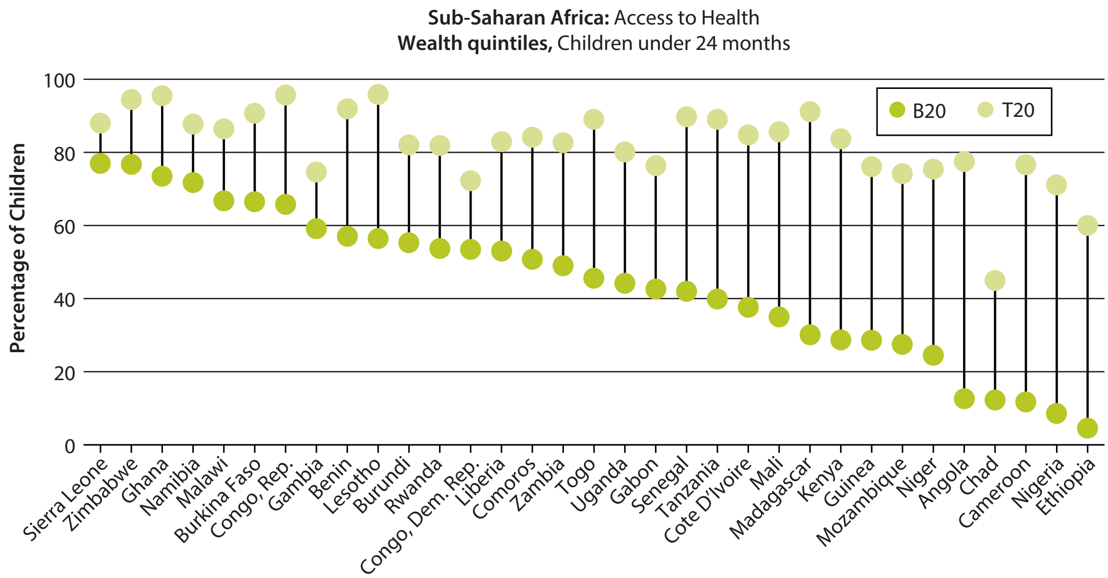
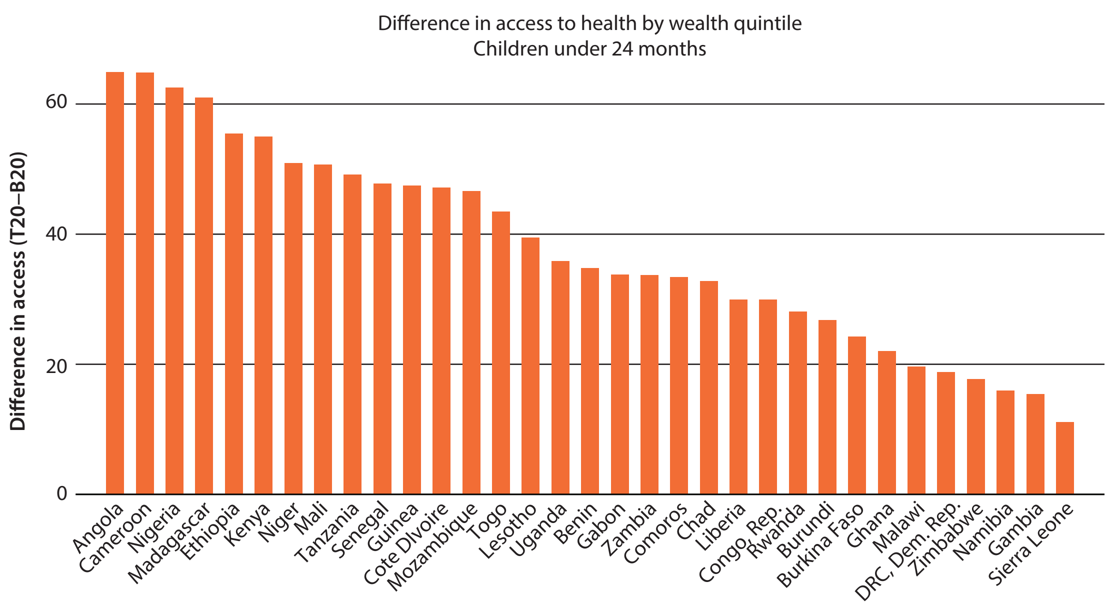


Figure 4.7 Inequities in access to adequate health within each country (children 0–23 months) *(continued)*

c) B20 versus T20: Percentage of children with access to adequate health

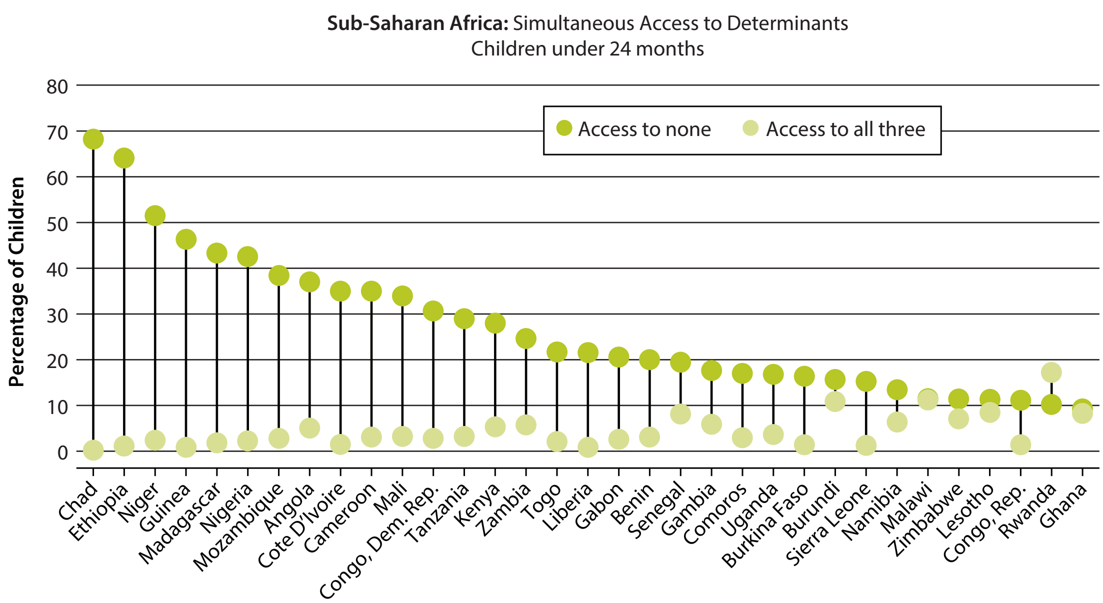


d) B20 versus T20: Difference in access to adequate health



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Figure 4.8 Inequities in joint access to the underlying drivers of nutrition within each country (children 0–23 months)



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Figure 4.9 Inequities in joint access to the underlying drivers of nutrition within each country: Urban versus rural areas (children 0–23 months)

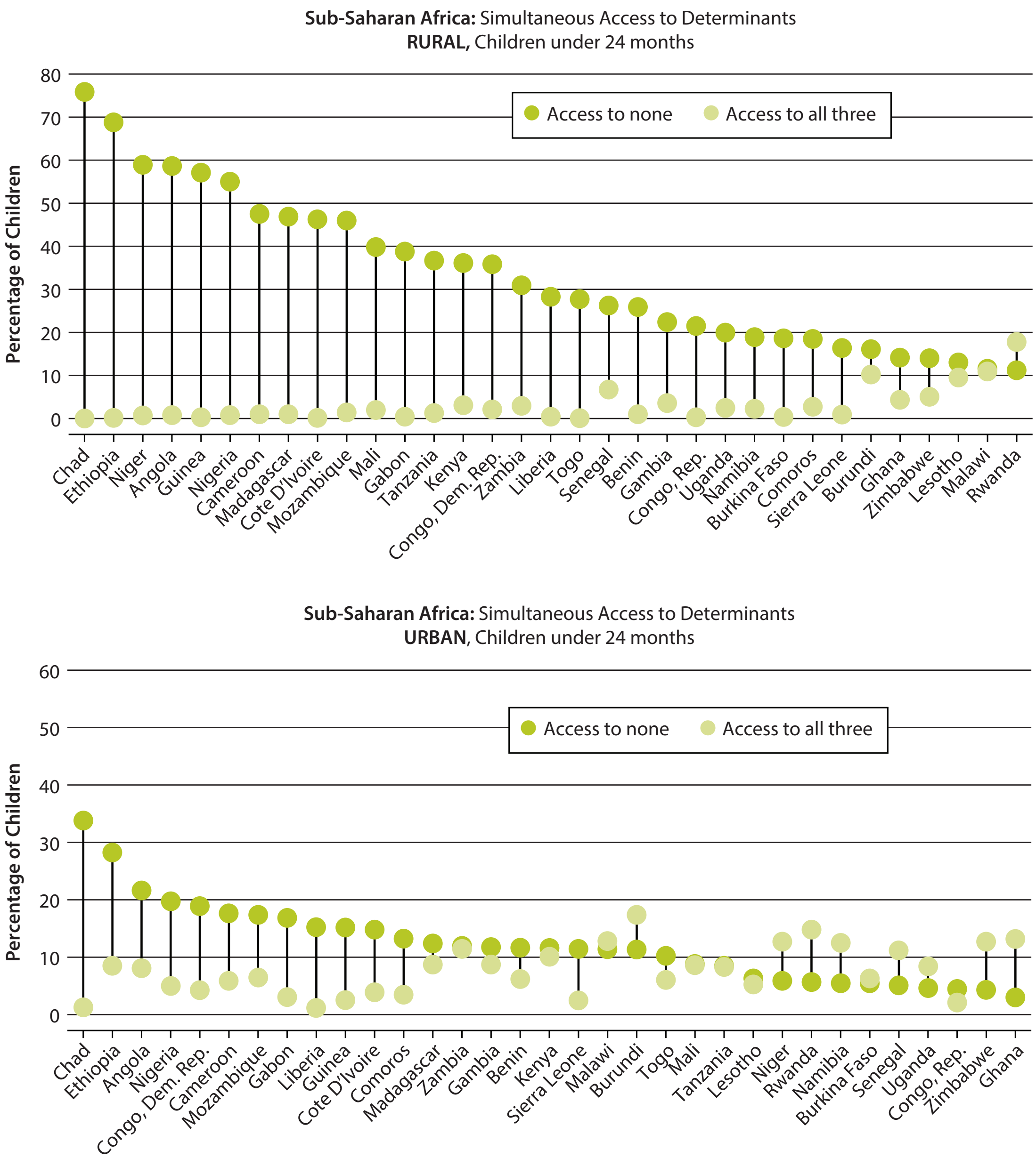


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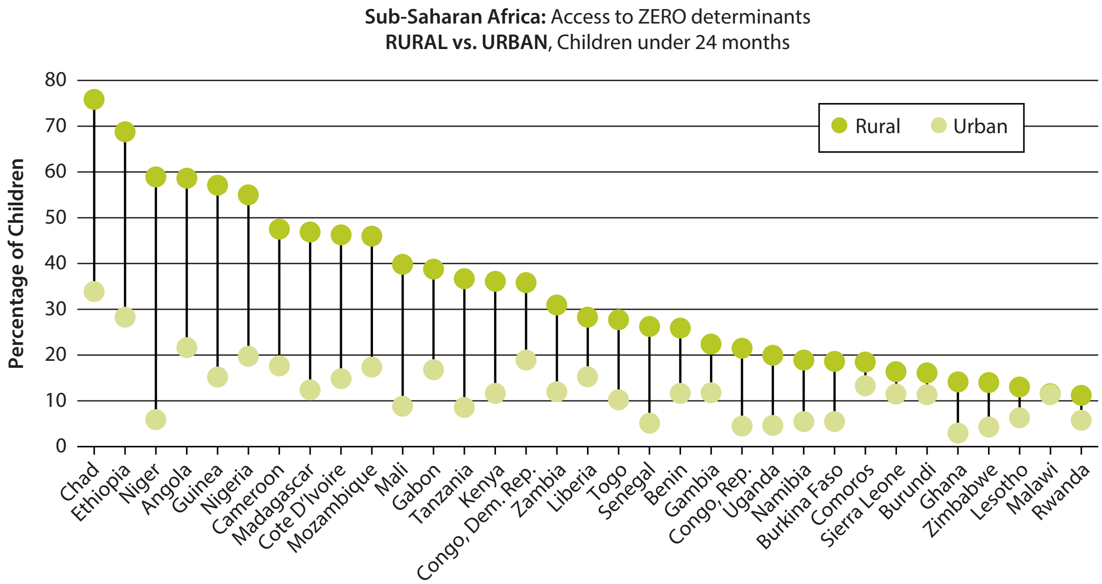
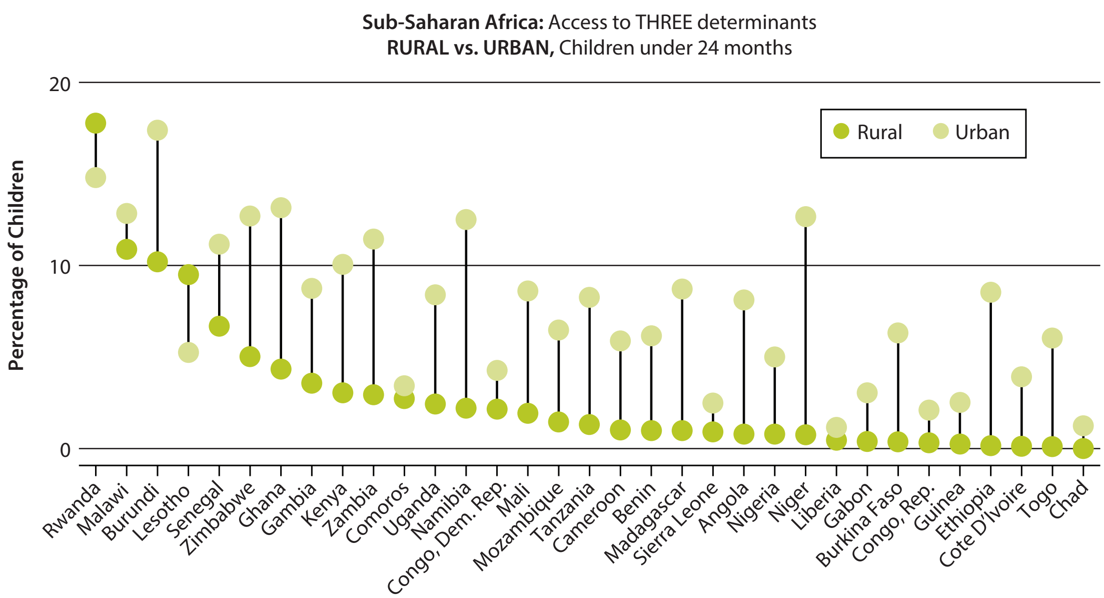
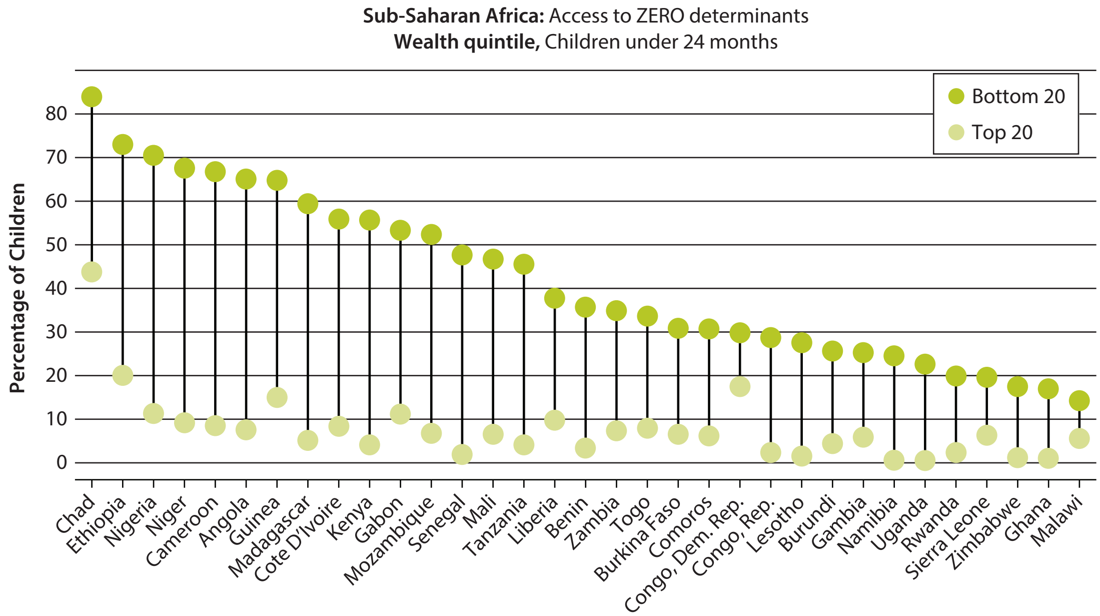
Figure 4.9 Inequities in joint access to the underlying drivers of nutrition within each country: Urban versus rural areas (children 0–23 months)) *(continued)*

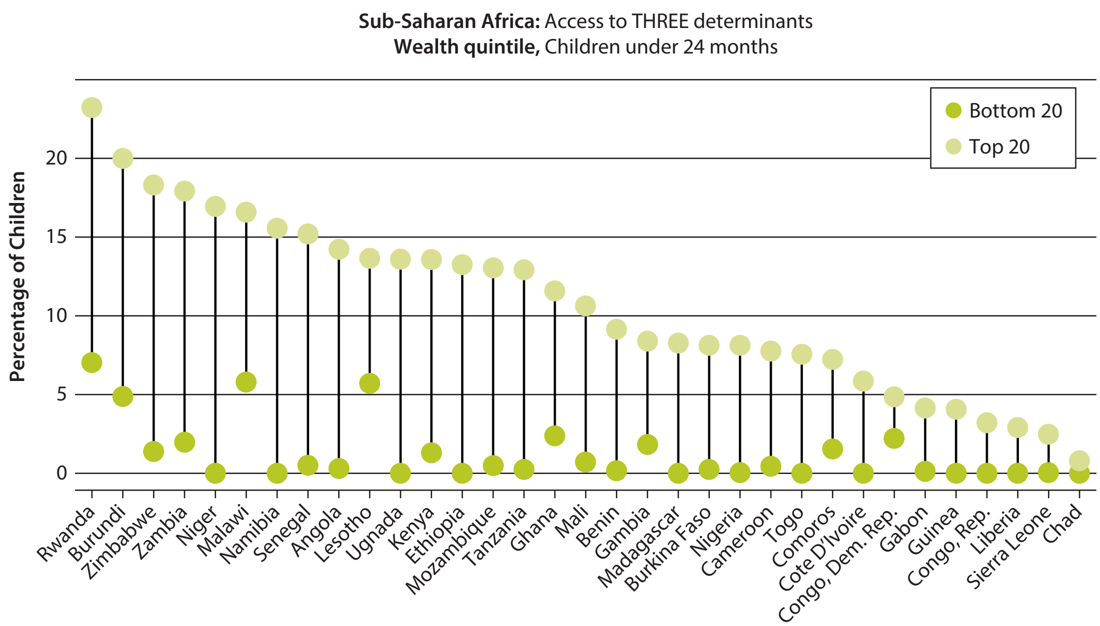




Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Figure 4.10 Inequities in simultaneous access to the underlying drivers of nutrition within each country: B20 versus T20 (children 0–23 months)





Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Similarly, in none of the countries studied do at least 10 percent of children from the poorest households have access to all three determinants, whereas in 17 countries more than 10 percent of the children from the wealthiest households have access to all three. But even so, in no country do more than 23 percent of the children from the wealthiest households have access to all three.

Endnotes

1. The stricter definitions of basic water—an improved source within a 30-minute round trip from the dwelling—or safely managed water—piped to premises with a minimum quality—are not considered here.
2. We do not have information on shared facilities for Ethiopia and thus cannot adjust the access to improved sanitation for Ethiopia. Thus, access to improved sanitation is less stringently defined for Ethiopia than for the other countries.
3. The measure is based on all surveyed households in the PSU, not only those with children under 24 months of age.
4. Taken from http://apps.who.int/immunization_monitoring/globalsummary/schedules.
5. Although sleeping under a mosquito net may be better considered as a caregiving behavior, given the scarcity of components to construct an index of care, it is introduced as a component of health given its nexus to preventing illness along the lines of use of ORS and antibiotics to treat illness.

CHAPTER 5

Stunting and Access to the Underlying Determinants of Nutrition

Following the description of the major patterns of access to the three underlying drivers of nutrition within countries in SSA, the analysis in this chapter proceeds with a closer investigation of the relationship between stunting prevalence (or the probability of stunting at the child level) and access to adequate levels of the underlying drivers on nutrition. The relationship between stunting prevalence and access is examined in a variety of ways. The correlation of stunting with the number of the drivers accessed at an adequate level at the same time is investigated first. This not only sheds more light on the general question of whether access to more nutrition determinants is better for nutrition outcomes but also helps address policy concerns about the marginal impact on stunting of providing access to one more nutrition driver in different target groups. Next, the analysis moves to finer level of detail by focusing on the relationship between stunting and access to the three specific nutrition drivers (food and care, WASH, and health) and all the different combinations of the three drivers, such as access to WASH and health at the same time, and so on. The advantage of the finer level of analysis is that it allows for identification of the marginal effects on stunting associated with access to specific sectors that can help address which underlying determinants of nutrition to focus on. The shortcoming associated with a finer level of analysis relates to the constraints and limitations imposed by the large inequalities in access to some of the drivers of nutrition such as access to adequate WASH. These limitations become even more apparent when simultaneous access to two or more drivers is correlated with stunting. As it is documented in this chapter, only a very small proportion of children have simultaneous access to all three nutrition drivers or even simultaneous access to two nutrition drivers as is the case with access to food/care and WASH (see Table 5.1).

Stunting and Simultaneous Access to the Drivers of Nutrition by Children

The analysis proceeds gradually, beginning with a general investigation of the relationship between stunting or HAZ scores and the number of nutrition drivers accessed at the same time. The patterns of correlation between stunting and access are best summarized by the PDF for HAZ and cumulative density function (CDF) of HAZ of groups of children with access to different number of nutrition drivers, based on the pooled DHS data across 33 countries for children 0–23 months of age. The CDF is particularly useful because it allows one to make inferences easily about the general relationship between having access to one or more drivers of nutrition not only for the prevalence of stunting (HAZ ≤ 2) but also for the prevalence of severe stunting (HAZ ≤ 3). It is important to bear in mind that the patterns emerging from a comparison of the CDF of HAZ of children with access to one or two or all three drivers of nutrition are simple correlations and do not imply causation. In the remainder of this chapter more concerted efforts are made to control for country effects (or even country-strata effects) as well as child, parental, and household characteristics in an effort to get closer to a causal inference. In addition, unconditional quantile regressions are estimated for different quantiles of the bottom half of the distribution of HAZ scores to explore differences in the relationship based on the child's nutritional status.

Table 5.1 Percentage of children with adequate access in each group/category

	Full sample	*Rural*	*Urban*	*Boys*	*Girls*	*Mother educated*	*Mother not educated*
Stunted	28	31	22	31	26	21	32
Adequate in:							
None	39	47	16	38	39	19	48
Access to any 1	40	38	44	41	39	45	37
Food/care	9	11	4	9	9	6	10
WASH	6	6	8	7	6	4	7
Health	25	21	33	25	24	34	20
Access to any 2	19	13	33	18	19	30	13
Food/care and WASH	1	1	2	1	2	1	2
Food/care and health	8	7	11	8	9	13	6
WASH and health	9	5	20	9	9	16	5
All 3	3	2	7	3	3	6	2
Observations	74,781	52,672	22,109	37,377	37,404	23,381	51,373

Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

	B20	*T20*	*Low GDP*	*High GDP*	*Low Gini*	*High Gini*	*Low tariff*	*High tariff*	*Low starch*	*High starch*
Stunted	34	17	30	27	27	29	29	25	27	31
Adequate in:										
None	57	11	43	35	41	37	41	32	35	49
Access to any 1	34	41	37	41	39	41	38	44	42	35
Food/care	12	3	12	7	11	7	10	6	7	13
WASH	4	8	4	8	4	9	7	5	8	3
Health	18	30	22	27	24	25	22	33	27	19
Access to any 2	9	39	17	20	18	19	17	21	20	14
Food/care and WASH	1	2	1	2	1	2	2	1	2	1
Food/care and health	6	10	8	8	9	8	8	9	8	7
WASH and health	2	27	7	10	8	9	8	11	10	6
All 3	1	10	3	3	3	3	3	3	4	2
Observations	16,916	11,752	32,033	42,748	34,201	40,580	44,239	30,542	37,096	37,685

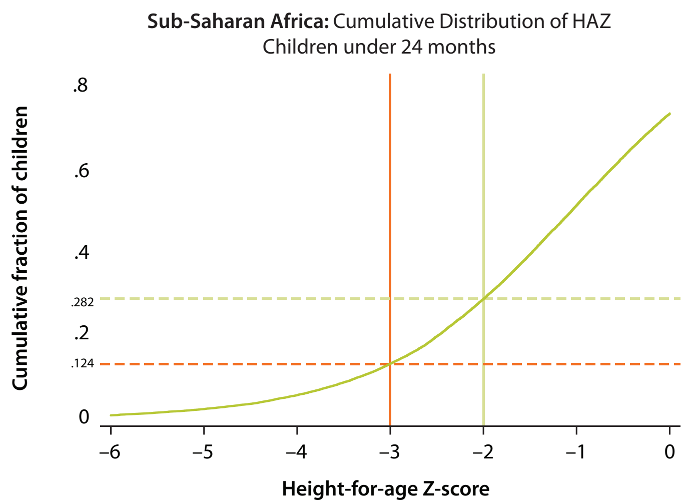
Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.

Figure 5.1 presents the CDF of HAZ scores of children 0–23 months old to summarize the information contained in the CDF. The horizontal axis contains the range of values of HAZ scores in the sample of children while the vertical axis is the cumulative fraction of children with HAZ less than a given value of HAZ. The vertical red line at –2 denotes the value of the threshold used to define stunting. A child is considered stunted if his/her HAZ score is less than 2 s. d. from the reference population. The yellow horizontal line denotes the point of intersection of the CDF with the –2 threshold for stunting while the red horizontal line denotes the point of intersection of the CDF with the –3 threshold used for severe stunting. Thus, 28.2 percent of the children under 24 months of age are stunted or have a HAZ score that is less than –2 and 12.4 percent of the children under 24 months of age are severely stunted or have a HAZ score that is less than –3.

Three binary variables are constructed by considering whether the child has access to adequate levels in the other drivers. Specifically, the binary variable *Aany1* is equal to 1 if the household has adequate level in one and only one of any of the three drivers of nutrition care. For example, *Aany1* = 1 if the child has adequate care and food only (and inadequate health and environment), or when the household is adequate in WASH services only (and inadequate in food and care and health), or when the household is adequate in health services only (and inadequate care and food and WASH). In the same fashion, *Aany2* takes the value of 1 if the household has adequate access to any two of the drivers at the same time, whereas *Aall3* identifies the few children that have simultaneous access to adequate level of all three nutrition drivers.

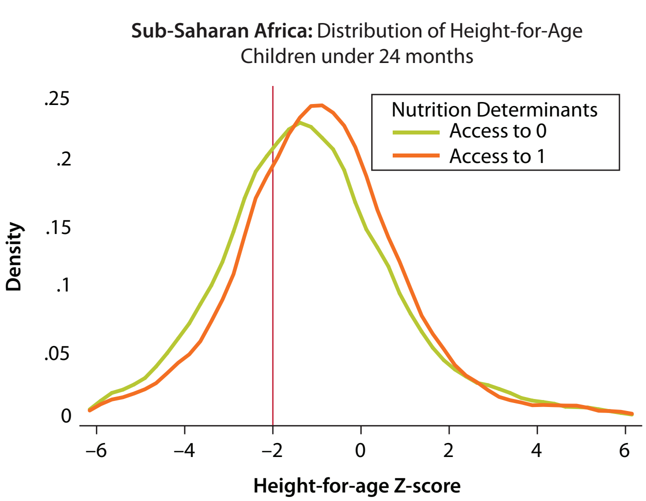
Figure 5.2 displays the PDF (left panel) and CDF (right panel) of HAZ for children who do not have access to adequate level of any of the three drivers of nutrition (access to 0) together with the distribution functions of the children who have access to only one (access to 1) of the three nutrition drivers. It is easily seen from the figure with the PDF that children with access to 1 driver have a higher mean HAZ score (the PDF shifts right) and that most of the differences in the PDF between children with access to 0 and 1 are in the lower left tail of the bell-shaped curve. In the figure with the PDF, stunting is represented by the area under the curve and to the left of the –2 threshold. In this case, it is easy to tell that stunting is lower among children with access to 1 driver compared to the stunting among children with access to 0 (area under the red PDF and to the left of the –2 threshold is smaller than the area under the green PDF and to the left of the –2 threshold.) The CDF curve on the right summarizes the same information but in a different way. The lower stunting rate associated with access to 1 nutrition driver can be inferred by the fact the red CDF intersects the –2 threshold at a lower point than the green CDF. The prevalence of stunting among children who do not have access to adequate level in any of the three

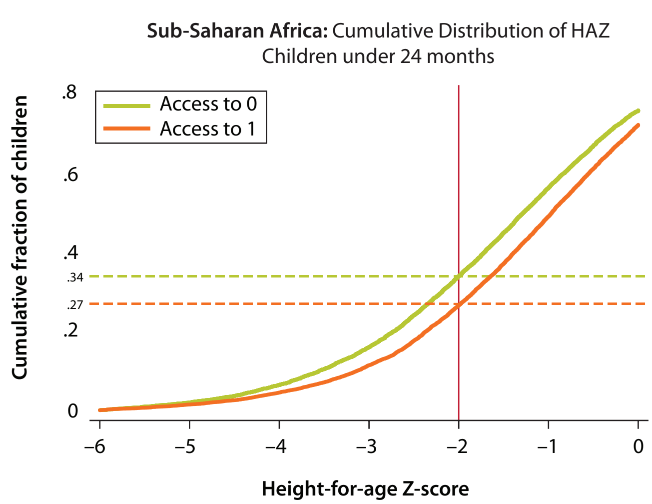
Figure 5.1 The cumulative distribution of HAZ scores (children 0–23 months)



Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.
Note: Sampling weights were standardized across the 33 DHS, following the procedure outlined by DHS. The sampling weight of the mother was multiplied by the ratio of the total number of women 15 to 49 years of age in the surveyed country to the number of women (15 to 49 years of age) surveyed. The total number of women was obtained from the World Population Prospects by the United Nations (2015).

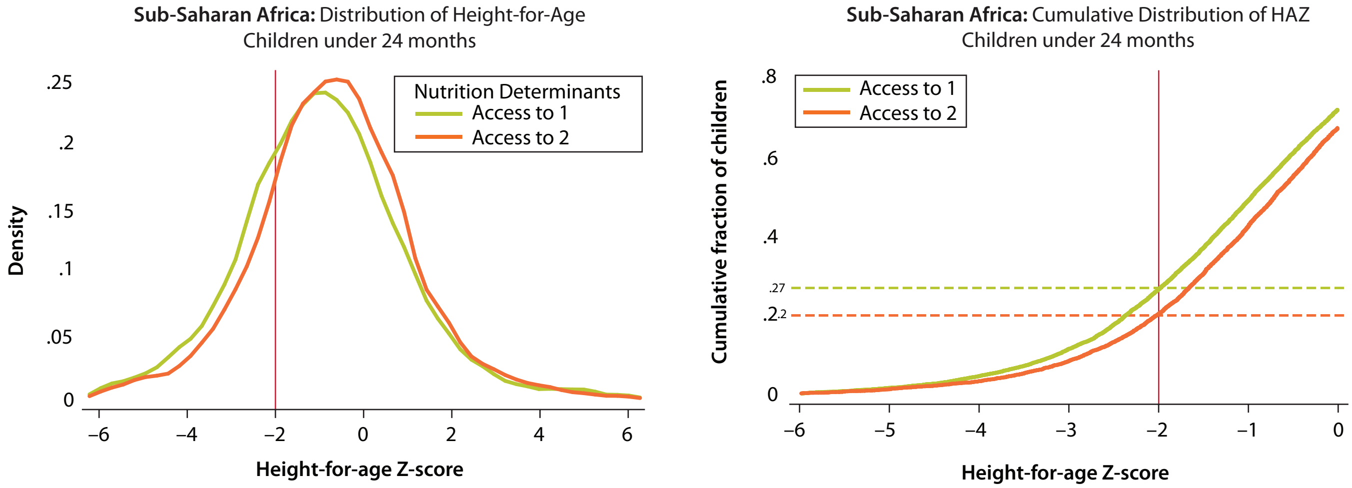
Figure 5.2 Access to 0 versus access to 1 driver of nutrition and the prevalence of stunting (children 0–23 months)





Source/Note: See Figure 5.1.

Figure 5.3 Access to 1 versus 2 drivers of nutrition and the prevalence of stunting (children 0–23 months)



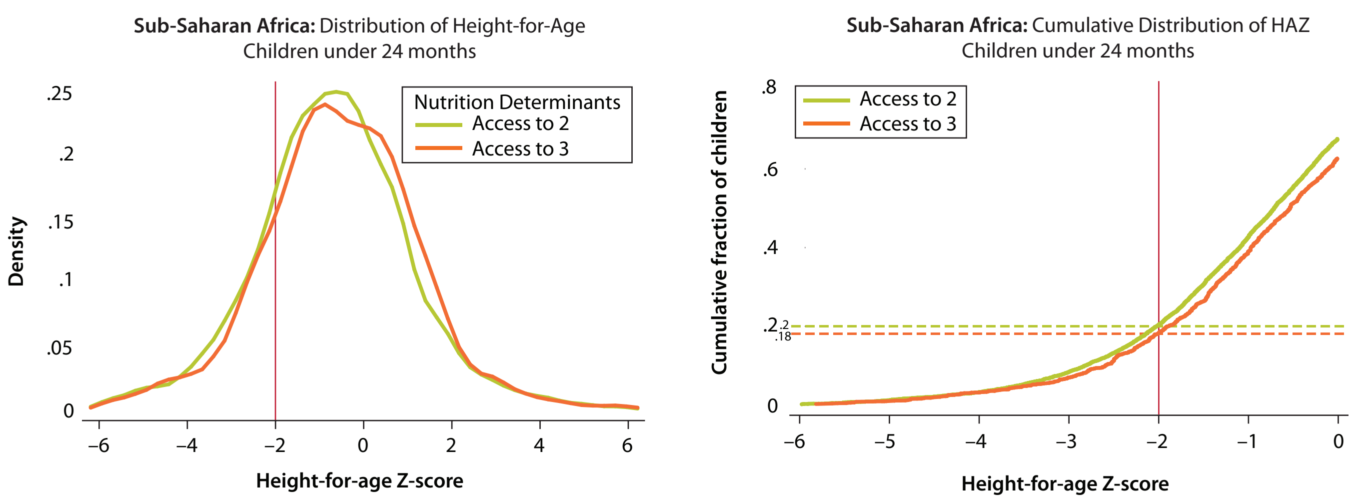
Source/Note: See Figure 5.1.

drivers of nutrition (access to 0) is 34 percent (Figure 5.2). In contrast, the prevalence of stunting among children with access to adequate level to only one (any one) of the three of the drivers of nutrition (access to 1) is 26 percent, 8 percentage points lower than the prevalence among children with access to none.

Figure 5.3 through Figure 5.5 allow similar comparisons between children with access to 1 driver and access to 2 drivers (Figure 5.3), children with access to 2 drivers and access to all 3 drivers (Figure 5.4), and children with access to 0 drivers and access to all 3 drivers (Figure 5.5). Figure 5.6 displays the PDF and CDF of the different groups of children in the same graph

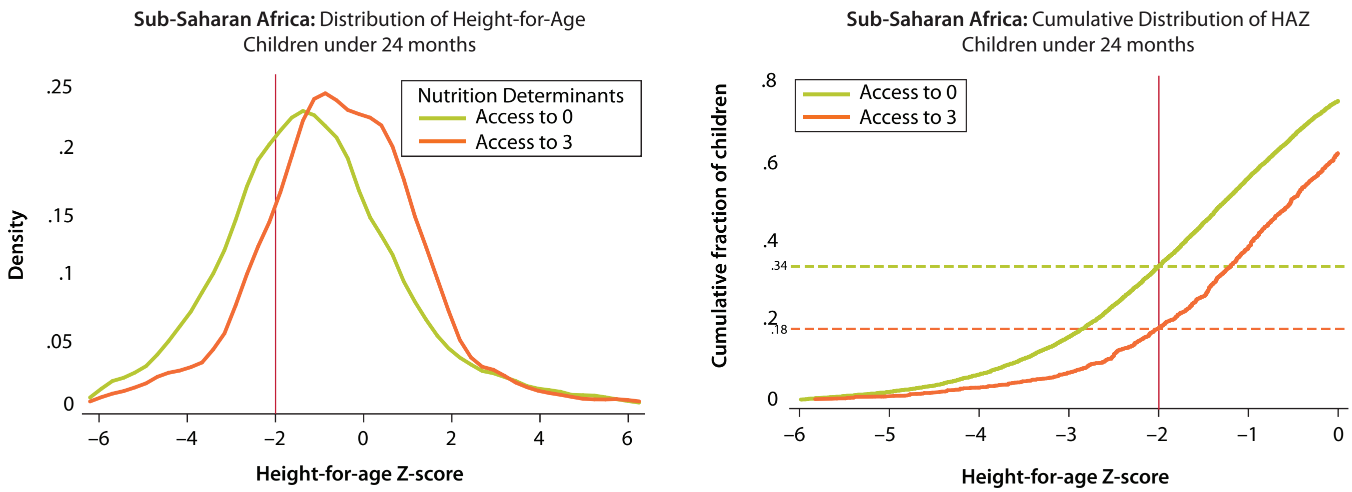
Figure 5.5 reveals that the prevalence of stunting among children with simultaneous access to adequate levels of all three nutrition drivers is significantly lower than children who do not have access to adequate level in any of the nutrition drivers. The prevalence of stunting among children who do not have access to adequate level in any of the three drivers of nutrition (access to 0) is 34 percent (Figure 5.5). In contrast, the prevalence of stunting among children with access to adequate level of all three of the drivers of nutrition (access to 3) is 18 percent, 16 percentage points lower than the prevalence among children with access to none. In addition, as the cumulative distribution function of the HAZ scores for

Figure 5.4 Access to 2 versus 3 drivers of nutrition and the prevalence of stunting (children 0–23 months)



Source/Note: See Figure 5.1.

Figure 5.5 Access to 0 versus 3 drivers of nutrition and the prevalence of stunting (children 0–23 months)

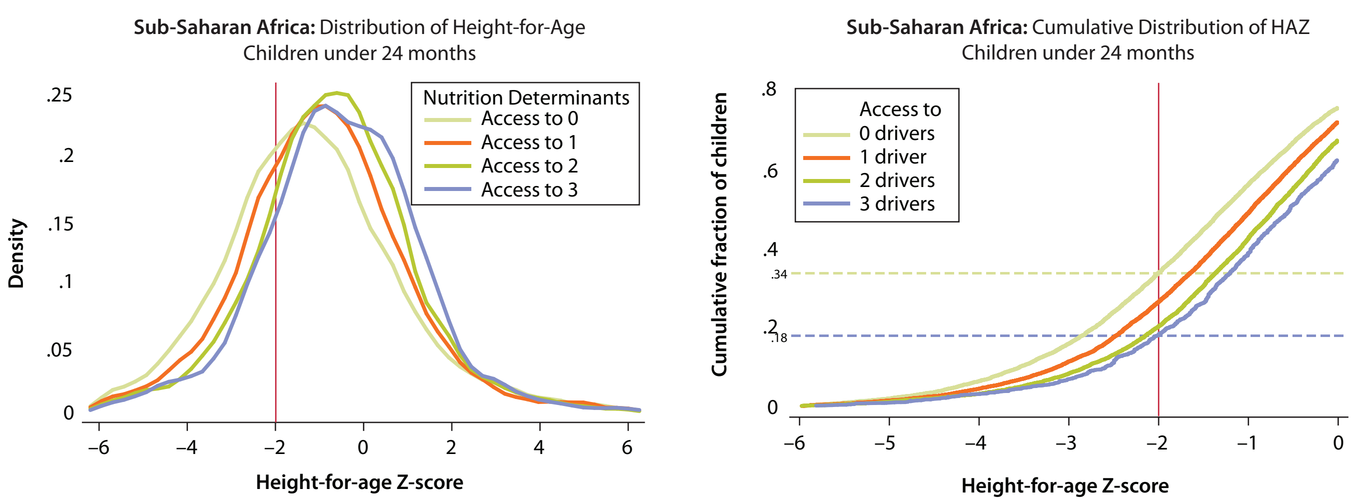


Source/Note: See Figure 5.1.

children less than 24 months of age highlights significant reductions in severe stunting rates—children more than 3 s. d. below the median height-for-age—are also prevalent.

Finally, Figure 5.6 reveals that the greatest reductions in stunting are associated with increases in access from none (0) to any 1 nutrition driver and from any 1 driver to simultaneous access to any 2 drivers. For example, the stunting rate among children with access to adequate level in any one nutrition driver is 26.7 percent compared to the stunting rate of 34.1 percent prevailing among children with access to none (see Figure 5.2). Lower stunting rates are also prevalent among children with simultaneous access to any two of the drivers (20.4 percent) compared to the stunting rates prevalent among children with access to any one of the drivers (26.7 percent) (see Figure 5.3). However, the marginal decline (gain) in the stunting rate is smaller than that associated with a change in access from none (0) to any one of the drivers. Finally, even lower stunting rates are prevalent among children with simultaneous access to all three of the drivers (18.3 percent) compared to the stunting rates prevalent among children with access to any two of the drivers (20.4 percent) (see Figure 5.4). In the context of budgetary constraints, these patterns have important implications for the targeting and potential impact of nutrition-sensitive operations in agriculture, WASH, and social protection, which are elaborated in the next section.

Figure 5.6 Access to 0 versus 1 or more drivers of nutrition and the prevalence of stunting (children 0–23 months)



Source/Note: See Figure 5.1.

The preceding figures are useful in summarizing the broad relationships in SSA countries between child stunting and access to the drivers of nutrition. The patterns are summarized by these figures but ignore the potential influence that individual child and parental characteristics or the country/region of residence may have on the relationship between stunting and access to one or more nutrition driver. To increase the credibility in these observed patterns, it is necessary to examine the robustness of the observed relationship in more detail.

For this purpose, the following model is estimated using the logit model for binary dependent variables:

$$Stunted_{ic} = \alpha + \alpha_1 Aany1_{ic} + \alpha_2 Aany2_{ic} + \alpha_3 Aall3_{ic} + X_{ic} + \mu_c + \varepsilon_{ic} \tag{1}$$

In equation (1), the dependent variable *Stunted* is a binary variable taking the value of 1 if child *i* in country *c* is stunted (that is, is his/her HAZ score less than −2 s. d. for the reference population, $HAZ_i \leq -2$) and = 0 otherwise. The variable μ_c denotes country fixed effect (or country-specific binary variables), whereas X_{ic} denotes a set of control variables summarizing parental, child, and household characteristics. These control variables include dummy variables for age, gender, multiple births and birth order; the age of the mother (in years); the marital status of the mother; mother's education level (in years); the mother's height (in cm); the number of household members; the number of children under 5 years of age; and whether the household lives in an urban or rural area.

In this specification, the constant term α provides an estimate of the stunting rate (or the probability of being stunted) in the reference group of children, whereas the coefficients a_1, a_2, and a_3 yield estimates of the 'marginal decline' in stunting associated with a child having access to adequate levels in one, two, or all three of the nutrition drivers.[1] Specifically, the coefficient a_1 yields an estimate of the decline in the stunting rate of children with access to any one of the three drivers of nutrition relative to the stunting rate in the reference group summarized by the constant term α that has inadequate access to all three nutrition drivers. A similar interpretation holds for the coefficients a_2 and a_3.

It is also important to bear in mind that the regression equation employed above does not allow for causal inferences on the 'impacts' of having access to adequate levels in the various clusters' adequacy components on nutrition nor does it provide a formal test of the UNICEF conceptual framework. Most of the components of each of the three drivers of nutrition are household choice variables (such as child care variables, immunizations, and visits for prenatal care), meaning that they are likely to be correlated with the error term of the regression ε_{ic} and it is practically infeasible to devise a credible identification strategy or find a set of instrumental variables that would allow reliable causal inferences.

With these considerations in mind, the inclusion of the country fixed effects (denoted by μ_c) and additional control variables pertaining to parental, child, and household characteristics (denoted by X_{ic}) may be considered as an effort at minimizing the influence of other contextual variables (omitted variable bias) on the relationship between stunting and access to the drivers of nutrition summarized by the coefficients a_1, a_2, and a_3.

Before presenting the estimates based on regression equation (1), it is useful to look at Table 5.1 which presents the percentage of children with access to different combinations of the drivers of nutrition. The feature that stands out in this table is the very low percentage of children with access to adequate level of all 3 nutrition drivers. The very low number of observations in this specific cell/group implies that standard errors of the coefficient estimate of simultaneous access to all 3 drivers are likely to be very high, making the coefficient α_3 statistically insignificant from 0.

The estimates in Table 5.2 reveal that the preliminary inference drawn from the simple cumulative distribution functions of stunting among children with differential access to the drivers of nutrition is very robust.[2] At the national level, stunting rates of children are lower for groups with access to one or more nutrition drivers than the stunting rates among children with inadequate access to all 3 determinants. This result holds irrespective of the specification used (for example, including country-level fixed effects or fixed effects at a finer level such as the stratum which typically identifies regions and urban/rural areas within regions of the country).

Table 5.2 Changes in the stunting rate for groups of children with simultaneous access to one or more of the drivers of nutrition: National-level estimates

	Country fixed effects	*Country-strata fixed effects*
Variables	*No covariates*	*No covariates*
Aany1: Adequate in any 1 driver	–0.078***	–0.057***
	(0.008)	(0.008)
Aany2: Adequate in any 2 drivers	–0.143***	–0.110***
	(0.008)	(0.008)
Aall3: Adequate in all 3 drivers	–0.167***	–0.134***
	(0.013)	(0.013)
Observations	74,781	74,634

Source: World Bank staff estimates based on children less than 24 months old from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.
Notes: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (1) excluding child, parental, and household characteristics. Robust standard errors in parentheses corrected for correlation at the cluster level.
Stratum is the lowest level of statistical representation of the DHS within a country, typically identifying regions and urban/rural areas within regions in a country.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

The estimates in Table 5.3 present the marginal effects on the probability of a child being stunted associated with simultaneous access to one or more of the drivers of nutrition. These child-level estimates reveal the same story as that obtained with the differences between the stunting rates of groups of children with access to one or more nutrition drivers. The probability that an individual child is stunted, controlling for child, parental, and household characteristics, is lower when a child has access to one or more nutrition drivers than the probability of stunting for a child with inadequate access to all three determinants. As in Table 5.2, this result holds irrespective of the specification used (for example, including country-level fixed effects or country-strata-level fixed effects). Also, the coefficients in Table 5.3 do not differ substantially between country fixed effects and country-strata fixed effects.

Controlling for child, parental, and household characteristics leads to a substantial decline in the coefficient estimates (compare estimates in Table 5.2 against estimates in Table 5.3). Irrespective of the specification used, these estimates are also useful at identifying target groups of the children that are deprived in all or some of the drivers of nutrition. Assuming that the policy objective is to decrease the prevalence of stunting, these estimates can be used to shed some light on the extent to which the allocation of scarce

Table 5.3 Marginal effects on the probability of stunting of simultaneous access to one or more of the drivers of nutrition: Child level estimates

	Country fixed effects	*Country-strata fixed effects*
Variables	*Including child, parental, and household covariates*	*Including child, parental, and household covariates*
Aany1: Adequate in any 1 driver	–0.022***	–0.020***
	(0.007)	(0.007)
Aany2: Adequate in any 2 drivers	–0.042***	–0.043***
	(0.009)	(0.009)
Aall3: Adequate in all 3 drivers	–0.038**	–0.051***
	(0.016)	(0.015)
Observations	68,533	68,391

Source: World Bank staff estimates based on children less than 24 months old from 31 country DHS from SSA. See Table 2.1 for the list of countries and years. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (1). Stratum is the lowest level of statistical representation of the DHS within a country, typically identifying regions and urban/rural areas within regions in a country.
Detailed estimates available upon request. All regressions include year fixed effects as well as child, parental, and household characteristics that consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

resources to different groups of children with differential access to the drivers of nutrition can have potential benefits in terms of reducing stunting.

Consider for example, the choice between allocating the same resources between two groups of children: group A composed of children that have inadequate access to all three nutrition drivers and group B composed of children that have adequate access to only one of the nutrition drivers. The estimated marginal effect of –0.022 of *Aany1* (first column in Table 5.3) implies that the probability of stunting for a child with access to any one driver is 2.2 percentage points lower than the probability of stunting in the reference group of children with inadequate access to all three nutrition drivers (group A). The coefficient –0.042 of *Aany2* (first column in Table 5.3) implies that the probability of stunting among children with access to any two of the drivers of nutrition is 4.2 percentage points lower than the probability of stunting among children with inadequate access to all three nutrition drivers. This, however, implies that there is only a 2.0 percentage point decline in the probability of stunting associated with having access to 2 drivers compared to 1 driver (–0.042 – (–0.022) = –0.020). Thus, allocating the same resources to group B instead of group A for the purpose of increasing their access from 1 to 2 nutrition drivers will decrease the stunting rate by only 2.0 percentage points.

The 0.2 percentage point higher marginal effect on stunting between providing access to 1 nutrition driver to children in group A composed of children that have inadequate access to all three nutrition drivers compared to allocating the resources to group B composed of children that have adequate access to only one of the nutrition drivers is not sufficiently robust to serve as a basis for policy advice. This becomes even more apparent from the estimates obtained after controlling for country-strata fixed effects (see second column of Table 5.3). In this case, the marginal effect on stunting of investing in group B is –2.3 percentage points compared to the –2 percentage points marginal effect of investing in group A. The small differences in the marginal effects on stunting associated with investing in group A versus group B suggest that the final decision will have to be based primarily on cost considerations.

Table 5.4 presents estimates of equation (1) for different country groupings, such as countries with relatively higher or lower values (among the group of 33 countries analyzed in this report) of GNI, Gini index of inequality, tariff rates, 1st wave countries as categorized by the World Bank versus all other countries, high versus low fragility countries, countries whose consumption is low or high in starch, landlocked versus non-landlocked countries, and countries in the Sahel regions versus non-Sahel regions. The list of countries composing each group may be found in Table 2.1.

The estimates in Table 5.4 reveal that the same general patterns identified in Table 5.2 also hold in most of these groups. Notable exceptions are the areas of countries in the Sahel region where access to

Table 5.4 Marginal effects on the probability of stunting of simultaneous access to one or more of the drivers of nutrition in different groups of countries

	Low GNI	*High GNI*	*Low Gini*	*High Gini*	*Low tariff*	*High tariff*	*Low fragility*	*High fragility*
Adequate in any 1 driver	–0.034***	–0.013	–0.029***	–0.016*	–0.016*	–0.042***	–0.074***	–0.019
	(0.012)	(0.008)	(0.011)	(0.008)	(0.008)	(0.011)	(0.015)	(0.016)
Adequate in any 2 drivers	–0.057***	–0.032***	–0.066***	–0.023**	–0.034***	–0.066***	–0.106***	–0.017
	(0.014)	(0.011)	(0.013)	(0.011)	(0.011)	(0.015)	(0.020)	(0.021)
Adequate in all 3 drivers	–0.072***	–0.015	–0.091***	0.003	–0.036*	–0.044	–0.080**	–0.059*
	(0.021)	(0.024)	(0.022)	(0.022)	(0.019)	(0.030)	(0.034)	(0.031)

Source: World Bank staff estimates based on children less than 24 months old from 31 country DHS from SSA. See Table 2.1 for the list of countries and years. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.

Notes: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (1). Robust standard errors in parentheses corrected for correlation at the cluster level.

Detailed estimates available upon request. All regressions include country and year fixed effects as well as child, parental, and household characteristics that consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.

High and low fragility countries are categorized based on IDA's resource allocation index. The 12 countries in the study are divided into two groups, such that 6 are 'low fragile' and 6 are designated as 'high fragile' countries. See Table 2.1 for specific countries in each group.

***p < 0.01, **p < 0.05, *p < 0.1.

Table 5.5 Marginal effects on the probability of stunting of simultaneous access to one or more of the drivers of nutrition in different groups of countries

	Low starch	*High starch*	*1st wave*	*Non 1st wave*	*Sahel regions*	*Non-Sahel regions*	*Landlocked*	*Non-landlocked*
Adequate in any 1 driver	–0.016**	–0.020	–0.011	–0.052***	–0.005	–0.031***	–0.025*	–0.021***
	(0.008)	(0.014)	(0.009)	(0.010)	(0.013)	(0.008)	(0.015)	(0.008)
Adequate in any 2 drivers	–0.038***	–0.021	–0.027**	–0.074***	–0.022	–0.061***	–0.041**	–0.043***
	(0.011)	(0.018)	(0.012)	(0.012)	(0.020)	(0.010)	(0.017)	(0.010)
Adequate in all 3 drivers	–0.016	–0.062**	–0.019	–0.080***	0.061	–0.082***	–0.076***	–0.016
	(0.022)	(0.031)	(0.023)	(0.019)	(0.044)	(0.016)	(0.021)	(0.022)

Source: World Bank staff estimates based on children less than 24 months old from 31 country DHS from SSA. See Table 2.1 for list of countries and years. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.
Notes: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (1). Robust standard errors in parentheses corrected for correlation at the cluster level.
Detailed estimates available upon request. All regressions include country and year fixed effects as well as child, parental, and household characteristics that consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
First Wave Country designation based on the World Bank classification. The 1st wave countries included in the study are Burkina Faso, Cameroon, Côté D'Ivoire, Ethiopia, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, and Tanzania.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

one or more nutrition drivers does not appear to have a statistically significant decrease in the probability of stunting relative to the probability in the group of children with inadequate access to all three nutrition drivers. Also, in countries with relatively higher tariffs, typically associated with higher food prices, and in countries with low fragility, the marginal effects of access to a higher number of nutrition drivers on the probability of a child being stunted are typically higher. Thus, access to one or more nutrition drivers is associated with greater decreases in stunting in countries where food prices are higher because of higher import tariffs, which suggests that increased access to the nutrition drivers may be a more effective policy instrument against undernutrition in economics where foods prices are higher (see Box 5.1).

Along similar lines, Table 5.6 presents estimates of equation (1) for different socioeconomic groups within countries such as urban and rural areas, boys and girls, children residing in households in the bottom 20 percent (B20) and top 20 percent (T20) of the asset index distribution with each country, and

Box 5.1 Tariffs, trade, and child stunting

In this report, the sample of 33 countries is partitioned into two groups of countries with relatively higher and lower tariffs to explore any potential differences links and interactions between access to the underlying drivers of nutrition and stunting. It is important to bear in mind that import tariff rates are an imperfect measure of the actual ease of trade given many non-tariff-based barriers such as licensing schemes, quotas, and customs rules.

The removal of trade barriers, such as import tariffs, change the national availability of food—both in terms of the types of foods available as well as their price—through changes in both imports and national production. At the household level, food availability is not only directly affected by these changes but also indirectly through any changes to the householdís income from the shifts in the countryís production profile. Whereas the impact of trade liberalization on economic growth and poverty has been extensively studied (for example Dollar and Kraay 2004), there are very few studies linking trade barriers to malnutrition measures per se. In a review of the effects of agricultural development policies, including trade liberalization, on nutrition, Dangour et al. (2013) after exhaustive search criteria only find four studies which explore the relationship empirically, of which only one measures undernutrition rates in children (in Andhra Pradesh in India). Although trade liberalization accelerates growth and poor households on average proportionately benefit from growth as non-poor households (Dollar and Kraay 2004), it is not evident that the welfare of a household, especially of those who rely on agriculture for their livelihoods, is improved (Calì, Hollweg, and Bulmer 2015). Furthermore, knowing that welfare is affected is not sufficient to draw conclusions on how the nutritional status of young children would be affected.

Table 5.6 Marginal effects on the probability of stunting of simultaneous access to one or more of the drivers of nutrition for different areas and socioeconomic groups within countries

	Urban	*Rural*	*Boys*	*Girls*	*B20*	*T20*	*Mother more educated*	*Mother less educated*
Adequate in any 1 driver	–0.026**	–0.020**	–0.037***	–0.005	–0.035**	–0.034*	–0.023*	–0.021**
	(0.012)	(0.008)	(0.010)	(0.010)	(0.014)	(0.018)	(0.012)	(0.009)
Adequate in any 2 drivers	–0.040***	–0.043***	–0.045***	–0.039***	–0.041**	–0.043**	–0.046***	–0.039***
	(0.015)	(0.011)	(0.013)	(0.012)	(0.021)	(0.020)	(0.013)	(0.012)
Adequate in all 3 drivers	–0.026	–0.057***	–0.043*	–0.033	–0.065	–0.045*	–0.053***	–0.022
	(0.023)	(0.022)	(0.023)	(0.023)	(0.054)	(0.025)	(0.019)	(0.025)

Source: World Bank staff estimates based on children less than 24 months old from 31 country DHS from SSA. See Table 2.1 for the list of countries and years. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (1). Robust standard errors in parentheses corrected for correlation at the cluster level.
Detailed estimates available upon request. All regressions include country and year fixed effects as well as child, parental, and household characteristics that consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

children with more educated mothers (more than 7 years of school). For each of these groups, the same general patterns prevail in the relationship between the probability of stunting and access to one or more nutrition drivers. However, what is striking in these estimates is the differences in the coefficients a_1, a_2, and a_3 between some groups. For example, the marginal effect of access to one or more nutrition drivers on the probability of stunting is higher for boys than for girls and for children with more educated mothers than less educated mothers (see Table 5.6).

The heterogeneity of these marginal effects provides useful information on the extent to which programs increasing access to one or more nutrition drivers may benefit some children more relative to others, depending on some key characteristics of the child (boys) or the household (educated mother). The results also underline the fact that given the low prevalence of access to two or three determinants for children from the poorest wealth quintile, only the estimate for access to one or two determinants are statistically significant. The fact that the coefficient estimates for α_3 is not statistically significant does not imply that access to three determinants is not associated with better nutritional outcomes for these children but rather reflects the fact that there is insufficient information to confidently estimate the difference.

Stunting and the Underlying Determinants of Nutrition

The analysis in the previous section raises an important policy question: if access to one or more of the nutrition drivers is associated with lower stunting, which one of the three drivers is this? In the context of budgetary constraints, efforts to provide adequate access to at least one driver need to prioritize interventions among different sectors. To this end, children are classified by their specific set of determinants (access to adequate food and care, access to adequate WASH, and access to adequate health services) to determine which combinations have relatively stronger associations with the lower stunting rates.

A variant of the methodology of the previous section is adopted to shed light on this issue. Seven binary variables are constructed by considering whether the child has access to adequate levels in the other drivers. Specifically, the binary variable FC is equal to 1 if the household has adequate care and food security only (and inadequate health and environment) and 0 otherwise. Similarly, W is 1 when the household is adequate in WASH services (and inadequate in food and care and health), and H is 1 when the household is adequate in health services only (and inadequate care and food and WASH) and is 0 otherwise. In the same fashion, FC_H takes the value of 1 if the household has adequate food and care practices and adequate health services at the same time (and inadequate WASH), and FC_W takes the value of 1 if the household has adequate food and care and adequate WASH (and inadequate health).

The model estimated using the logit model for binary dependent variables is as follows:[3]

$$Stunted = \alpha + \beta_{FC}FC + \beta_{W}W + \beta_{H}H + \beta_{FC_W}FC_W + \beta_{FC_H}FC_H + \beta_{W_H}W_H + \beta_{FCW_H}All3 + X + \mu + \varepsilon \quad (2)$$

In equation (2), the subscripts for child i in country c are dropped to minimize clutter and the dependent variable *Stunted* along with the control variables X and μ are identical to those in (1). As in equation (1), the constant term α provides an estimate of the stunting rate (or the probability of being stunted) among children in the reference group (that is, with inadequate access to all three drivers of nutrition: care and food security ($FC = 0$), WASH/environment ($W = 0$), and health ($H = 0$). The coefficients β yield estimates of the marginal effect on the probability of a child being stunted when a child has access to adequate levels in only one specific driver or a specific combination of two of the three drivers (holding child, parental, and household characteristics, X, constant). Specifically, the coefficient β_{FC} yields an estimate of the decline in the probability of stunting associated with access to adequate food and care only ($FC = 1$) but inadequate access to health ($H = 0$), and inadequate access to WASH ($W = 0$), in comparison to the probability of a child being stunted in the reference group summarized by the constant term α. The coefficients β_H and β_W have analogous interpretations for health and WASH, respectively.

Table 5.7 presents the estimates of equation (2) including country-level fixed effects and strata-level fixed effects with the controls X excluded (left column) and then included (right column). When the control variables X are excluded, the coefficients can be interpreted as the difference in the stunting rate among children in different groups relative to the group of children with inadequate access to all three nutrition drivers. When the control variables X are included, the coefficients can be interpreted as the marginal effects in the probability of stunting relative to the probability of stunting in the reference group included in the constant term.

Table 5.7 The marginal effect on the probability of stunting of access to adequate level in combinations of the underlying drivers of nutrition

Variables	*Country fixed effects*	*Country-strata fixed effects*
Food/care determinant (FC)	–0.009	–0.003
	(0.013)	(0.012)
WASH determinant (W)	0.032**	–0.019
	(0.012)	(0.011)
Health determinant (H)	–0.048***	–0.030***
	(0.008)	(0.008)
Food/care and WASH (FC_W)	–0.002	–0.032
	(0.021)	(0.020)
Food/care and health (FC_H)	–0.066***	–0.050***
	(0.012)	(0.011)
WASH and health (W_H)	–0.041***	–0.043***
	(0.012)	(0.011)
All 3	–0.044***	–0.054***
	(0.017)	(0.016)
Observations	67,125	66,992

Source: World Bank staff estimates based on 31 recent DHS from Africa. See Table 2.1 for the list of countries and years. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level. Stratum is the lowest level of statistical representation of the DHS within a country, typically identifying regions and urban/rural areas within regions in a country.
All regressions include year fixed effects as well as child, parental, and household characteristics that consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

The estimates in Table 5.7 confirm the leading role of the nutrition-specific interventions carried out primarily by the health sector. This result is also robust to the inclusion of country-strata fixed-effects instead of country fixed-effects. Controlling for child, parental, household characteristics as well as for the country of residence, the probability of stunting associated with having access to adequate health only, decreases by 4.8 percentage points when the geographic location of the household within a country is not taken into consideration, and by 3.0 percentage points after taking into account potential differences associated with living in an urban or rural area and a specific region of the country. In both cases the marginal effect of health on the probability of stunting is greater than the marginal effect of having access to adequate food and care only,[4] or access to adequate WASH only. Thus, if budgetary or other considerations allow for interventions covering deprived children by only one sector, this sector should be health.

As discussed earlier (see Table 5.3), the estimates in Table 5.7 could also provide policy guidance on which sector could be scaled up in a targeted group that is already covered by the health sector. Controlling for child, parental, household characteristics as well as for the geographic location of the household within the country of residence (that is, for country-strata fixed effects), the probability of stunting associated with having simultaneous access to adequate health **and** adequate WASH (W_H), decreases by 4.3 percentage points relative to the reference group (that is, children with inadequate access to all three nutrition drivers). This implies that the marginal decline in stunting associated with adding access to adequate WASH services to the group of children who already have access to adequate health is 1.3 percentage points ($-0.043 - (-0.030) = -0.013$). The marginal decline in stunting associated with adding access to WASH is similar to the 2.0 percentage point marginal decline in the probability of stunting associated with providing simultaneous access to adequate health and adequate food and care. As earlier (see discussion of Table 5.3), the estimates of the differences in the marginal effects are not sufficiently robust to serve as a basis for policy advice.[5] This suggests that the final decision will have to be based primarily on cost considerations.

In any case, it is important to bear in mind that the relationship prevailing in the pooled sample of children, may not necessarily reflect the relationship that may prevail within any given country and serves as a warning against policies being guided by evidence that is not country specific.

Table 5.8 conducts a more in-depth investigation, by replacing in the regressions the three drivers of nutrition with the individual components of the three drivers of nutrition. As in Table 5.7, estimates are presented by excluding and then including child, parental, and household characteristics (X) with country fixed effects and then with strata-level fixed effects. Except for access to improved sanitation, all the variables related to water (W1–W5) turn statistically insignificant when strata-level fixed effects are included along with other controls X. This is because there is very little or no variation among households in access to the different components of WASH within strata.

The coefficient of age-appropriate breastfeeding, however, appears to have a significant positive effect on stunting irrespective of the specification estimated. One possible explanation for this rather unexpected sign is the possibility of endogeneity bias, arising from age-appropriate breastfeeding behavior being followed closely mainly for children who are stunted. A related explanation is selection bias. Part of the positive correlation between breastfeeding (both exclusive and complementary) and stunting is due to the fact that those who are breastfed are less likely to die (Victora et al. 2016). The children who would have died had they not received breastmilk are most likely the weaker ones and thus in the pool of breastfed children are those who would have died otherwise and who do not make it in the non-breastfed group.[6]

A Brief Summary of the Country-Specific Estimates

Detailed estimates of regression equation (2) (with strata fixed effects) for each of the 33 countries analyzed in this report can be found in Annex C. It is important to point out, however, that the determinant that is most frequently correlated with lower stunting is access to health care. Access to WASH is associated with lower probabilities of stunting in Gabon, Guinea, Lesotho, and Uganda. Access to health is associated with lower probabilities of stunting in Burundi, Cameroon, Chad, Democratic Republic of

Table 5.8 The marginal effects on stunting prevalence of access to the components of the underlying drivers of nutrition

	Country fixed effects		*Country-strata fixed effects*	
Variables	*No covariates*	*Including child, parental, and household controls*	*No covariates*	*Including child, parental, and household controls*
F: Child has adequate food intake	–0.060*** (0.008)	–0.035*** (0.009)	–0.052*** (0.008)	–0.028*** (0.008)
C1: Immediate skin-to-skin contact	–0.008 (0.007)	–0.005 (0.007)	–0.008 (0.007)	–0.007 (0.007)
C2: Age-appropriate breastfeeding	0.053*** (0.007)	0.053*** (0.009)	0.037*** (0.007)	0.040*** (0.009)
W1: Improved non-shared sanitary facilities	–0.057*** (0.013)	–0.032** (0.014)	–0.056*** (0.013)	–0.029** (0.013)
W2: Improved water source	–0.006 (0.007)	0.007 (0.008)	0.001 (0.007)	0.002 (0.007)
W3: Handwashing facility on site	–0.036*** (0.012)	–0.012 (0.013)	–0.026** (0.012)	–0.017 (0.013)
W4: Percentage of households using open defecation in cluster	–0.051*** (0.013)	–0.076*** (0.014)	0.015 (0.014)	0.011 (0.014)
W5: Disposal of feces	0.073*** (0.015)	0.049*** (0.016)	0.048*** (0.014)	0.023 (0.015)
H1: Had 4 or more prenatal checks	–0.048*** (0.006)	–0.039*** (0.007)	–0.021*** (0.006)	–0.024*** (0.006)
H2: Birth assisted by trained professional	–0.056*** (0.007)	–0.044*** (0.007)	–0.008 (0.007)	–0.015** (0.007)
H3: Child has been to at least one postnatal checkup	0.011 (0.007)	0.004 (0.007)	0.021*** (0.007)	0.006 (0.007)
H4: Vaccinations up to date	–0.111*** (0.007)	–0.027*** (0.007)	–0.104*** (0.006)	–0.022*** (0.007)
H5: Child sleeps under a mosquito bed net	–0.031*** (0.007)	–0.023*** (0.007)	–0.017*** (0.007)	–0.013* (0.007)
Observations	51,724	46,685	51,491	46,456

Source: World Bank staff estimates based on 26 recent DHS from Africa. See Table 2.1 for the list of countries and years. Cameroon, Republic of Congo, Gabon, and Niger have no information on handwashing facilities; Republic of Congo and Gabon have no information on disposal of feces; Ethiopia and Lesotho have no information on mosquito nets; and Mozambique has no information on postnatal checkups, and thus these countries are not part of the pooled components analyses. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level. Stratum is the lowest level of statistical representation of the DHS within a country, typically identifying regions and urban/rural areas within regions in a country.
Child, parental, and household characteristics consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Congo, Kenya, Lesotho, Niger, Namibia, Niger, Togo, and Zimbabwe. Access to food/care is associated with lower probabilities of stunting in Angola, Benin, Chad, Democratic Republic of Congo, and The Gambia.

Also, the combination of WASH and health is associated with lower probability of stunting in nine countries and WASH and food/care in two countries, health of food/care in seven countries, and access to all three in seven countries.

Testing the Sensitivity of the Findings

The analysis so far has focused on the extent to which the access to adequate level in the underlying determinants is associated with stunting which is a binary variable. In this section, the sensitivity of the findings is explored by applying the unconditional quantile regressions (UQR) method on different quantiles of the distribution of HAZ scores. The UQR method (Firpo, Fortin, and Lemieux 2009) allows for the estimation of the effect of a variable of interest, such as increased access to adequate level in one or more of the drivers of nutrition, at specific points (for example, lower 20th percentile) of the unconditional or marginal distribution of HAZ. Thus, the UQR method allows for the possibility that the effects of increased access to the drivers of nutrition may differ between children who have lower HAZ scores and children who have higher HAZ scores. In fact, the method allows for the possibility of separate effects at any quantile of interest.

Given that stunting prevalence in the sample of 33 countries analyzed in this report ranges between 10 and 50 percent, we estimate equations (3a and 3b) using the UQR method at the bottom 10 percent, 20 percent, 30 percent, and 40 percent of the distribution of HAZ scores.

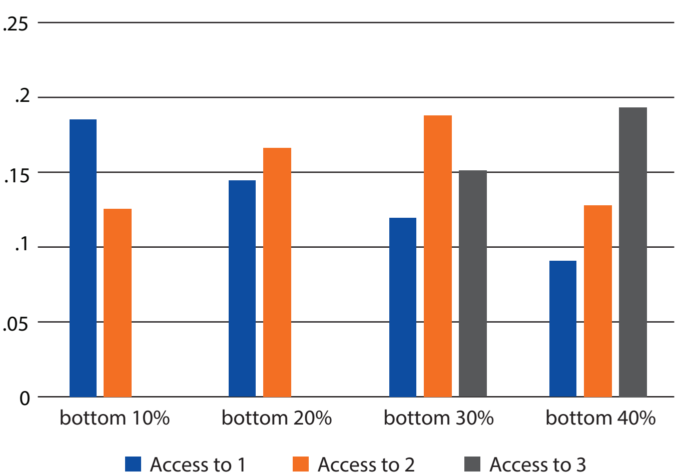
$$HAZ = \alpha + \alpha_1 Aany1 + \alpha_2 Aany2 + \alpha_3 Aall3 + X + \mu + \varepsilon \tag{3a}$$

$$\begin{aligned} HAZ = \alpha + \beta_{FC} FC + \beta_W W + \beta_H H + \beta_{FC_W} FC_W + \beta_{FC_H} FC_H \\ + \beta_{W_H} W_H + \beta_{FCW_H} All3 + X + \mu + \varepsilon \end{aligned} \tag{3b}$$

The subscripts for child i in country c are dropped to minimize clutter.

Figure 5.7presents the differential effect of simultaneous access to one or more drivers of nutrition on height-for-age by quantiles of HAZ scores (that is equation 3a) for children 0–23 months of age. (Only coefficients that are statistically significant are included in the figure.) Among children at the bottom 10 percent of the distribution of HAZ, the only two variables that have a positive and statistically significant effect on height-for-age is whether the child has access to 1 or 2 of the 3 nutrition drivers (*Aany1* and *Aany2*). The absence of any significant effect of the *All3* variable is because very few of the children at the bottom decile of the HAZ score distribution have simultaneous access to all three of the nutrition drivers. The same pattern holds for children at the bottom 20 percent of the HAZ score distribution; both *Aany1* and *Aany2* are significantly positive, but access to any two appears to have a slightly stronger effect on the HAZ score. At the 30th quantile, access to all three nutrition drivers is associated with an increase in HAZ score of 0.15 s. d., whereas at the 40th quantile, access to one of the three nutrition drivers is associated with an increase in HAZ score of 0.19 s. d.

Figure 5.7 The effect of simultaneous access to one or more of the drivers of nutrition at the lower quantiles of the HAZ score distribution

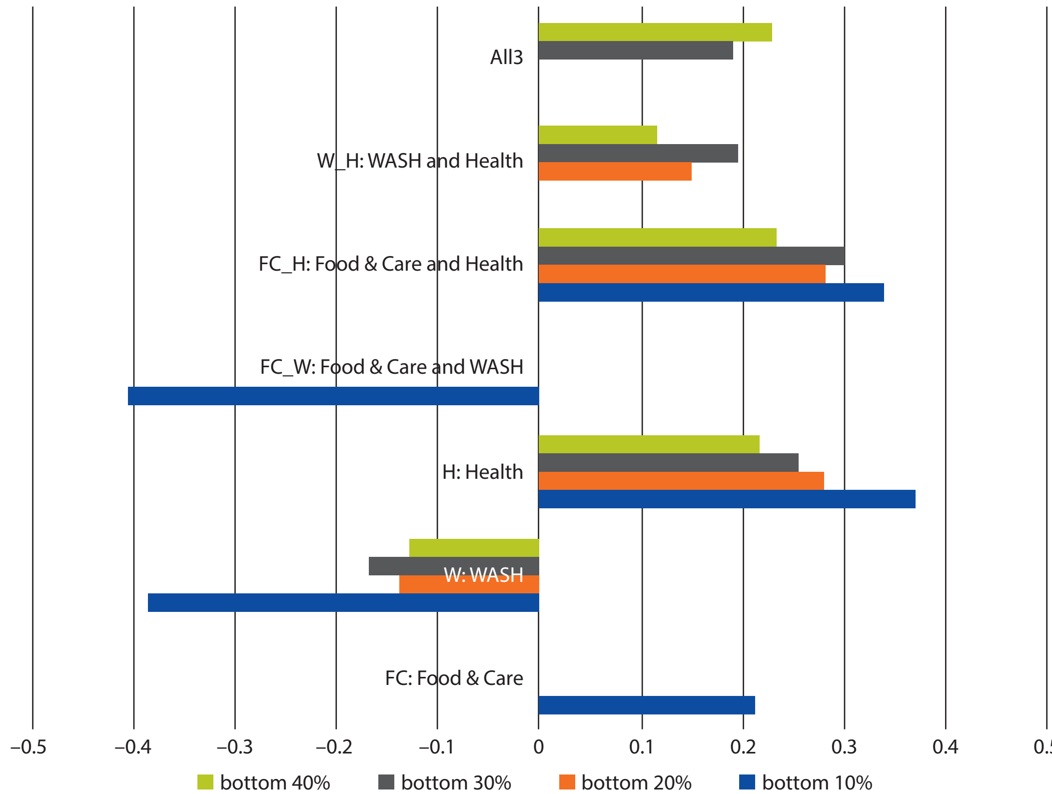


Source: World Bank staff estimates based on 33 recent DHS from Africa. See Table 2.1 for the list of countries and years.
Note: UQR estimates obtained including country fixed effects. Detailed estimates available upon request. The regressions include child, parental, and household characteristics including the following variables: dummy variables for age (months), gender, birth order, multiple births, mother's education in years, marital status (married, never married, or other), mother's height, mother's age, wealth dummy (poorer, middle, richer, richest), number of children under 5 years of age, number of household members, and whether household is in rural or urban area.

In sum, these estimates suggest that access to 1 or 2 or all 3 of the drivers of nutrition is associated with a heterogeneous effect on HAZ scores, that varies according to the level of the HAZ score. Access to 1 nutrition driver has the highest effect on HAZ scores among children at the bottom of the distribution of HAZ (bottom 10 percent) whereas the effect size of access to 2 nutrition drivers increases between the 10th and 30th quantile of the HAZ distribution reaching a maximum at the 30th quantile. Also, the marginal effect of increased access to nutrition drivers seems to vary according to the level of the HAZ score. The marginal effect on HAZ of access to 2 nutrition drivers at the 20th quantile (or the difference between the red and blue bars at the 20th quantile) is considerably smaller than the marginal effect of access to 2 nutrition drivers at the 30th or 40th quantile.

Figure 5.8 presents the differential effect of access to combinations of the 3 specific drivers of nutrition (food and care, WASH, and health) on height-for-age by quantiles of HAZ scores (that is, equation 3b). Access to health only has a positive effect on height-for-age,

Figure 5.8 The effect of effects of access to combinations of the 3 drivers of nutrition at the lower quantiles of the HAZ score distribution



Source: World Bank staff estimates based on 33 recent DHS from Africa. See Table 2.1 for the list of countries and years.
Note: UQR estimates obtained including country fixed effects. Detailed estimates available upon request. The regressions include child, parental, and household characteristics including the following variables: dummy variables for age (in months), gender, birth order, multiple births, mother's education in years, marital status (married, never married, or other), mother's height, mother's age, wealth dummy (poorer, middle, richer, richest), number of children under 5 years of age, number of household members, and whether household is in rural or urban area.

regardless of the quantile evaluated. The importance (or marginal effect on HAZ score) of access to only health is higher at lower quantiles of HAZ.

Access to WASH alone has the negative correlation with height-for-age. This is an unexpected result, although, in general, the group of children with access to adequate WASH services only and inadequate access to the other drivers of nutrition such as health and food and care is most likely a unique group in itself. Access to both food and care and health is positively correlated with height-for-age across the four quantile regressions. Access to both WASH and health and access to all three are also positively correlated with height-for-age. However, WASH and health are not correlated with HAZ at the bottom quintile and all three are only correlated with HAZ at the 30th and 40th quantiles.

Endnotes

1. Strictly speaking, since the control vector X_{ic} and the country fixed effects μ_c are included in the regression, the constant term a is the stunting rate among children in a certain country (the omitted country dummy) with inadequate access to all 3 drivers of nutrition and a specific combination of child, parental, and household characteristics that depends on the way the set of control variables in X_{ic} is constructed.
2. Sampling weights were standardized across the various DHS, following the procedure outlined by DHS. The sampling weight of the mother was multiplied by the ratio of the total number of women 15 to 49 years of age in the surveyed country to the number of women (15 to 49 years of age) surveyed. The total number of women was obtained from the World Population Prospects by the United Nations (2015).

3. For a more detailed discussion of the regression model and the interpretation of the coefficients, the reader is referred to Annex A.
4. The lack of significance of the F_W (Food/Care and WASH) variable is due to the very small number of children in this group. As Table 5.1 indicates, only 1 percent of the total sample of children has simultaneous access to adequate food/care and WASH. In the country fixed effects model, the positive and significant marginal effect of WASH on stunting is mainly driven by the component on the presence of proper facilities for the disposal of feces (W5). As can be seen in Table 5.8, this is the only component of WASH that has a positive significant effect in three of the four specifications estimated.
5. It is also important to point out that unless the geographic location of the household within the country of residence is taken into consideration, different policy conclusions emerge. The estimates in Table 5.7, controlling for country fixed effects imply that the marginal effect of simultaneous access to health and WASH on stunting is smaller than the marginal effect of having access to health only (–0.048), whereas the marginal effect of simultaneous access to food/care and health is –0.066, implying a 1.8 percentage point decline in stunting above that is accomplished by access to health only.
6. In an exhaustive review of the literature, Horta and Victora (2013) and Victora et al.(2016) did not find evidence of breastfeeding affecting child growth (based on studies in mainly middle-income countries).

CHAPTER 6

An Application at the Country Level: The Case of Tanzania

The analysis so far has investigated the relationship between access to nutrition drivers and stunting prevalence based on cross-sectional data on children pooled across 33 countries. As such, the patterns of correlation emerging from the analysis reflect relationships that prevail, on average, among stunting and access to the drivers of nutrition by children residing in different countries. This approach requires that uniform definitions and thresholds based on international standards be applied across all countries. In addition, the threshold levels used to define 'adequate access' to health, or food and care, and WASH have to be sufficiently lax to not preclude representation of the children in countries that are relatively more disadvantaged. The advantage of pooling data on children across many countries based on common definitions and thresholds, is not only in terms of increased sample size overall, but also in that pooling increases number of observations on children with access to adequate levels to different combinations of nutrition drivers. This advantage, however, comes at a cost, since the relationship prevailing in the pooled sample of children, may not necessarily reflect the relationship that may prevail within any given country.

Bearing these considerations in mind, this chapter applies the same methodology using data from only one country, Tanzania. A separate annex accompanying this report includes a brief for each of the 33 countries included in the report summarizing access to the determinants of nutrition and their components as well as the simple correlation between stunting and the number of determinants.[1] Appendix C presents the country-specific regression (logit) estimates of stunting and access to combinations of drivers of nutrition.

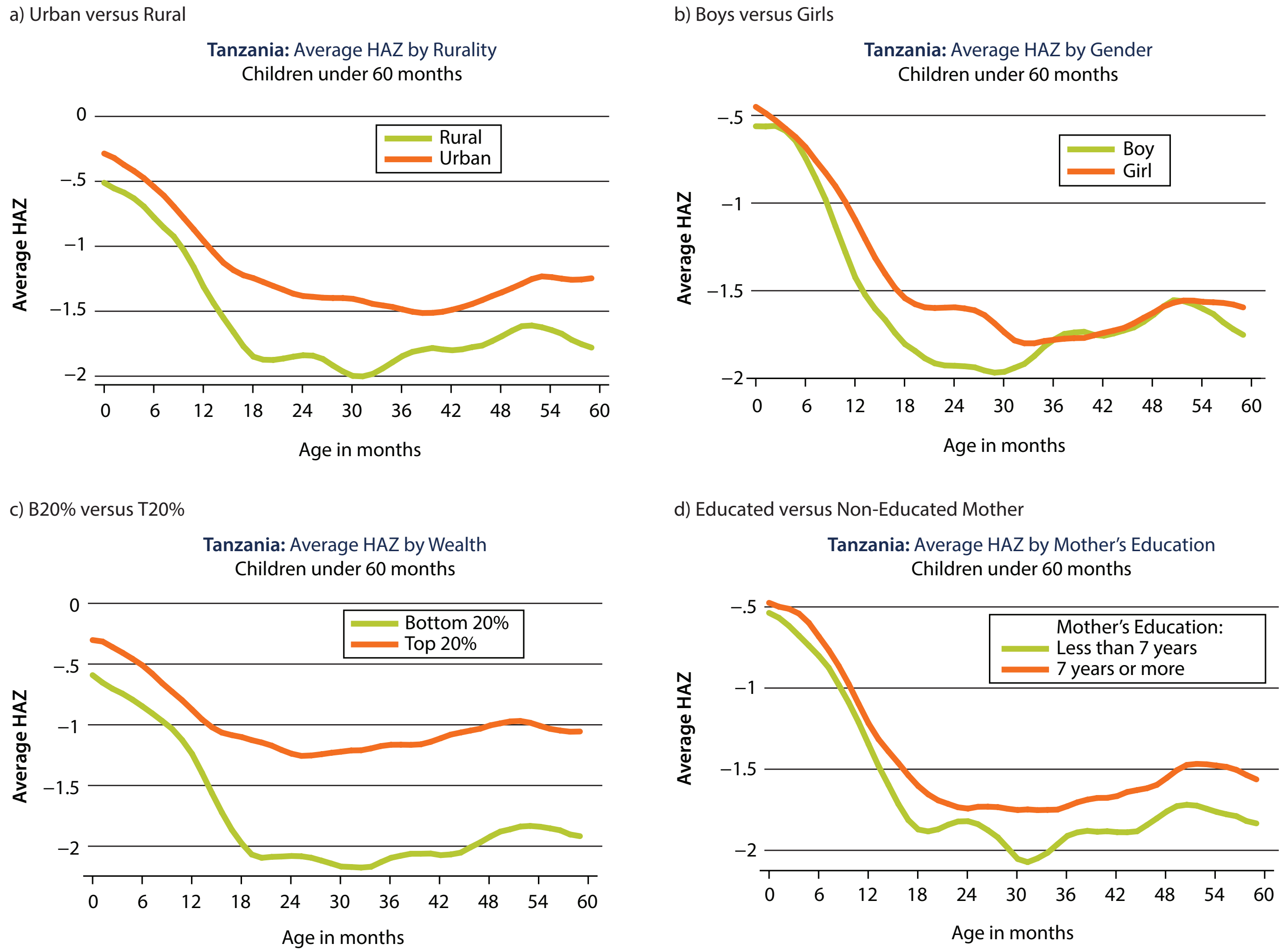
Stunting and the Underlying Determinants of Nutrition in Tanzania

With a stunting rate of 28 percent among children less than 2 years of age, Tanzania ranks around the middle among the 33 countries included in this study (for example, 16th in rank from the country with the highest stunting rate, Burundi, and 18th from the country with the lowest stunting rate, Ghana; see Figure 3.5). Thus, Tanzania's ranking provides the opportunity of determining the extent to which relationships among sample averages based on the sample of children pooled across the 33 different countries, also hold for a specific country, such as Tanzania, with an average stunting rate.

Figure 6.1 highlights the fact that growth faltering is prevalent among children in Tanzania, with growth faltering being faster in rural areas relative to urban areas, for boys relative to girls, for children in less wealthy households (for example, bottom 20 percent of the wealth distribution), and for children whose mother has a relatively lower level of education. Thus, an emphasis on the first 1,000 days window in Tanzania is necessary, if policies and specific programs are to have an ultimate effect on the prevalence of chronic undernutrition.

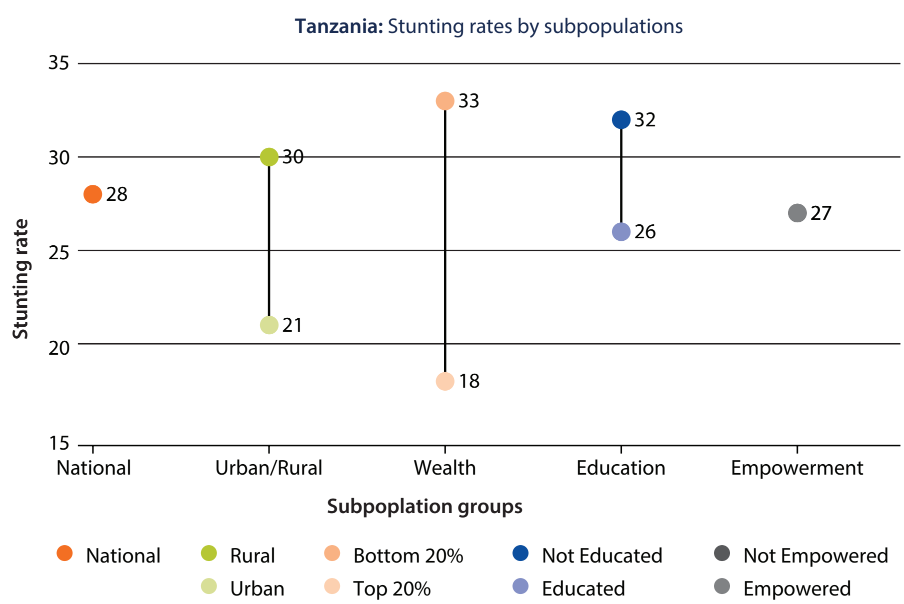
Figure 6.2 presents the prevalence of stunting among children less than 2 years of age in Tanzania, as well as for different geographic areas and different socioeconomic groups. Clearly, Tanzania is characterized by substantial differences in the prevalence of stunting between rural and urban areas, between less and more wealthy households, and children with less or more educated mothers. There do not appear

Figure 6.1 Growth faltering in Tanzania by socioeconomic characteristics (children 0–59 months)



Source: World Bank staff estimates based on Tanzania 2016 DHS.

Figure 6.2 Stunting prevalence among children under 24 months

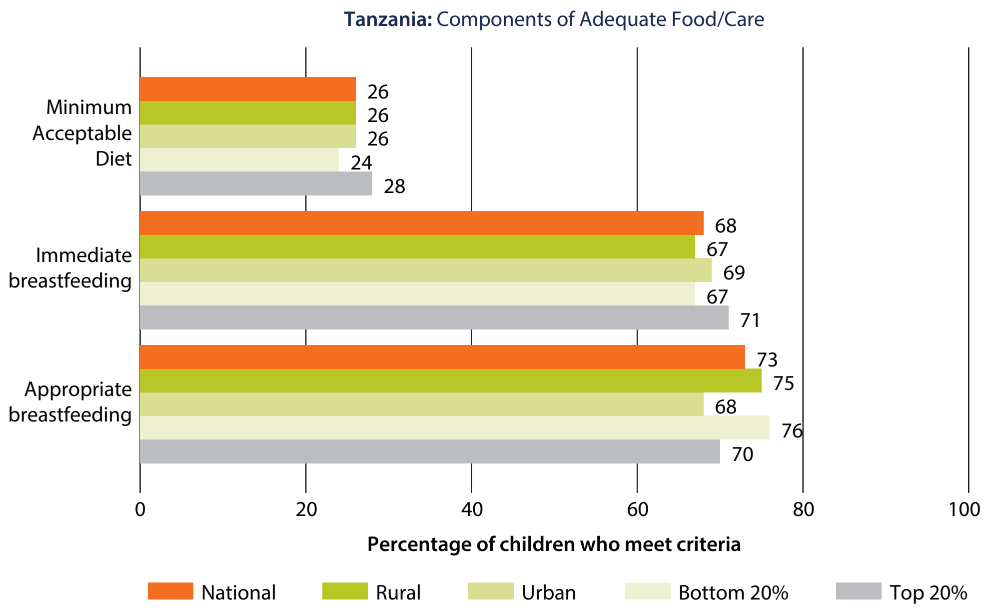


Source: World Bank staff estimates based on Tanzania 2016 DHS.

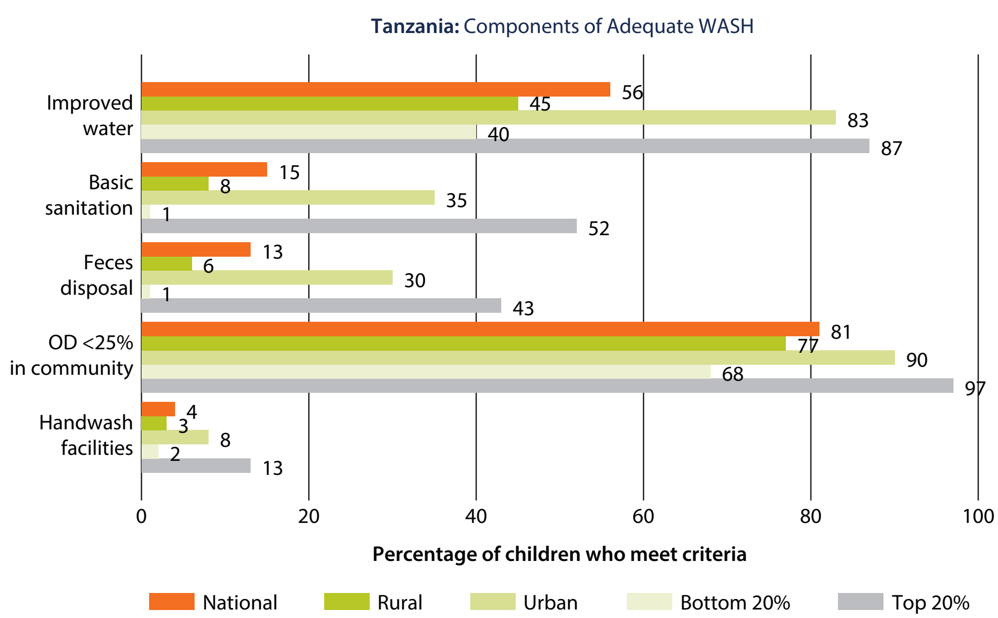
to be any significant differences in the prevalence of stunting among children with more empowered or less empowered mothers.

The panels in Figure 6.3 summarize the access to the components of food and care, environment (WASH), and health, among children 0–23 months of age, at the national level, for rural and urban areas in the country, and for children in the wealthiest (T20) and in the poorest (B20) households. Specifically, food and care consists of the following components, each summarized by a corresponding binary variable

Figure 6.3 Access to the different components of food/care, WASH, and health (children under 24 months)



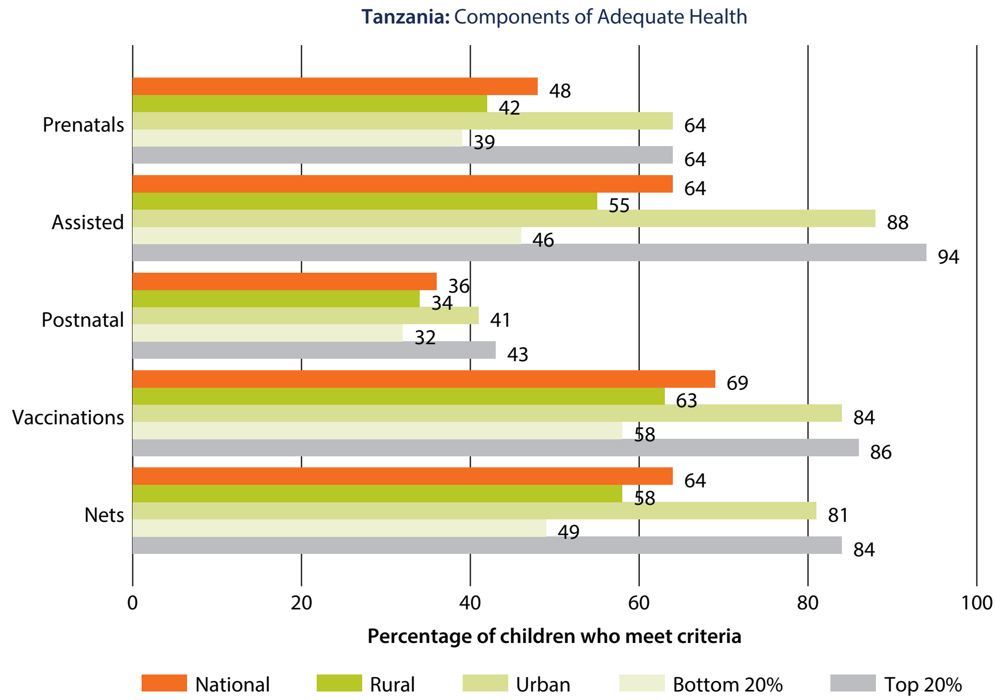
Source: Author estimates based on Tanzania 2016 DHS.
Note: *Exclusive for first 6 months and complementary 6 months to 23 months.



Source: Author estimates based on Tanzania 2016 DHS.
Note: *Based on all households in the child's PSU..

figure continues on next page

Figure 6.3 Access to the different components of food/care, WASH, and health (children under 24 months) *(continued)*



Source: World Bank staff estimates based on Tanzania 2016 DHS.

(0 = no, 1 = yes): if the child, depending on its age, consumes a minimum acceptable diet (based on types of foods consumed and feeding frequency), whether breastfeeding was initiated within an hour of birth, and whether the child is age appropriately breastfed at the time of the survey. WASH or environment consists of the following binary components: (a) access to an improved source of water for drinking, (b) access to basic sanitation in the dwelling, (c) access to proper children's feces disposal, (d) access to a handwashing station with soap, and (e) living in a community where less than 25 percent of the households openly defecate. Lastly, health consists of the following binary components: (a) mother used prenatal services at least four times while pregnant, (b) child was delivered by a skilled professional, (c) child received a postnatal check within two months of birth, (d) child is compliant with national vaccination schedule, and (e) child sleeps under a mosquito net.

Figure 6.3 reveals that access to the component of food/care is considerably less heterogeneous between urban and rural areas, and between the least wealthy (B20) and wealthiest (T20) households than access to the determinants of WASH and health. For example, the percentage of children from wealthier households (T20) with access to improved water, basic sanitation, proper disposal of feces, handwashing facilities, more than four prenatal visits, postnatal care, vaccinations, and sleeping under mosquito nets is considerably higher than the percentage of children from less wealthy households (B20) with access to the same determinants of nutrition.

Following the methodological approach applied to the pooled country data, the various underlying determinants of undernutrition may be categorized into three groups: (a) adequate household food security and care practices, (b) adequate household environment (WASH), and (c) adequate health services. By necessity, the aggregation of 13 different determinants of nutrition into three aggregate groups (food/care, WASH, and health) involves a number of decisions that can be questionable. The criteria adopted in the report were based on practical considerations. First, the three aggregate groups (food/care, WASH, and health), arguably, correspond to the activities and operations of different sectors. Second, the thresholds used to identify whether a child has access to 'adequate' food/care, 'adequate' WASH, or 'adequate' health were rather lax, to allow a sufficient number of children in the different groups and/or combinations of these groups.

For the purpose of comparison, Table 6.1 presents the percentage of children with access to adequate food/care, adequate WASH, and adequate health and different combinations using the less strict definition for adequate used in this report, and a stricter definition that considers access as adequate only if the child has access to all of the components in the determinant (all three components of food/care, all five components of WASH, and all five components of health). It should also be noted that the categories reported in Table 6.1 are mutually exclusive, meaning that children in any of these categories, do not have access to any of the other drivers of nutrition. For example, at the national level, 34 percent of children have access to adequate health only and no access to adequate food/care or adequate WASH, or only 10 percent of the children have access to adequate WASH and health at the same time.

Table 6.1 reveals that the strict definition of adequate access results in a very small percentage of children being categorized as having access to any of the determinants. With the strict definition, the percentage of children with access to adequate health only, at the national level decreases to 7 percent (from 34 percent based on the less strict definition). There is also a large decrease in the percentage of children with simultaneous access to WASH and health (from 10 percent down to 0 with the strict definition). Clearly, applying the strict criterion of adequate access renders this methodological approach useless since 75 percent of the children end up being classified as not having access to an adequate level in any of the three determinants of nutrition. For this reason, the Tanzania case study has been carried out using the less strict definition for adequate used in this report.[2]

Correlation between Stunting and Access to the Drivers of Nutrition

Figure 6.4 presents maps with rates of stunting and access to adequate WASH and health by region of Tanzania.[3] Such maps are not only helpful for highlighting the heterogeneity of stunting and access to the drivers of nutrition across space, but also useful for the targeting of nutrition specific and nutrition sensitive interventions.

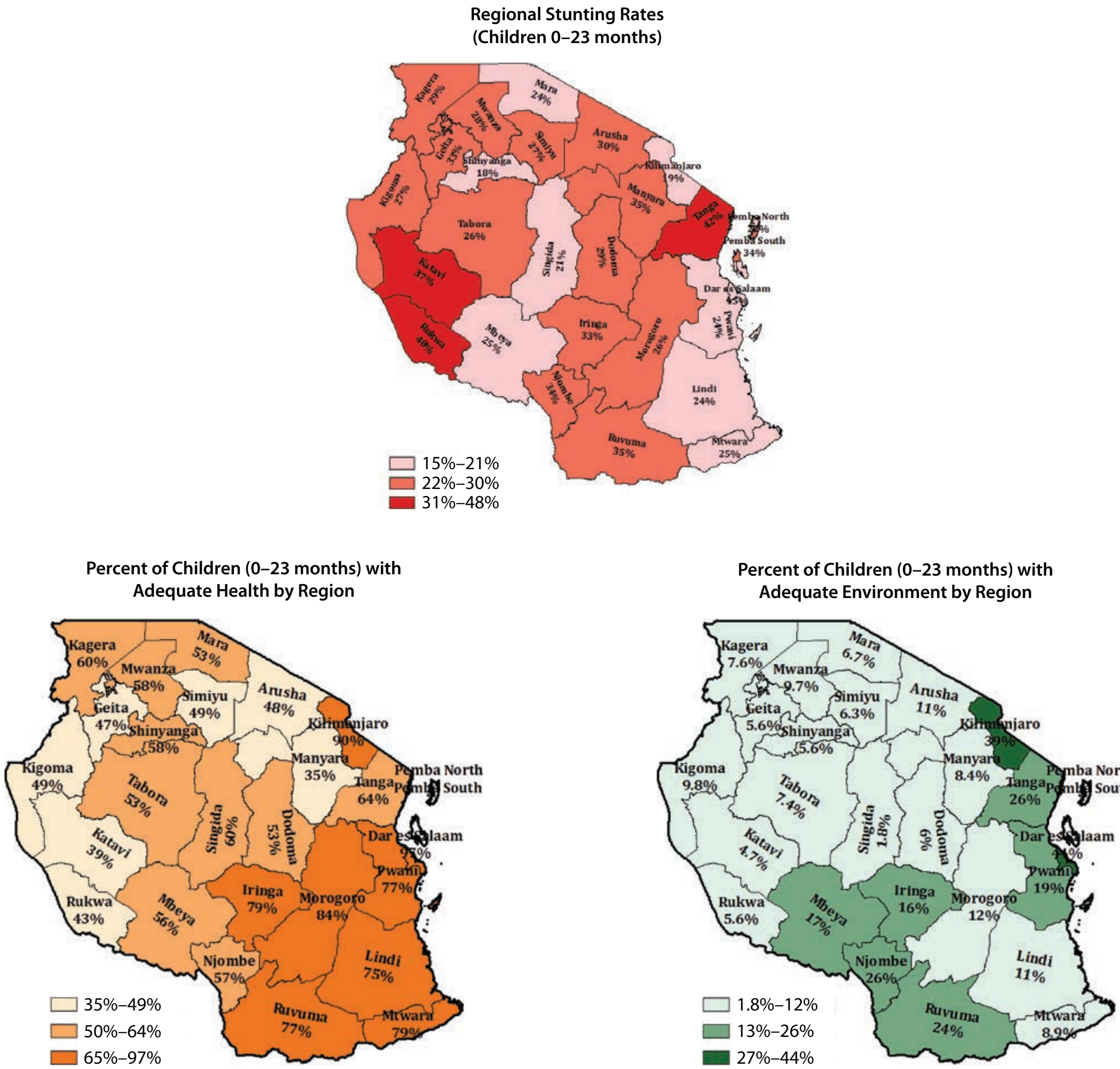
The maps of access to adequate WASH, and adequate health provide information on the joint distribution of WASH and health, that are essential for identifying important gaps in access potentially affecting the impact of other nutrition-related interventions. For example, the scaling up of nutrition-sensitive agricultural operations aiming to increase food security and dietary diversity is unlikely to take into consideration the extent to which there is access to improved water and sanitation or to adequate health services in the geographic areas under consideration. The maps of access to adequate WASH and health

Table 6.1 Percentage of children (less than 24 months) in Tanzania with access to the three drivers of nutrition based on two different definitions of 'adequate'

	Percentage of children adequate in					
	Less strict definition used in the report			*Strict definition*		
	National	*Rural*	*Urban*	*National*	*Rural*	*Urban*
None	29	37	9	75	79	67
Food/care	9	11	3	15	16	12
WASH	1	1	2	1	0	2
Health	34	32	41	7	4	15
Food/care and WASH	0	0	0	0	0	0
Food/care and health	13	13	13	2	1	3
WASH and health	10	4	24	0	0	1
All 3	3	1	8	0	0	1

Source: World Bank staff estimates based on Tanzania 2016 DHS.

Figure 6.4 Tanzania: Regional stunting rates and access to health and WASH



Source: World Bank staff estimates based on Tanzania 2016 DHS.
Note: The data of the blank areas is not included in DHS.

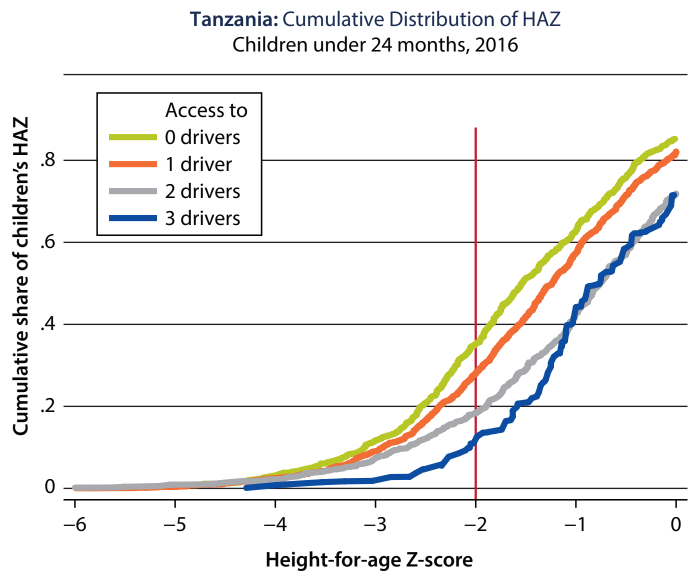
provide a more holistic view and pinpoint better the geographic areas where inadequacies in WASH or health (or in both) may be more prevalent, thus enabling the joint prioritization of operations and improved cost efficiency of interventions.

The maps highlight the regional differences in access. Access to adequate health is concentrated in the eastern part of the country, whereas access to WASH is concentrated in the south and northeast of the country. However, even in these regions stunting rates can be among the highest in the country. The north-central and western regions have relative low prevalence of access to both health and WASH.

Figure 6.5 provides a 'visual' estimate of the extent to which access to only one, or simultaneous access to two, or to all three of the underlying drivers of nutrition is associated with lower prevalence of stunting in Tanzania.[4] Figure 6.5 reveals children with access to all three nutrition drivers have the lowest rate of stunting among children with access to only two drivers or one driver or access to none at all

(0 drivers). Moreover, Figure 6.5 suggests that the greatest reductions in stunting are associated with increases in access from any one driver to simultaneous access to any two drivers or with increases from simultaneous access to any two drivers to access to all three drivers of nutrition. This result contrasts with the finding from the pooled country data (see Figure 5.6), where, the marginal decline (gain) in the stunting rate with increases in access from none (0) to any one driver is larger than that associated with a change in access from one to two drivers or from two to all three drivers. This finding also reinforces the point made above that the relationship prevailing in the pooled sample of children, may not necessarily reflect the relationship that may prevail within any given country and serves as a warning against policies being guided by evidence that is not country-specific.

Figure 6.5 Access to 0 versus 1 or more drivers of nutrition and the prevalence of stunting (children 0–23 months)



World Bank staff estimates based on Tanzania 2016 DHS.

Table 6.2 provides quantitative estimates of the marginal decrease in the stunting rate relative to the stunting rate prevailing among children with access to adequate level in none of the three drivers of nutrition).[5] These estimates reinforce the preliminary findings from Figure 6.4. Consider, for example, the choice between allocating the same resources between two groups of children: group A composed of children that have inadequate access to all three nutrition drivers and group B composed of children that have adequate access to only one of the nutrition drivers. The estimated marginal effect of –0.046 of *Aany1* (second column in Table 6.2) implies that the probability of stunting for a child with access to any one driver is 4.6 percentage points lower than the probability of stunting in the reference group of children with inadequate access to all three nutrition drivers (group A). The coefficient –0.095 of *Aany2* (second column in Table 6.2) implies that the probability of stunting among children with access to any two of the drivers of nutrition is 9.5 percentage points lower than the probability of stunting among children with inadequate access to all three nutrition drivers. This, implies that there is a 5.4 percentage point decline in the probability of stunting associated with having access to two drivers compared to one driver (–0.097–(–0.043) = –0.054). Thus, assuming the costs associated with providing access to a nutrition driver to group B are equal to the costs of providing access to one driver to group A, a slightly greater decline in stunting can be accomplished by targeting the limited resources to provide access to a second driver to group B.

Table 6.2 Changes in the stunting rate for groups of children with simultaneous access to one or more of the drivers of nutrition: Tanzania

Variables	*No covariates*	*Including child, parental, and household covariates*
Aany1: Adequate in any 1 driver	–0.070***	–0.043**
	(0.023)	(0.021)
Aany2: Adequate in any 2 drivers	–0.168***	–0.097***
	(0.024)	(0.026)
Aall3: Adequate in all 3 drivers	–0.241***	–0.155***
	(0.037)	(0.047)
Observations	3,726	3,719

Source: World Bank staff estimates based on children less than 24 months old from Tanzania DHS 2016.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (1) excluding child, parental, and household characteristics. Robust standard errors in parentheses corrected for correlation at the cluster level.
***p < 0.01, **p < 0.05, *p < 0.1.

It is important to point out that the preceding discussion is based on the implicit assumption that the objective of policy is to reduce the stunting (or head count) rate. One key implication of this objective is that it tends to favor the allocation of resources to the group of children that are already closer to the stunting threshold (that is, already have access to an adequate level in one of the nutrition drivers). An alternative policy objective, such as reducing the prevalence of severe stunting among children (as opposed to the head count stunting rate assumed above) is likely to favor the targeting of these resources to children in group A instead of children in group B.

The estimates presented in Table 6.3 are useful for addressing the question of whether access to specific nutrition drivers or to specific combinations of drivers are associated with lower stunting.[6] These estimates confirm the earlier results obtained based on the pooled data across SSA countries. In Tanzania, as is the case on average in SSA countries, access to adequate health only is associated with a significantly lower stunting rate among children compared to children with inadequate access to all three nutrition drivers. Controlling for child, parental, and household characteristics as well as for the locality of residence, the prevalence of stunting among children having access to adequate health only decreases by 4.3 percentage points. Thus, *ceteris paribus*, if budgetary or other considerations allow for interventions covering deprived children by only one sector in Tanzania, this sector should be health.

The estimates in Table 6.3 also provide policy guidance on the next sector that could be scaled up in a targeted group that is already covered by the health sector. Controlling for child, parental, household characteristics, the probability of stunting associated with having simultaneous access to adequate health and adequate WASH (W_H), decreases by 9.8 percentage points relative to the reference group (that is, children with inadequate access to all three nutrition drivers). This implies that the marginal decline in stunting associated with adding access to adequate WASH services to the group of children who already have access to adequate health is 5.5 percentage points (–0.098 – (–0.043) = –0.055). The marginal decline in stunting associated with adding access to WASH is slightly higher than the 5.1 percentage point marginal decline in the probability of stunting associated with providing simultaneous access to adequate health and adequate food and care (–0.094 – (–0.043) = –0.051).

Table 6.3 The marginal effect on the probability of stunting of access to adequate level in combinations of the underlying drivers of nutrition: Tanzania

Variables	*No covariates*	*Including child, parental, and household covariates*
Food/care determinant (FC)	–0.110***	–0.032
	(0.031)	(0.030)
WASH determinant (W)	0.001	–0.018
	(0.062)	(0.068)
Health determinant (H)	–0.054**	–0.043**
	(0.022)	(0.022)
Food/care and WASH (FC_W)	–0.385***	–0.239*
	(0.135)	(0.125)
Food/care and health (FC_H)	–0.195***	–0.094***
	(0.028)	(0.029)
WASH and health (W_H)	–0.136***	–0.098**
	(0.039)	(0.040)
All 3	–0.286***	–0.169***
	(0.064)	(0.062)
Observations	3,726	3,719

Source: World Bank staff estimates based on children less than 24 months old from Tanzania DHS 2016.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level. Access to food/care and WASH simultaneously predicts stunting perfectly.
All regressions include child, parental, and household characteristics that consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
***p < 0.01, **p < 0.05, *p < 0.1.

In line with the results based on the pooled data for SSA countries, simultaneous access to all three nutrition drivers is associated with a significantly lower stunting rate. Controlling for child, parental, and household characteristics, the probability of stunting associated with having simultaneous access to all three nutrition drivers, decreases by 16.9 percentage points relative to the reference group (that is, children with inadequate access to all three nutrition drivers). Bearing in mind some of the caveats already discussed above, this large coefficient also implies that the marginal effect associated with increasing access from two to three drivers is larger than the marginal effect associated with increasing access from one to two drivers. For example, providing access to all three nutrition drivers to a group of children with access to adequate food/care and health (FC_H) leads to a marginal decline in stunting by 7.5 percentage points, an effect that is larger than the 5.1 percentage point marginal decline associated with adding access to adequate food/care services to the group of children who already have access to adequate health.

The Tanzania case also underlines the importance of the multisectoral approach. To realize the largest reductions in stunting it is necessary to address all the underlying determinants of nutrition. Addressing only some will improve child nutrition, but the results suggest that one determinant is not a substitute for another.

Monitoring Progress in Nutrition and Access to the Drivers of Nutrition

In this section, an example is provided to monitor changes in the mean value of HAZ scores associated with increased access to the drivers of nutrition using the 2005 and 2016 waves of the DHS in Tanzania.[7] For children ages 0 to 23 months (the sample), the stunting rate dropped from 44.7 percent to 31.9 percent, whereas the mean value of HAZ scores increased by 0.48 s. d. (from –1.79 s. d. in 2005 to –1.31 s. d. in 2016). The method employed is the standard Blinder-Oaxaca (BO) decomposition applied to two surveys over years (Jann 2008).

The BO decomposition is best described in terms of a regression equation applied to any two groups (for example, different years or gender). Using a variant of equation (3b) above the HAZ score of a child *i* in year *t* can be expressed as in equation (3c):

$$HAZ_{it} = a_t + \beta_{1t}P_{it} + \beta_{2t}X_{it} + \varepsilon_{it} \tag{3c}$$

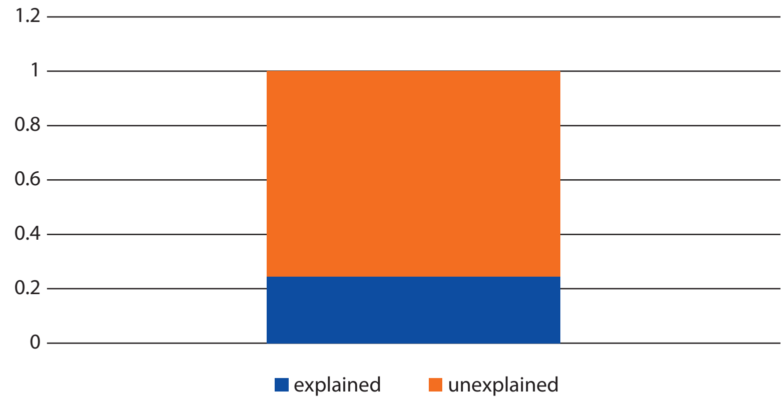
where P_{it} denotes access to policy variables of interest and X_{it} denotes child, parental, and household characteristics, as above. The policy variables of interest include the components of the underlying drivers of nutrition: whether the child had adequate food intake, child had immediate skin-to-skin contact at birth, had age appropriate breastfeeding, the child's mother had four or more prenatal care visits, the child delivery was assisted by a trained professional, child had been to at least one postnatal care checkup, child received all age-appropriate vaccinations, child slept under a mosquito net, the household had access to improved water, the household had access to an improved toilet, had access to handwashing facilities, disposed of the child's stools properly, and if the majority of households in the community (75 percent) used some sort of a sanitation facility.

Following Jann (2008), the BO is based on the insight that the difference in the mean between the two years (or groups) can be expressed as the sum of the difference in the mean values in the different years of the explanatory variables, P_{it} and X_{it}, multiplied by a weighted average of their respective coefficients in the different years, t and t–k, and the difference in the values over time of the coefficients of the same variables multiplied by a weighted average of the mean values in the different years of the explanatory variables: [8]

$$\overline{lnHAZ_t} - \overline{lnHAZ_{t-k}} = \left(\overline{P_t} - \overline{P_{t-k}}\right)\beta_1^* + (\beta_{1t} - \beta_{1t-k})P^* + \left(\overline{X_t} - \overline{X_{t-k}}\right)\beta_2^* + (\beta_{2t} - \beta_{2t-k})X^* \tag{3d}$$

Figure 6.6 presents the contribution of explained factors and unexplained factors on the reduction of the mean value of HAZ scores over the years. In Tanzania, 24 percent of the reduction in stunting over the years is explained by the change in explained factors (that is, the changes in the mean values of the

Figure 6.6 Fraction of increase in mean HAZ between 2016 and 2005 attributable to explained factors: Tanzania (children 0–23 months)

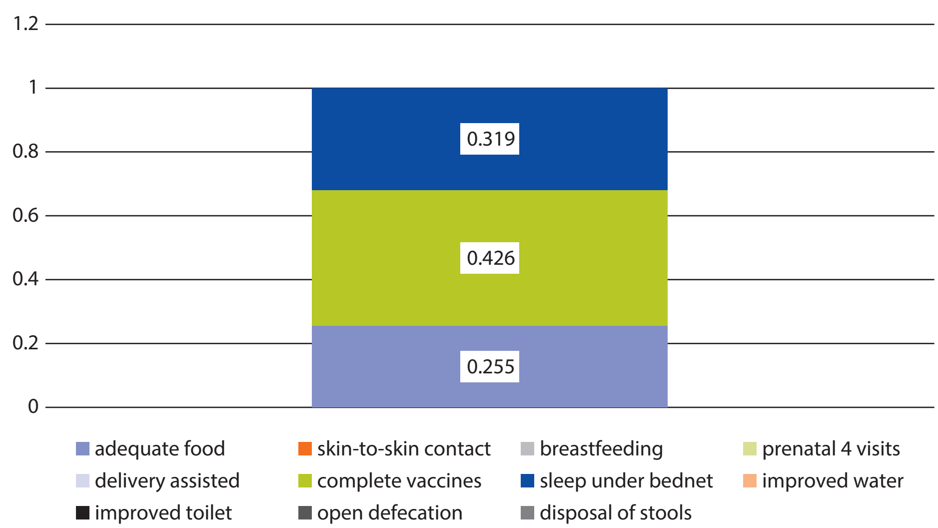


Source: Author's estimates based on the individual child data (0–23 months of age) from two waves of Tanzania DHS.
Notes: The regression estimated included the following explanatory variables; whether the child has adequate food intake, had immediate skin-to-skin contact at birth, has age-appropriate breastfeeding, the child's mother had four or more prenatal care visits, the child delivery was assisted by the trained professional, child has been to at least one postnatal care checkup, child received all the vaccinations, child sleeps under mosquito net, the household has access to improved water, the household has access to improved toilet, handwashing facilities, disposal of stools, and if the majority of households in the community (75 percent) use some sort of a sanitation facility, age, gender, and birth order, the age of the mother, the marital status of the woman, her education level, multiple births, mother's height, number of household members, and number of children under 5 years of age.

policy variables P_i and the changes in the mean values of the child, parental, and household characteristics), with the remaining 76 percent attributed to unexplained factors (changes in the coefficients β_1 and β_2 over the years). Upon closer investigation, all (or 100 percent) of the change in explained factors is due to changes in the mean values of the policy variable P_i.

Figure 6.7 focuses further on the contribution of individual components of the policy variable P_i, that is, the variables proxying the underlying drivers of nutrition. Receiving all the vaccinations (42.6 percent)

Figure 6.7 Decomposing the contribution of access to the drivers of nutrition to the increase in mean HAZ between 2016 and 2005: Tanzania (children 0–23 months)



Source: Author's estimates based on the individual child data (0–23 months of age) from two waves of the Tanzania DHS.
Notes: The regression estimated included the following explanatory variables; whether the child has adequate food intake, had immediate skin-to-skin contact at birth, has age-appropriate breastfeeding, the child's mother had four or more prenatal care visits, the child delivery was assisted by the trained professional, child has been to at least one postnatal care checkup, child received all the vaccinations, child sleeps under mosquito net, the household has access to improved water, the household has access to improved toilet, handwashing facilities, disposal of stools, and if the majority of households in the community (75 percent) use some sort of a sanitation facility, age, gender, and birth order, the age of the mother, the marital status of the mother, her education level, multiple births, mother's height, number of household members, and number of children under 5 years of age.

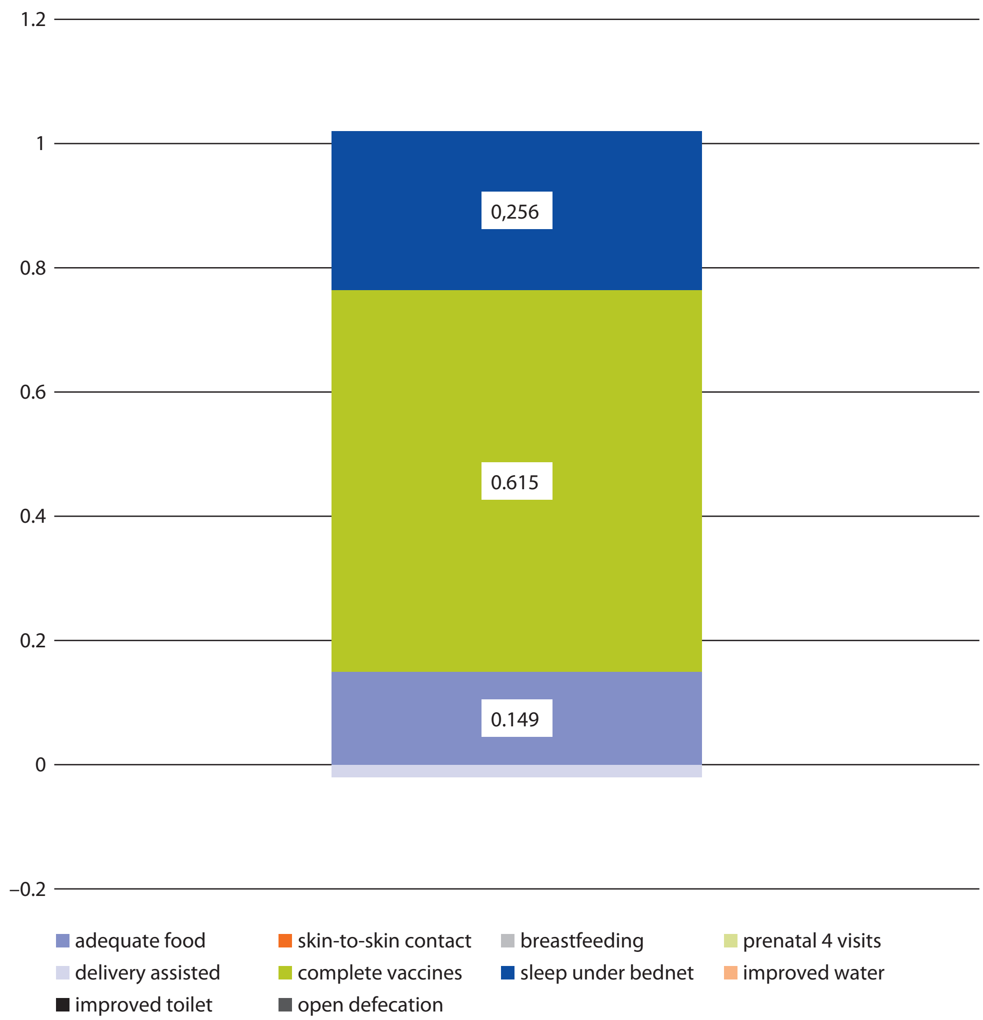
has the highest contribution followed by sleeping under mosquito nets (31.9 percent) and then by deliveries assisted by trained professionals (25.5 percent), to the increase in mean HAZ in Tanzania between 2005 and 2016.

Headey and Hoddinott (2015) have also applied the methodology of the BO decomposition in various South Asian countries by imposing the restriction that the unexplained factors (the coefficients β_1 and β_2) do not change over the years. In this case the general decomposition expression (3d) reduces to:

$$\overline{lnHAZ_t} - \overline{lnHAZ_{t-k}} = \left(\overline{P_t} - \overline{P_{t-k}}\right)\beta_1^* + \left(\overline{X_t} - \overline{X_{t-k}}\right)\beta_2^* \tag{3e}$$

Figure 6.8 based on the above restriction yields results that are consistent with those of Figure 6.7 with some changes in the relative size of contribution. Receiving all the vaccinations has the highest contribution (61.5 percent) followed by sleeping under mosquito nets (25.6 percent) and then by

Figure 6.8 Decomposing the contribution of access to the drivers of nutrition to the increase in mean HAZ (with restrictions imposed): Tanzania (children 0–23 months)



Source: Author's estimates based on the individual child data (0–23 months of age) from 2005 and 2016 Tanzania DHS.
Notes: The regression estimated included the following explanatory variables; whether the child has adequate food intake, had immediate skin-to-skin contact at birth, had exclusive breastfeeding, the child's mother had four or more prenatal care visits, the child delivery was assisted by the trained professional, child has been to at least one postnatal care checkup, child received all the vaccinations, child sleeps under mosquito net, the household has access to improved water, the household has access to improved toilet, handwashing facilities, disposal of stools, and if the majority of households in the community (75 percent) use some sort of a sanitation facility, age, gender, and birth order, the age of the mother, the marital status of the mother, her education level, multiple births, mother's height, number of household members, and number of children under 5 years of age. Standard errors are corrected for clustering at cluster level.

deliveries assisted by trained professionals (14.9 percent), to the increase in mean HAZ in Tanzania between 2005 and 2016.

Endnotes

1. The Annex of the country-specific notes can be accessed at: http://documents.worldbank.org/curated/en/467711529406437446/
2. In fact, regression equations (1) and (2) of Chapter 5 have also been estimated using the strict definition for adequacy, but due to the reasons outlined above none of the relevant coefficients tuned out to be statistically significant.
3. A regional map of access to adequate Food/Care is provide in the separate annex of country-specific notes. It is not presented here to simplify the discussion.
4. Figure 6.4 for Tanzania corresponds to Figure 5.6 constructed based on the pooled data from 33 SSA countries including Tanzania.
5. Table 6.2 is obtained by estimating regression equation (1) in Chapter 5 using data from the Tanzania DHS 2016. Note that the only difference between the estimates reported in Table 6.2 and the estimates for Tanzania in Annex C (column 29) is that the estimates in Annex C are obtained including binary variables identifying regions and rural/urban areas within a country (strata fixed effects) that typically tend to absorb a lot of the variation in cross-sectional samples.
6. Table 6.3 is obtained by estimating regression equation (2) in Chapter 5 using data from the Tanzania DHS 2016 and corresponds to Figure 5.6 based on the pooled data from 31 SSA countries including Tanzania.
7. Given the change in the reference population of children by the WHO in 2006, we have ensured that the measures of HAZ scores over time are based on the 2006 WHO reference group.
8. Note: $\beta_1^* = [W\beta_{1t} + (I - W)\beta_{1t-k}]$, $P^* = [(1 - W)\bar{P}_t + W\overline{P_{t-k}}]$, $\beta_2^* = [W\beta_{2t} + (I - W)\beta_{2t-k}]$, and $X^* = [(1 - W)\bar{X}_t + W\overline{X_{t-k}}]$, where W is a matrix of relative weights given to the coefficients of Group A and I is the identity matrix. This is equivalent to using the coefficients from a pooled model over both groups as the reference coefficients (Jann 2008).

CHAPTER 7

Income Growth is the *'sine qua non'* of a more Effective Multisectoral Approach

Increased access to adequate levels of the underlying determinants of nutrition, analyzed extensively in the previous chapters, is a necessary but not sufficient condition for reducing undernutrition. According to the UNICEF conceptual framework, the 'basic determinants of nutrition' which consist of the economic, political, environmental, social, and cultural context also have a critical role in the determination of the nutritional status of children. Prominent among these factors are the income of the household, the education of the mother, and the extent of autonomous decision making by the mother.

Policies related to the basic determinants of nutrition are typically considered as part of the long-run development strategy of countries, though many programs related to these long-run objectives can also have positive impacts on child undernutrition and stunting in the short term. For example, income redistribution programs, such as conditional or unconditional cash transfer programs can increase the income controlled by mothers, which can translate to improved child nutrition in the short term. Along similar lines, programs in the agricultural sector that increase agricultural productivity or yields sustainably can also have impacts on undernutrition in the short term through higher agricultural profits after harvest. A complete analysis of the distinct role these factors play in the nutritional status of children is beyond the scope of this report.[1] Instead, this chapter focuses on two key moments of income distribution, the mean and the variance, and the relation of each with child undernutrition. Specifically, the next section focuses on the role of household assets/wealth as a proxy for household income and explores some of the interactions of this proxy with other basic determinants such as the mother's education and autonomy on child nutrition, while the section following provides more evidence on the effect of weather-related shocks on child stunting and undernutrition.

Average Income

Household income (or consumption expenditures) measure a household's ability to purchase and consume goods and services and thus is a strong correlate with the poverty status of the household. Higher income allows households to be able to afford the inputs that are essential for the child's health and nutrition, such as the quantity and quality of food needed for proper nutrition, the water and sanitation facilities that minimize exposure to pathogens, and the preventive and curative health services needed. Thus, income affects child nutrition by determining the quantity and quality of the underlying determinants of nutrition demanded by households for their children.

A recent analysis of the potential role of income growth in reducing undernutrition in Africa based on cross-country time-series data suggests that the association between economic growth and the reduction stunting prevalence is lower in Africa, where a 1 percent increase in per capita GNI is associated with a 0.2 reduction in stunting prevalence. In contrast, in other regions, a 1 percent increase in GNI is associated with a 0.6 percent decrease in the prevalence of stunting (World Bank 2017a). However, it is questionable whether such aggregate estimates provide an adequate representation of the relation between income and undernutrition and stunting at the household level within countries in SSA.

The literature abounds with estimates of the calorie-income or calorie per capita expenditure elasticity (that is, Subramanian and Deaton 1996). Such estimates, however, provide information on only one of the important inputs for child health (that is, caloric availability) and nutrition. On the other hand, the literature on the relationship between income and nutritional outcomes such as height-for-age or weight-for-age, especially in SSA countries, is rather thin. Estimates of the income elasticity of stunting or HAZ scores within countries require household-level data on income or consumption expenditures together with child anthropometric measures (such as height and weight) as part of the same survey, and household surveys with these two key variables are scarce.[2] Notable exceptions are Haddad et al. (2003) with estimates for Kenya, Mozambique, and South Africa, Krishna, et al. (2015) and Christiansen and Alderman (2004) for Ethiopia, and Alderman, Hoogeveen, and Rossi (2006) for Tanzania.

In consideration of the absence of any systematic evidence of the relationship between income and undernutrition in the SSA, this report carries out an analysis of the relationship between the percentile of the wealth index distribution within each of the 33 countries analyzed, and child HAZ scores.[3] Sahn and Stifel (2003), in a study of 10 countries, including Cote d'Ivoire, Ghana, Madagascar, and South Africa, provide supporting evidence in favor of the use of the wealth (or assets) index as a valid predictor of child nutrition outcomes.[4] A more recent longitudinal study by Krishna et al. (2015) also finds that the baseline wealth index is significantly associated with higher HAZ and lower odds of stunting and that household wealth in early life influences growth faltering even beyond the 1,000-day window.

The advantage of the approach adopted in this report is that such an analysis can be carried out for all countries where a DHS is available. This is because the wealth index is included as part of the publicly available survey data or can be easily calculated. The disadvantage is that comparable estimates are not available in the literature on undernutrition, thus making it rather difficult to relate the estimate of the coefficient of the wealth percentile, to the available 'income' or 'per capita expenditures' elasticity estimates in the literature.

To unpack the role of wealth as a determinant of growth faltering among children, separate estimates are presented for younger (0–23 months) and older children (24–59 months). Income or wealth may have what appears to be a small positive impact on the HAZ score of children in their first two years of life, but these small positive effects compound as the child ages, resulting in larger differences in HAZ scores that are more apparent later in the life of children. Given that the focus of the report is on stunted children which implies children with lower HAZ scores, the analysis is carried out for the five bottom deciles of the HAZ distribution. (that is, q=0.10 to q=0.50) using the unconditional quantile regression (UQR) method proposed by Firpo, Fortin, and Lemieux (2009).[5] Specifically, two different specifications are estimated. The specification of equation (4a) is essentially a reduced form that can be considered as being derived from an underlying behavioral model of household utility maximization subject to constraints with child health and nutrition as the main determinant of household welfare (see Annex D).

$$HAZ_{ic} = \alpha + \gamma_1 pctileWI_{ic} + X_{ic} + \mu_c + \varepsilon_{ic} \tag{4a}$$

where $pctileWI_{ic}$ denotes the percentile of the wealth index (treated as a continuous variable), X_{ic} denotes a set of control variables summarizing parental, child and household characteristics and μ_c denotes country fixed-effect (or country-specific binary variables). The X_{ic} control variables include: dummy variables for age, gender, multiple births and birth order, the age of the mother (in years), the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, and the number of children under 5 years of age.

Equation (4b) is a variant of equation (4a) with the addition of the available components of the composite measures of food and care, WASH, and health (denoted by P_{ic}). For children between 0 and 23 months, these components include: whether a child had a minimum acceptable diet, had immediate skin-to-skin contact at birth, was age-appropriately breastfed, the child's mother had four or more prenatal care visits, the child delivery was assisted by the trained professional, child had been to at least one postnatal checkup, child received all the age-appropriate vaccinations, child slept under a mosquito net, the household had access to improved water, the household had access to improved toilet, had access to handwashing facilities, disposed of stools properly, and if the majority of households in the community

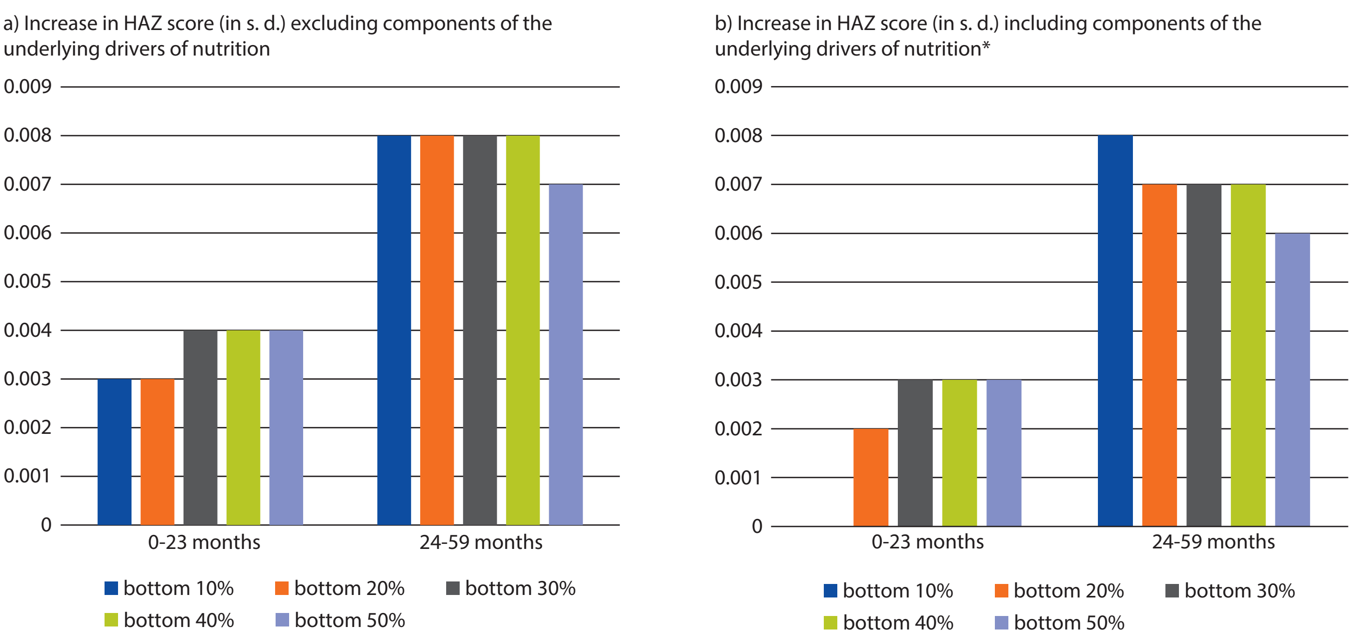
(75 percent) used some sort of a sanitation facility. For children between 24 and 59 months the components of the underlying drivers of nutrition do not include the following variables that are not collected for older children: whether the child had a minimum acceptable diet, had immediate skin-to-skin contact at birth, had age appropriate breastfeeding, the child's mother had four or more prenatal care visits, the child delivery was assisted by the trained professional, and the child has been to at least one postnatal care visit.

$$HAZ_{ic} = \alpha + \gamma_1 pctileWI_{ic} + X_{ic} + P_{ic} + \mu_c + \varepsilon_{ic} \qquad (4b)$$

Specification (4b) offers the advantage of testing whether including the components of the underlying drivers of nutrition has a significant impact on the size of the coefficient of the *pctileWI* variable, that is, γ_1 in equation (4a). According to the assumption that is implicit in the UNICEF model, higher household income affects nutrition primarily, if not exclusively, by increasing the demand for adequate levels of the components of the underlying drivers of nutrition. Under the maintained assumption that the available components of the composite measures of food and care, WASH, and health (P_{ic}) included in equation (4b) provide sufficient statistics for 'access to the underlying drivers of nutrition' the direct effect of income (proxied here by *pctileWI*) in equation (4b) should be considerably diminished (or even become insignificantly different from 0, that is, $\gamma_1 = 0$) relative to the one obtained from specification (4a). Evidence that the estimate of the coefficient γ_1 from equation (4b) does not differ substantially from that in equation (4a) would suggest that income has a significant direct effect on child nutrition (HAZ) aside from that captured by the components of food and care, WASH, and health, denoted by P_{ic} in equation (4b).[6]

Figure 7.1 presents the effect of increased wealth on HAZ scores for different quantiles of HAZ scores for children 0–23 months and 24–59 months of age for the specifications in equations (4a) and (4b). Two

Figure 7.1 The relationship between HAZ scores and percentile of household wealth among older and younger children



Source: World Bank staff estimates based on children ages 0–23 and 24–59 months from 33 country DHS from SSA. See Table 1 for list of countries and years.
Note: UQR estimates including country fixed effects. Detailed estimates available upon request. Both sets of regressions include child, parental, and household characteristics contain the following variables: dummy variables for age (months), gender, and birth order, multiple births, motherís education in years, marital status (married, never married, or other), motherís height, motherís age, wealth dummy (poorer, middle, richer, richest), number of children under 5 years of age, number of household members, and household is in a rural or an urban area.
*The components of the underlying drivers of nutrition include: whether a child had immediate skin-to-skin contact at birth, had age-appropriate breastfeeding, the childís mother had four or more prenatal care visits, the child delivery was assisted by a trained professional, child has been to at least one postnatal care visit, child received all the vaccinations, child sleeps under a mosquito net, the household has access to improved water, the household has access to improved toilet, handwashing facilities, disposal of stools, and if the majority of households in the community (75 percent) use some sort of a sanitation facility. For children ages 24–59 months, the components of the underlying drivers of nutrition do not include the following variables (not collected for older children): whether a child had immediate skin-to-skin contact at birth, had age appropriate breastfeeding, the childís mother had four or more prenatal care visits, the child delivery was assisted by a trained professional, and child has been to at least one postnatal care visit.

important findings emerge. First, irrespective of the quantile of HAZ or the specification estimated, increased wealth has a significant effect on the HAZ of younger children and older children. For example, an increase in the ranking of the wealth index value of the household by 10 percentage points is associated with an increase in HAZ score by 0.03 s. d. for younger children whose HAZ score is at the 50th quantile of the HAZ distribution.[7] For older children (children ages 24–50 months) who are at the 50th quantile of the HAZ distribution the same 10 percentage point increase in the ranking of the wealth index of the household is associated with an increase in the HAZ score by 0.06 s. d. (see Figure 7.1a).[8]

The higher coefficient for older children confirms that the true effect of wealth on HAZ is discernible only at later points in the life of children. The HAZ score of older children is the outcome of chronic undernutrition experienced earlier in life and the average HAZ score of older children differs significantly between older children from the top and bottom of the wealth distribution. As the growth faltering curves reveal in Figure 3.3e, there is a much larger gap between the growth faltering curve of children at the B20 and the T20 of the distribution of wealth among older children (older than 24 months) than among younger children. This implies that, *ceteris paribus*, any given increase in wealth is by default associated with a larger change in HAZ scores among older children than younger children.

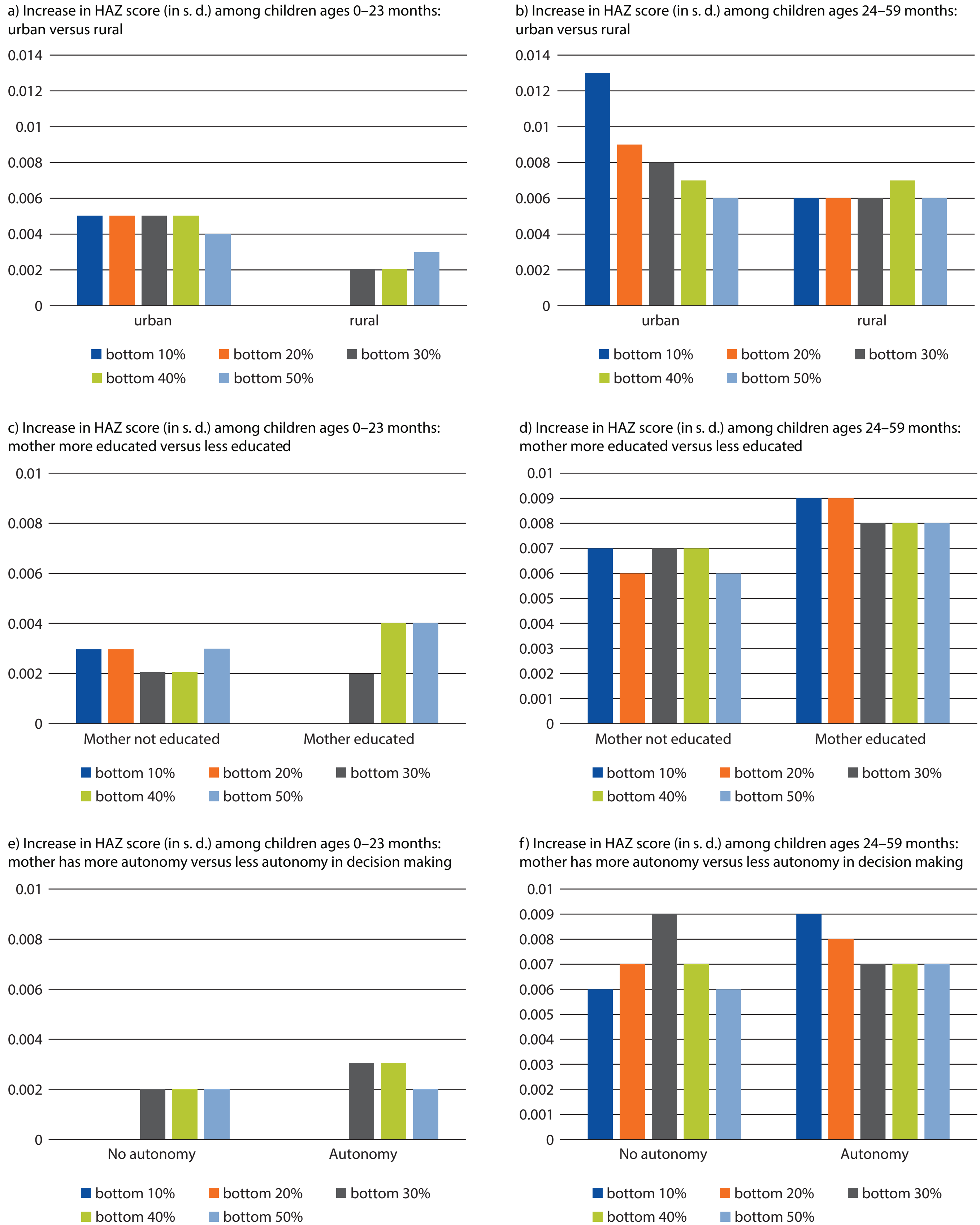
Second, a comparison of the coefficients γ_1 from equation (4a) (panel a in Figure 7.1) does not differ substantially from those obtained from equation (4b) (panel b in Figure 7.1). The coefficient at the bottom 10 percent of the HAZ distribution for older children (24–59 months) remains unchanged at 0.008 s. d. (compare panels and b in Figure 7.1). Similarly, the coefficients for the 40 percent quantile for the same age group remain unaffected at the value of 0.007 s d. Irrespective of the quantiles or the age groups compared, coefficients are either the same or slightly lower under specification (4b) (see panel b in Figure 7.1), but only for the lowest quintile in the younger group does the γ_1 become statistically insignificant. These results suggest that income has a significant direct effect on child nutrition (HAZ score) aside from that captured by the components of food and care, WASH, and health (P_{ic}).

Figure 7.2 presents corresponding estimates of the effect of higher wealth on HAZ scores by quantiles of HAZ scores based on equation (4a) for children 0–23 months and 24–59 months of age, in urban and rural areas, for children whose mothers have more or less education, and for children whose mothers have more or less autonomy in decision making at home. It was also confirmed that estimation of equation (4b) for the same groups resulted in minor differences in the estimate of γ_1 as in Figure 7.2, based on the full sample. More educated mothers are those with more than 7 years of education, whereas mothers with more autonomy in decision making are defined based on the top half (>50th percentile) of the values of the first principal component derived from the following variables: whether the married mother usually makes the decisions on how to spend her earnings, on her health care, on large household purchases, on visits to family or relatives, on what to do with the money the husband earns and whether she is employed all year or in seasonal work.

As before, the association between increases in wealth ranking and increases in child HAZ score is stronger among older children irrespective of location and level of education and autonomy of the mother. Among younger children, there are some minor differences in how increases in wealth are associated with increases in HAZ, between urban and rural areas (Figure 7.2a) or between more and less educated mothers (Figure 7.2c) or more or less autonomous mothers (Figure 7.2e). Among older children, the larger coefficients in urban areas relative to rural areas (Figure 7.2b), for more educated mothers relative to less educated mothers (Figure 7.2d), and for children whose mothers have more autonomy in decision making than those with less autonomy (Figure 7.2f), imply that the smaller differences in the basic determinants of nutrition early in the life of children end up compounding with others and thus translating to greater differences in the HAZ scores as children age.

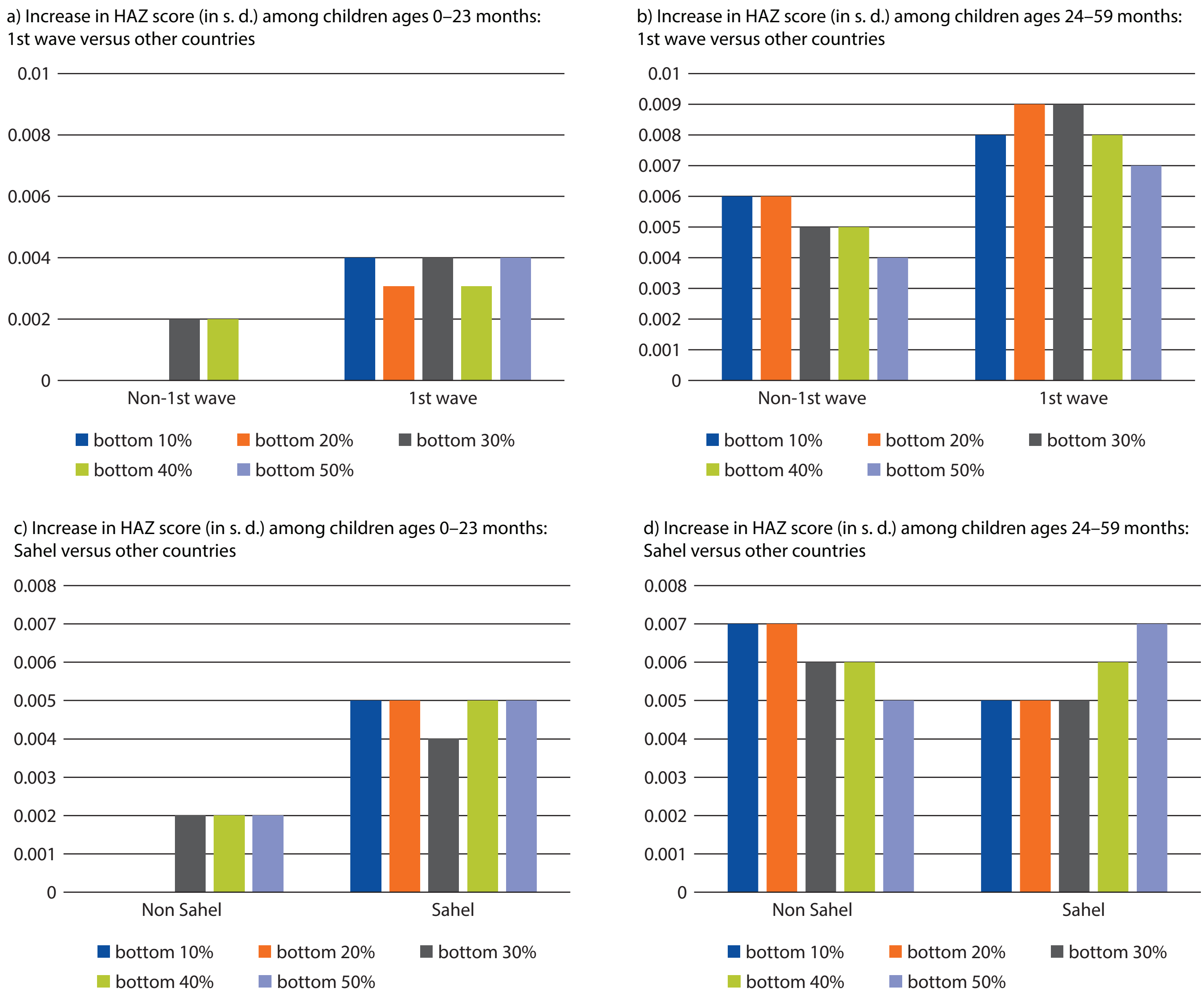
In the same spirit, Figure 7.3 presents the association between increases in wealth ranking and increases in child HAZ score for younger and older children in two groups of countries where efforts to decrease child undernutrition are either starting as part of the Investing in Early Years initiative (1st wave versus other countries) or countries where there are ongoing concerns regarding the potential of cash transfers relative to direct food transfers in kind in reducing food insecurity and child undernutrition (that is,

Figure 7.2 Differences in the relationship between HAZ scores and percentile of household wealth between some key basic determinants of nutrition



Source: World Bank staff estimates based on children ages 0–23 and 24–59 months from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.
Notes: UQR estimates including country fixed effects. Detailed estimates available upon request. The regressions include child, parental, and household characteristics which consist of the following variables: dummy variables for age (months), gender, and birth order, multiple births, mother's education in years, marital status (married, never married, or other), mother's height, mother's age, wealth dummy (poorer, middle, richer, richest), number of children under 5 years of age, number of household members, and whether household is in rural or urban area.

Figure 7.3 Differences in the relationship between HAZ scores and percentile of household wealth between groups of countries

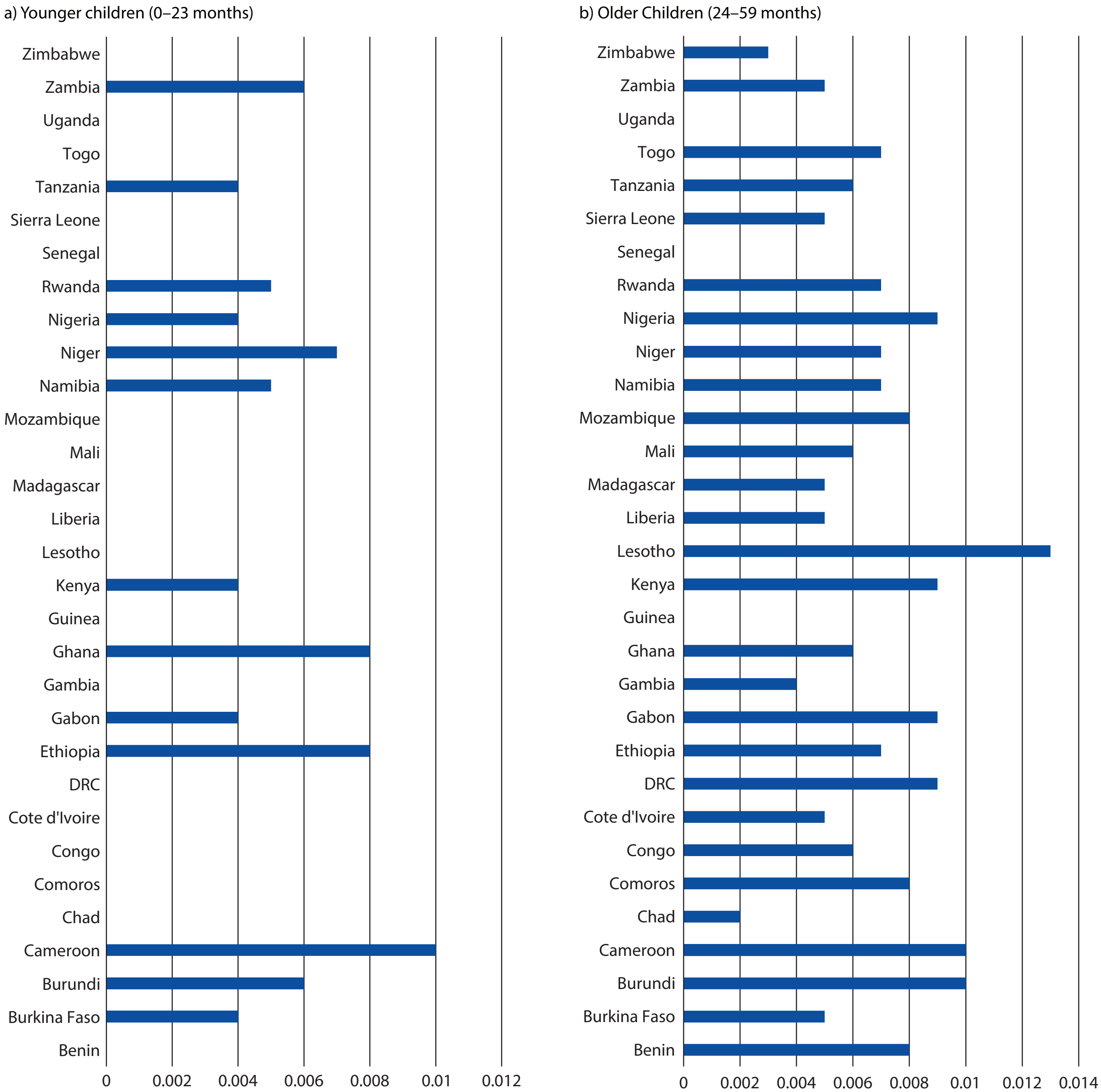


Source: World Bank staff estimates based on children ages 0–23 and 24–59 months from 33 country DHS from SSA. See Table 1 for list of countries and years.
Notes: UQR estimates including country fixed effects. Detailed estimates available upon request. The regressions include child, parental, and household characteristics contain the following variables: dummy variables for age (months), gender, and birth order, multiple births, mother's education in years, marital status (married, never married, or other), mother's height, mother's age, wealth dummy (poorer, middle, richer, richest), number of children under 5 years of age, number of household members, and household is in rural or urban area

countries in the Sahel region). In line with the patterns observed before, increases in the wealth ranking percentile in the Sahel countries and in the 1st wave countries have a higher effect on child HAZ score for older compared to younger children.

To complete the picture, Figure 7.4 presents the country-specific estimates of equation (4a) at the median value of HAZ scores for younger and older children. As above, the country-specific estimates suggest a significant pattern of correlation between wealth and child HAZ scores for both older and younger children. In Tanzania, for example, the above estimates suggest that a 10 percentage point increase in the wealth index, which is equivalent to a 17 percent increase of mean consumption, leads to the 0.04 (for children 0–23 months) to 0.06 s. d. (for children 24–59 months) increase in HAZ. The new estimates are comparable to existing estimates for Tanzania. Alderman, Hoogeveen, and Rossi (2006), for example, depending on the specification used, estimate that a doubling (or a 100 percent increase) of household PCE would result in an increase in HAZ score of 0.1–0.2 s. d. among children less than 60 months of age. Given that a 100 percent

Figure 7.4 Country-specific estimates of the relationship between median (q = 0.5) HAZ scores and the percentile of household wealth



Source: World Bank staff estimates based on children ages 0–23 and 24–59 months from 33 country DHS from SSA. See Table 2.1 for the list of countries and years.
Notes: UQR estimates including country fixed effects. Detailed estimates available upon request. The regressions include child, parental, and household characteristics and contain the following variables: dummy variables for age (months), gender, and birth order, multiple births, mother's education in years, marital status (married, never married, or other), mother's height, mother's age, wealth dummy (poorer, middle, richer, richest), number of children under 5 years of age, number of household members, and household is in rural or urban area

Box 7.1 Agricultural chemicals and child nutrition

One necessary condition for the advancement of food security in SSA is the increase in the productivity of existing cropland. Currently, many households practice low-input, subsistence farming. In Asia, for example, the use of the Green Revolution technologies that were initiated in the 1960s included high-yielding variety seeds, irrigation, pesticides, and nitrogenous fertilizers. These resulted in dramatically higher yields of staple crops (for example, wheat and rice), a reduction in the incidence of hunger, and increase in food security, and substantial improvements in the living standards of rural poor farmers and agricultural wage workers.

As the efforts to increase productivity and agricultural crop yields in Africa intensify, it is important to have a balanced view of not the benefits but also the potential costs involved. One key lesson learned from the Green Revolution in Asia, is that the dramatic increases in the productivity of land took place at some cost to the environment in these countries. Specifically, the heavy use of fertilizers and pesticides for the purpose of increasing crop yields resulted in high levels of toxicity and the contamination of surface and ground water, especially in India (Brainerd and Menon 2014).

Heeren, Tyler, and Mandeya (2003) provide evidence from South Africa, one of the major users of pesticides in the African continent, that there is a statistically significant association between birth defects and the exposure of the mothers to certain types of agricultural chemicals. One of the three types of exposure found to be significantly correlated with birth defects was the use of plastic containers previously used for the storage of agricultural chemicals but later used for storing of water for household use. Aside from birth defects, background exposure to pesticides in the environment is also known to have adverse effects on the cognitive, neurological, and behavioral development of children (Liu and Schelar 2012).

However, the adverse effect of agricultural chemicals on the nutritional status of children as measured by height-for-age and weigh-for-age Z scores, is still questionable due to the scarcity of evidence. Brainerd and Menon (2014) supply the only empirical evidence available on this issue. They evaluate the impact on child health from water contamination resulting from applications of fertilizer agrichemicals early in the growing season in India. They find that children exposed to higher concentrations of fertilizer agrichemicals during the month of conception are more likely to have a higher mortality rate, lower height for age and lower weight for age. Also, this adverse effect was even more apparent among the children of uneducated poor women living in rural India. They report that for a 10 percent increase in the level of agrichemical toxins in water, weight-for-age Z scores of children 5 years of age decline by 0.014 s. d.. Although this is a modest effect, it is useful to know that exposure in the first month of life has such long lasting negative effects on child health.

Source: Adapted from Brainerd and Menon (2014) and Heeren, Tyler, and Mandeya (2003).

increase in PCE is equivalent to an increase by 58.8 percentage points in the value of the wealth index, the estimated increase in HAZ based on these new estimates is 0.35 s. d. for older children and 0.23 s. d. for younger children, only slightly higher than those estimated by Alderman, Hoogeveen, and Rossi (2006).

Variability of Income

In addition to the critical role of the average level of household income, the variability of income over time has a distinct effect on child nutrition. Variability in income, one of the main causes of food insecurity, is caused by a confluence of factors composed primarily of weather-related shocks such as irregularities in the amount and timing of rainfall in relation the crop cycle, the seasonal nature of agricultural production (lean versus peak season), and the constraints in the ability of households to transfer resources across time (that is, the absence of credit and insurance markets). In rural economies based largely on rain-fed agriculture, household income is highly dependent on rainfall realizations. Credit constraints limit households' ability to smooth consumption over time, rendering health more vulnerable to economic shocks (Behrman and Deolalikar 1987). Lastly, insofar as households are spatially dispersed and transport infrastructure is weak, markets in food staples may not be well integrated. Localized rainfall shocks may, consequently, influence food prices. When seasonal rains are plentiful, yields will be high, food supplies robust, and prices low. Such general equilibrium effects reinforce the positive association between rainfall and household purchasing power or real income. Given the seasonal nature of agricultural production and limited borrowing opportunities, the effect from income to consumption, and thereby to child nutrition, is likely to take place with some delay; higher rainfall during the current crop season can increase consumption only after harvest.

Another important channel through which excess rainfall can influence child nutritional status is through the alteration of the disease environment net of any parental responses to child illness. Flooding for example, may hinder access to health facilities and damage the existing water and sanitation facilities, thus increasing its association with higher contemporaneous incidence of diarrheal disease, and even typhoid and cholera. Standing water also indirectly leads to an increase in vector borne diseases, such as malaria and dengue, through the expansion in the number and range of vector habitats. Such illnesses lower the capacity to take in and retain essential nutrients from food. Insofar as parents cannot entirely prevent or perfectly ameliorate these effects of child illness, excess rainfall shocks will have a negative impact on nutritional status through the disease channel.

Table 7.5 provides suggestive evidence attesting to the impact of rainfall variability experienced during the 1,000-day window on the prevalence of stunting among children less than 24 months of age in the rural areas of SSA.[9] Grid-level data of mean and median absolute deviation (MAD) of rainfall based on historic rainfall data between 1960 and 2014 for all of SSA were merged to the clusters of the DHS of 21 countries.[10] The coefficient of variation at cluster level was calculated as ratio of MAD and mean rainfall. The estimates reveal that increases in the variability of rainfall as proxied by the coefficient of variation of rainfall at the cluster level are associated with an increase in the probability of stunting by 33.4–70.2 percentage points depending on the specification. Taken at face value these large coefficients suggest that significant declines in stunting could be accomplished by policies that decrease the local variability of rainfall. However, these estimates are not particularly useful for country-specific policy design, as they become statistically insignificant when country-strata fixed effects are used in place of country fixed effects.[11]

To shed more light on the impact of rainfall variability on child chronic undernutrition, Table 7.6 presents estimates from selected countries of the impact of rainfall shortfalls during the growing season in the DHS cluster where the child lived. As discussed above, the seasonal nature of agricultural production and limited borrowing opportunities, imply that the effect from income on consumption, and therefore child nutrition, is likely to take place with some delay; lower (higher) rainfall during the current crop season can decrease (increase) consumption only after harvest. To this end, observations on children and their

Table 7.5 The relationship between rainfall variability (coefficient of variation) on the prevalence of stunting among children 0–23 months of age in rural areas of SSA

Variables	*(1)*	*(2)*	*(3)*
Coefficient of Variation of Rainfall at the DHS cluster level	0.507*** (0.110)	0.334*** (0.113)	0.702*** (0.175)
Year of interview dummies	Yes	Yes	Yes
Child, parental, and household			
Characteristics c	No	Yes	Yes
Drivers of nutrition	No	No	Yes
Observations	44,456	37,539	23,031
R-squared	0.015	0.137	0.142

Source: World Bank staff estimates.
Source of grid-level rainfall mean and median absolute deviation: Harvest Choice (2015a): https://harvestchoice.org/data/pre_mean and Harvest Choice (2015b):https://harvestchoice.org/data/pre_mad.
Note: OLS estimates including country fixed effects. Detailed estimates available upon request.
Child, Parental, and Household Characteristics consists of the following variables: dummy variables for age, gender, and birth order, the age of the mother (in years), the marital status of the mother, mother's education level (in years), preceding birth intervals and mother's height (in cm), the number of household members, and the number of children under 5 years of age. Drivers of nutrition consist of the following variables: whether a child had immediate skin-to-skin contact at birth, had exclusive breastfeeding, the child's mother had four or more prenatal care visits, the child delivery was assisted by the trained professional, child has been to at least one postnatal care checkup, child received all the vaccinations, child sleeps under mosquito net, the household has access to improved water, the household has access to improved toilet, handwashing facilities, proper disposal of stools, and the fraction of households in the community practicing open defecation (have no sanitation facility).
Robust standard errors in parentheses ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 7.6 The relationship between rainfall shortfalls during the growing season and the prevalence of stunting among children less than 60 months of age in selected countries in SSA

Variables	*Benin 2011–12*	*Congo, Dem. Rep. 2007, 2013–14*	*Mozambique 2014*	*Nigeria*	*Rwanda*
Rainfall shortfall in s. d. units during the last growing season	0.0320* (0.0167)	0.0331* (0.0178)	0.0155 (0.0107)	0.0242** (0.00945)	0.0221* (0.0124)
Year of interview dummies	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Observations	4,142	1,845	5,021	13,073	1,970
R-squared	0.040	0.056	0.042	0.090	0.077

Source: World Bank staff estimates. Source of grid level information on growing period: Harvest Choice: http://harvestchoice.org/labs/measuring-growing-seasons.
Note: The coefficients reported in Table 7. are obtained using (−1) * SPI as a right-hand-side variable in the regression. SPI for the last growing season is the SPI for the DHS cluster where the child resides. The SPI dataset is accessible at http://stream.princeton.edu/AWCM/WEBPAGE/interface.php?locale=en
Other controls include: dummy variables for age, gender, and birth order, the age of the mother (in years), the marital status of the mother, mother's education level (in years), preceding birth intervals and mother's height (in cm), the number of household members, and the number of children under 5 years of age.
Robust standard errors in parentheses ***p < 0.01, **p < 0.05, *p < 0.1.

anthropometric measures from the DHS are merged at the cluster level with grid-level data on the beginning and end date of the growing season[12] and data on the value of the Standardized Precipitation Index (SPI) during the last completed growing season before the date of interview of the household and its members. The SPI is a standardized measure analogous to a Z-score that can be interpreted in terms of standard deviation units from the normal mean precipitation.[13]

The estimates in Table 7.6 confirm that significant declines in stunting could be accomplished by policies and programs that decrease the vulnerability of household income from weather-related shocks. A shortfall in rainfall by 1 s. d. from the normal mean precipitation in the cluster during the most recently completed growing season is associated with a 3.2 percentage point increase in the probability of being stunted across all children ages 0–60 months in Benin, a 3.31 percentage point increase in the Democratic Republic of Congo, no significant increase in the probability of stunting in Mozambique, and 2.42 percentage point and 2.21 percentage point increases in Nigeria and Rwanda, respectively.

In recent years, there has been an increasing policy emphasis on social protection programs that provide the basis for both increasing the level and decreasing the variability of incomes (Del Ninno, Coll-Black, and Fallavier 2016; Del Ninno and Mills 2015). These programs serve not only as useful instruments to respond ex post to the incidence of droughts, floods, and other natural disasters, but also help households build their resilience before shocks hit. Cash transfer programs, for example, redistribute income to the poorer segments of the population and allow households to invest in human capital and child nutrition, build assets, and diversify their livelihood strategies. Public works programs help households and communities to reduce their vulnerability to shocks while improving community infrastructure and the opportunities for new and improved livelihoods.

In parallel or in combination, increased access to insurance products and credit markets can ensure better and more efficient use of resources by eliminating the incentive to adopt low-risk/low-return crops and production methods, and alleviate inter-temporal distortions on human and productive capital investment such as cutting down on food consumption and health services or withdrawing children from school.

All in all, the arguments in this chapter highlight the importance of pursuing a balanced strategy toward the reduction of undernutrition. Increased access to adequate levels of the underlying drivers of nutrition coordinated across different sectors (analyzed in Chapter 5) should not be considered in isolation from programs increasing income and minimizing income variability. Instead, programs and interventions aimed at increasing the level **and** stability of income among populations where stunting is prevalent should be considered as indispensable and essential (*sine qua non*) ingredients of 'multisectoral' efforts to reducing undernutrition in SSA.

Endnotes

1. Carlson, Kordas, and Murray-Kolb (2015) provide an up-to-date review of the literature on the links between women's autonomy and child nutrition. Alderman and Headey (2017) and Desai and Alva (1998) carry out some of the most comprehensive evaluations of the causal relationship between mother's education and children's height-for-age.
2. Moreover, if such data are available, then the sample of children covered is relatively small. For example, in the recent LSMS-ISA surveys covering nine countries in SSA, the emphasis on the panel nature of the sample tends to reduce the sample coverage of children ages 0 to 5 years for which anthropometric measurements are taken.
3. An alternative approach is to impute per capita expenditures (PCE) from a household survey such as the LSMS-ISA to the DHS using variables that are available in both surveys and then use the imputed PCE instead of the percentile of the household wealth index used here. Given that this can be done only in the countries with contemporaneous LSMS and DHS surveys, this alternative approach was not pursued.
4. In fact, they report that "for most of the samples included in their paper, the asset index performed as well, if not better than reported expenditures in predicting children's height-for-age Z-scores." It should be noted however, that the systematic review of Howe et al. (2009) suggest that the wealth index is a poor proxy for consumption expenditure.
5. In the pooled sample of children younger than 24 months, the 0.3 and 0.4 quantiles of the HAZ distribution bound the value of HAZ score used as the threshold for the definition of stunting (HAZ <-2).
6. It is also possible that the maintained and untested assumption is incorrect, meaning that the variables included in P_{ic} do a very poor job in capturing "access to the underlying drivers of nutrition." However, the analysis in Chapter 5 suggests the contrary.
7. The estimates in the figures reflect the effect of a 1 percentage point increase in the ranking of the wealth index value of the household, in the HAZ score.
8. A 10 percentage points increase in the ranking of the wealth index value of the household translates to a 12240.38 Naira (US$76.5) increase in per capita expenditure in Nigeria, a 640.1 Birr per year per adult equivalent (AE) increase (US$27.2) in Ethiopia, 708,626.2 Shilling per year (around US$315.6) in Tanzania, and 107,643.4 Shilling per month (US$29.72) in Uganda.
9. Additional evidence on the long-term impacts of rainfall shocks experienced during infancy in SSA is contained in the recent report by Damania et al. (2017).
10. Prior to release of the geographic dataset corresponding to the respective DHS survey of each country, the cluster Geographic Positioning System (GPS) coordinates for the center of the populated areas of the clusters were geographically displaced. Coordinates of urban clusters were displaced up to a maximum distance of 2 km and in rural areas, the displacement distance was up to 5 km with a further, randomly selected 1 percent of rural clusters displaced up to 10 km.
11. This is primarily because there is very small variability in the coefficient of variation of rainfall within rural areas of different regions in any given country.
12. General information and some data can be found in the link http://harvestchoice.org/labs/measuring-growing-seasons.
13. The SPI dataset is available for a grid with 0.25° resolution, which is equal to a square of 25 km by 25 km in the equator (and this square getting smaller away from the equator) with geo-coordinates for each point in the grid accessible at http://stream.princeton.edu/AWCM/WEBPAGE/interface.php?locale=en from the African Flood and Drought Monitor (AFDM) online platform developed by Princeton University and UNESCO's International Hydrological Program (IHP).

CHAPTER 8

How Can a Multisectoral Strategy to Reducing Stunting Produce the Desired Results?

The analysis in the report offers new insights on how data can be used to inform allocation decisions of different sectors that can strengthen multisectoral efforts aiming to reduce stunting. In practice, however, there is little assurance that involving multiple sectors in the effort to reduce undernutrition will produce the desired outcomes.

The history of multisectoral initiatives on nutrition contains many nonperforming projects (IEG 2009; World Bank 2014). Multisectoral nutrition planning was favored by the international development community in the 1970s, but it quickly became apparent that it was overly ambitious and too dependent on other sectors that are reluctant to be coordinated (Levinson and Balarajan 2013). A more recent example, is the case of multisectoral AIDS projects in Africa, where a number of sectors such as health, WASH, and education were involved. When budgets, governance, and accountability structures are driven mainly by sector-specific considerations within country ministries as well as within international organizations, 'multisectoral' initiatives tend to reduce clarity and specificity on the role and responsibility of each sector (IEG 2009).

Yet, in recent years there have been a few countries, such as Peru, Senegal, and Brazil, that have been quite successful in reducing undernutrition significantly through multisectoral approaches tailored to their needs and circumstances. This section synthesizes the main findings of this report with the lessons offered from these successful country cases for the purpose of identifying the key ingredients of a multisectoral strategy in the reduction of undernutrition that maximizes the potential to produce the desired outcomes in practice.

The Joint Targeting of Interventions by Different Sectors

One fundamental ingredient of a successful strategy is the scale-up of interventions by agriculture (food security), health care, and WASH that are jointly targeted to geographic areas (or populations within these areas) with high prevalence of stunting.[1] The primary purpose of these jointly targeted operations is to increase access to the underlying determinants of nutrition as envisioned by the UNICEF conceptual framework underpinning this report. For sector-specific investments to contribute to the reduction of stunting and to speed up progress toward the SDGs, the prevalence of stunting needs to be considered as an additional criterion when prioritizing and allocating scarce resources at the country and subnational levels. The very high proportions of children with inadequate access to all three drivers of nutrition (Figure ES.4) suggest that the strategy of joint targeting would apply to almost all countries in SSA.

This requires taking stock of the sectors operating in the target areas (or target population groups) and redirecting operations of the missing sectors to the target areas. The absence of some key sector from the target areas, such as agriculture, WASH, or social protection, may also act as a deterrent for the sector (or sectors) already operating in the target areas to be the 'first mover' in terms of adopting nutrition-sensitive interventions. The descriptive statistics on access to adequate WASH in the 33 countries covered by the report (Chapter 3) in combination with the recently completed WASH Poverty Diagnostic of the Water and Poverty and Equity Global Practices (World Bank 2017b), confirm the very limited coverage by the WASH sector in the rural areas where stunting is prevalent. The same also applies to the fraction of the population covered by social protection schemes (Del Ninno, Coll-Black, and Fallavier 2016). For example, the Productive Safety Net Program of Ethiopia, one of the largest in SSA covers only 10 percent of the population (World Bank 2012).

This report provides country authorities with a holistic picture of the gaps in access to the drivers of nutrition within countries that is critical for the formulation of a more informed, evidence-based, and balanced multisectoral strategy against undernutrition in their countries. Much work remains to be done in terms of coordinating the targeting of service delivery in stunted areas if all key sectors are to contribute jointly in the reduction of stunting. While there is a broad correlation between monetary poverty and children's health at the country level, the targeting of stunted children is not as simple as distinguishing between urban and rural areas or using 'poverty maps' identifying the poor and non-poor regions. Not all children in poor households or in rural areas are undernourished, and, in many countries, not all children in non-poor households or in urban areas are well nourished. The 33 country-specific notes attached as a separate annex to this report are a first step in this direction.

With limited budgetary resources, the greatest decline in stunting can be accomplished by targeting the scarce resources to children who do not have adequate access to any of the three nutrition drivers (more details in Chapter 5). If the same resources were to be allocated to increasing access to an additional nutrition driver among children who already have access to one driver the consequent decline in stunting is likely to be smaller.

The estimates also provide policy guidance useful for the sequencing of sector-specific interventions in target areas (or target populations).

- First, if budgetary or other considerations allow for interventions covering deprived children by only one sector, this sector should be health. Thus the 'biggest bang for the buck' in reducing stunting is through expanded coverage by the health sector addressing the immediate causes of undernutrition (Figure ES.7). The findings also empirically validate the sequencing of integrated approaches to improving nutrition outcomes such as the one currently in process for Madagascar and in preparation for other 1st wave countries. As soon as other sectors succeed in redirecting their operations to the target areas an acceleration in the reductions in stunting is very likely to follow.
- Second, if a target area is already covered by the health sector, the decision of whether to cover the same target area by sectors such as WASH or agriculture should be based mainly on costs rather than benefits. This is because the benefits in terms of accelerating reductions in stunting through simultaneous coverage by WASH or agricultural (food/care) operations appear to be similar. However, country-specific analyses would need to be carried out to confirm whether the regional relationship holds nationally.

Increased access to adequate levels of the underlying drivers of nutrition coordinated across different sectors should not be considered in isolation from programs increasing incomes and minimizing income variability in rural areas, both important determinants of household demand for better nutrition (see Chapter 7). Instead, programs and interventions aimed at increasing the level and stability of income among populations where stunting is prevalent should be considered as indispensable components of a 'multisectoral' approach to reducing undernutrition in SSA. Household constraints faced at different points in time may interact with the utilization of services. Thus, multisectoral interventions against undernutrition are likely to be more effective when accompanied by broader development policies and programs that mitigate the impacts of weather-related risks.

There is an increasing policy emphasis on adaptive social protection and climate-smart agriculture programs that provide the basis for increasing the level and decreasing the variability of incomes in rural areas (Del Ninno, Coll-Black, and Fallavier 2016; Del Ninno and Mills 2015; Lipper et al. 2014; Tirado et al. 2013; Wheeler and von Braun 2013). These programs serve not only as useful instruments to respond ex post to the incidence of droughts, floods, and other natural disasters, but also help households build their resilience before shocks hit. Drought-resistant seeds for maize, for example, have the potential of increasing both the level and the stability of income from agricultural activities in African countries. Cash transfer programs can redistribute income to the poorer segments of the population and allow households to invest in human capital and in child nutrition, to build assets, and to diversify their livelihood strategies. Public works programs can help households and communities to reduce their vulnerability to shocks while improving community infrastructure and the opportunities for new and improved livelihoods. In parallel or in combination, increased access to insurance products and credit markets can ensure better and more efficient use of resources by eliminating the incentive to adopt low-risk/low-return crops and production methods, and alleviate inter-temporal distortions on human and productive capital investment such as cutting down on food consumption and health services or withdrawing children from school.

The experience of Peru highlights the contribution of income growth in reducing stunting. Between 2007 and 2012 the prevalence of stunting declined by 21.4 percentage points from 54.7 percent to 33.3 percent in the districts targeted by the CRECER strategy (Levinson and Balarajan 2013; World Bank 2012). The contemporaneous income growth and poverty reduction in Peru during the same period had a critical facilitating role in the success of the multisectoral efforts at decreasing undernutrition. Specifically, the poverty rate between 2004 and 2011 decreased by 31 percentage points (from 58.8 percent to 27.8 percent and extreme poverty from 16.7 percent to 6.3 percent). Although the declines in stunting cannot be exclusively attributed to economic growth and poverty reduction in Peru, it is important for policy makers in SSA countries, to consider income growth and reduced income variability as necessary but not sufficient conditions for the reduction of child stunting.

More research is needed on the extent to which sector-specific nutrition-sensitive interventions have any measurable impact on stunting over and above the impact from access and utilization (or the targeting) of the services provided by the normal operations of sector-specific programs. Nutrition-sensitive interventions are believed to be essential for achieving adequate access to the underlying determinants of nutrition by improving or redirecting or adding marginal changes to normal sector operations to enhance the coverage and effectiveness of nutrition-specific interventions through the health sector. Recent reviews of the evidence available on the nutritional effects of nutrition-sensitive interventions (Galasso et al. 2017; Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013) as well as the review in Annex E of this report, confirm that there is a strong potential, but very little in terms of solid evidence. For example, the evidence of the nutritional effect of agricultural programs is inconclusive, mainly because of poor quality evaluations. There is also a scarcity of evidence on the nutritional effect of social safety net programs, while combined early child development and nutrition interventions show promising synergies in child development and, in some cases, nutrition. Moreover, future evaluations of nutrition-sensitive interventions should take into serious consideration the possibility that the impacts of nutrition-sensitive interventions are likely to depend on the scale of coverage by other sectors as well as on the extent to which the other sectors implement nutrition-sensitive interventions.[2]

Attention to the Incentive Structure

The adoption of a governance and accountability structure that provides the right incentives to all actors involved is the other fundamental ingredient of a successful multisectoral strategy. A common feature of all countries with successful multisectoral projects against stunting, is the importance of a coordination system that is supported by high levels of government. The NEP of Senegal, for example, involving the Ministries of Health and Education, was coordinated by a unit attached to the Prime Minister's office (CLM) (IEG 2016). Along similar lines the CRECER strategy in Peru was placed not in a line ministry but directly under the Prime Minister's Office. In Brazil, a new ministry, the MDS was created to provide a platform for coordination with other ministries, such as the Ministry of Education administering the National School Food Program and the Ministry of Agricultural Development involved in the Food Acquisition Program.

In the development community, aside from the impetus generated by the SDGs, there is a confluence of factors that contribute toward a more solid foundation for multisectoral projects aiming to reduce undernutrition. This foundation allows for operations that are better structured, better performing, and potentially much more effective than in the past. Most of the 33 countries analyzed in this report (with Angola being the only exception) are members of the SUN movement whose framework is by now endorsed by 59 developing countries and over a hundred partners and nearly 3000 CSOs that are members of SUN. All members of SUN are prioritizing nutrition as an investment in their growth and recognizing nutrition as an investment in economic and social development to strengthen its nation.

The renewed emphasis on eliminating extreme poverty and boosting shared prosperity has also provided the incentive for different sectors to reevaluate their country engagement strategy. The recent WASH Poverty Diagnostic Initiative, for example, generated new insights on how data can be used to inform allocation decisions to reduce inequalities and prioritize investment in WASH to boost human capital.[3] Also, new models of operational engagement with client countries, such as the MPA, offer the opportunity to improve coherence across interventions and strengthen the strategic focus of operations within client countries. The MPA approach is ideally suited for long-term engagement with multiple sectors as in the case of nutrition. In addition, the MPA separates engagements into phases, which facilitates greater learning and adaptation. Combined with PBF with disbursement-linked targets, the MPA program has the potential to give the proper incentives to the local authorities implementing the program. In the case of Peru and Brazil, for example, the use of specific targets has been associated with highly positive results in terms of generating proactive initiatives and encouraging local ownership and accountability at subnational levels.

This report contributes to the analytical foundations of a more effective multisectoral approach and as such constitutes only one component of a much broader effort aimed at improving the results of multisectoral projects toward the reduction of undernutrition. It is imperative that the renewed efforts yield the desired results especially in SSA countries.

Endnotes

1. For conceptual clarity, nutrition sensitivity in this report is considered as an add-on component to the normal operations and activities of a sector program, distinct from the targeting of the program or project. Nutrition-sensitive interventions are generally identified with efforts to **redirect**, or improve, or add marginal changes to normal sector operations to enhance the coverage and effectiveness of nutrition-specific interventions through the health sector (for example, see Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013).
2. This also has important implications for the design of randomized control trials of nutrition-sensitive interventions, if the findings of the impact evaluation are to have any external validity for scaling up.
3. The synthesis report and the country-specific studies of the WASH Poverty Diagnostic can be accessed at: http://www.worldbank.org/en/topic/water/publication/wash-poverty-diagnostic.

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ANNEX A

Exploring the Relationship between Height-for-age and the Three Drivers of Nutrition

This annex provides more details about the model used to investigate the relationship between height-for-age *Z* scores and access to the three drivers or different combinations of these three drivers. To keep the notation simple, the presentation uses the continuous HAZ score as a dependent variable instead of stunting which is binary variable.

Each child is assigned into one of the seven *exclusive* groups, each group distinguished by whether the household/child has access to an adequate level of only one or only two or all three of the drivers of nutrition. For this purpose, seven *binary variables are constructed by taking into consideration whether the child has access to adequate levels in the other clusters*. Specifically, the binary variable B_{FC} is equal to 1 if the household has adequate care and food security *only* (and inadequate health, and environment) and 0 otherwise. Similarly, B_W is 1 when the household is adequate in WASH services (and inadequate in food and care and health), and B_H is 1 when the household is adequate in health services *only* (and inadequate care and food, and WASH) and is 0 otherwise. In the same fashion, B_{FC_H} takes the value of 1 if the household has adequate food and care practices and adequate health services at the same time (and inadequate WASH), and B_{FC_W} takes the value of 1 if the household has adequate food and care and adequate WASH (and inadequate health).

A comparison of the mean values of height-for-age *Z* scores in each of these groups of children can shed light on the extent to which simultaneous access to adequate levels of more than one of the drivers is associated with higher heights for age *Z* scores of children. Estimates of the regression model below can provide the answer to this question:

$$HAZ_i = \alpha + \beta_{FC}B_{FC} + \beta_W B_W + \beta_H B_H + \beta_{FC_W} B_{FC_W} + \beta_{FC_H} B_{FC_H} + \beta_{W_H} B_{W_H} + \beta_{FC_{WH}} B_{FC_{WH}} + \varepsilon_i \tag{1}$$

In this specification, the constant term α provides an estimate of the mean value of HAZ scores for children without access to an adequate level for all four underlying determinants of nutrition: care and food security ($B_{FC} = 0$), WASH/environment ($B_W = 0$), and health ($B_H = 0$). With $E(HAZ|B = 1 \text{ or } 0)$ denoting the expected (or mean) value of height-for-age (outcome), conditional on having adequate access ($B = 1$) or inadequate access ($B = 0$), the expected height-for-age when the child does not have adequate access to any of the four determinants is:[1]

$$E(HAZ_i | B_{FC} = 0, B_H = 0, B_W = 0, B_{FC_W} = 0, \ldots, B_{FC_{HW}} = 0) = \alpha$$

The coefficients β_j yield estimates of the increase in the mean HAZ score of children when a child has access to adequate levels in one of the clusters only (or net of the potential gain in HAZ of having access to an adequate level in one or more of the other clusters). That is:

$$E(HAZ_i|B_{FC}=1)=\alpha+\beta_{FC}$$

$$E(HAZ_i|B_W=1)=\alpha+\beta_W$$

$$E(HAZ_i|B_H=1)=\alpha+\beta_H$$

$$E(HAZ_i|B_{FC_W}=1)=\alpha+\beta_{FC_W}$$

$$E(HAZ_i|B_{FC_H}=1)=\alpha+\beta_{FC_H}$$

$$E(HAZ_i|B_{W_H}=1)=\alpha+\beta_{W_H}$$

Specifically, the coefficient β_{FC} yields an estimate of the increase in the mean HAZ score of children (compared to the mean HAZ score of the reference group summarized by the constant term α), who have access to adequate food and care only ($\beta_{FC} = 1$) but do not have access to adequate health, or to adequate WASH. The coefficients β_H, and β_W have analogous interpretations for health and WASH, respectively.

When a child has access to two adequacies, for example *FC* and *W*, the difference in the mean HAZ score for these children in comparison with those who have access to none is given by B_{FC_W}. That is, as with the case of access to one determinant, the improvement in the mean height for those with access to two determinants is given by the respective estimate of β.

Endnotes

1. It is also assumed that $(\varepsilon_i|B_{FC}, B_H, \ldots, B_{FC_{H_W}}) = 0$.

ANNEX B

In Search of Synergies

By definition, synergies are present when various elements are combined and interact to produce a total effect that is greater than the sum of the individual elements. In this annex, an effort is made to derive some quantitative estimates of the role of synergies associated with having simultaneous access to adequate levels in one or more of the clusters of food and care, health, and WASH on child nutrition.

The estimates of the coefficients β_{FC}, β_W, β_H, β_{FC_W}, β_{FC_H}, β_{W_H}, *and* $\beta_{FC_{W_H}}$ in equation (1) of Annex A can also provide evidence on the presence or absence of synergies among the drivers of nutrition. If synergies (or complementarities) are present, then one would expect that $\beta_{jk} > \beta_j + \beta_k$. For example, if there are significant synergies between health and WASH, *ceteris paribus*, one would expect the decline in the stunting rate of children with simultaneous access to adequate health and adequate WASH to be greater than reduction in stunting associated with one group children having access to adequate health only, and the reduction in stunting associated with yet another group of children having access to adequate WASH only (that is, $\beta_{W_H} > \beta_W + \beta_H$).

The case $\beta_{jk} \leq \beta_j + \beta_k$, suggests that there is some substitutability between the two determinants. That is, access to one determinant may change the nutritional context of the child such that access to another determinant does not yield as large returns than were it to be employed in a context without access to that determinant. It is also plausible that the potential synergies associated with simultaneous access to two of the underlying determinants of nutrition are not realized either because of poor coordination between the local entities implementing interventions on *j* and *k*, for example, health and WASH practices, and/or neglect of the impediments and negative side effects associated with inadequate access to the other underlying determinants of nutrition (food and care practices).

For more direct evidence on synergies, an alternative econometric specification is also estimated. The main difference in the model used to investigate more fully the potential role of synergies is that the definition of the access variables is 'inclusive', meaning that the access variables are constructed without any consideration to whether the child has access to adequate levels in the other drivers. Specifically, the model (Model B) estimated is

$$HAZ_i = \alpha + \gamma_{FC} A_{FC} + \gamma_W A_W + \gamma_H A_H + \gamma_{FC_W}(A_{FC} * A_W) + \gamma_{FC_H}(A_{FC} * A_H)$$
$$\gamma_{WH}(A_W * A_H) + \gamma_{FC_{WH}}(A_{FC} * A_W * A_H) + \varepsilon_i, \qquad (2)$$

where HAZ_i is the Height-for-Age *Z*-scores for the child *i*, and A_{FC} is equal to 1 if the household has adequate care and food and 0 otherwise. Similarly, A_H is 1 when the household is adequate in health services and is 0 otherwise; A_W is 1 when the household is adequate in WASH services. The key difference between these binary variables from the ones in Annex A is that they are constructed irrespective of whether the child also fulfills the conditions to other groupings of adequacies.

As in equation (1) in the Annex A, the constant term α provides an estimate of the mean value of HAZ scores for children with access to **inadequate** food and care ($A_{FC} = 0$), **inadequate** health ($A_H = 0$), and **inadequate** WASH ($A_W = 0$). That is, with $E(HAZ \mid A = 1 \text{ } or \text{ } 0)$ denoting the expected (or mean) value of height-for-age (outcome), conditional on having adequate access ($A = 1$) or inadequate access ($A = 0$) to driver A, the expected height-for-age for when the child does not have adequate access to any of the three drivers is[1]

$$E(HAZ_i|A_{FC}=0,\ A_H=0,\ A_W=0)=\alpha$$

The coefficients γ yield estimates of the increase in the mean HAZ score of children when a child has access to adequate levels in one of the drivers only (or net of the potential gain in HAZ of having access to an adequate level in one or more of the other clusters). That is:

$$E(HAZ_i|A_{FC}=1,\ A_H=0,\ A_W=0)=\alpha+\gamma_{FC}$$

$$E(HAZ_i|A_{FC}=0,\ A_W=1,\ A_H=0)=\alpha+\gamma_W$$

$$E(HAZ_i|A_{FC}=0,\ A_W=0,\ A_H=1)=\alpha+\gamma_H$$

Specifically, the coefficient γ_{FC} yields an estimate of the increase in the mean HAZ score of children (compared to the mean HAZ score of reference group summarized by the constant term, α, that have access to adequate food and care (A_{FC} = 1) but do not have access to adequate health, (A_H = 0), and adequate WASH (A_W = 0). The coefficients γ_H and γ_W have analogous interpretations for health and WASH, respectively. The γ estimates for having access to one determinant are the same as the β estimates for access to one determinant in Annex A. That is, $\gamma_{FC} = \beta_{FC}$.

The coefficients γ_{jk} in model B above yield estimates of the synergies associated with having access to adequate levels in more than one of the drivers of nutrition. Specifically, the mean HAZ score of children having simultaneous access to adequate health (A_H = 1) **and** adequate WASH (A_W = 1) is summarized by the expression,

$$E(HAZ_i|A_{FC}=0,\ A_W=1,\ A_H=1)=\alpha+\gamma_W+\gamma_H+\gamma_{W_H}.$$

The expression for the mean value of HAZ scores of children in households with access to adequate health **and** adequate WASH consists of the sum of three components: the first component is the increase in HAZ scores associated with children in households with adequate health only (that is, γ_H); the second component (that is, γ_W) is the increase in HAZ scores associated with children in households with adequate WASH only, and the third component (that is, γ_{W_H}) is the increase in HAZ scores associated with children in households that have access to both adequate health **and** adequate environment. Thus, the coefficient γ_{W_H} yields information on whether there are additional (extra) gains in HAZ scores derived from having simultaneous access to adequate health and adequate WASH. A significant and positive value of the coefficient γ_{W_H} implies synergies from the simultaneous access to adequate WASH and adequate health services in the production of child nutrition (after controlling for possible synergies of having simultaneous access to adequate food and care and health).[2] The mean HAZ of children from having access to adequate level of the other two drivers (for example, food/care and health, or food/care and WASH) are similarly defined. Note that these estimates are different from those in Annex A and $\gamma_{W_H} \neq \beta_{W_H}$.

The mean HAZ of children having simultaneous access to three components (that is, adequate food/care (A_{FC} = 1) **and** adequate health (A_H = 1), **and** adequate WASH (A_W = 1)) is given by the expression,

$$E(HAZ_i|A_{FC}=1,\ A_W=1,\ A_H=1)=\alpha+\gamma_{FC}+\gamma_W+\gamma_H+\gamma_{FC_W}+\gamma_{FC_H}+\gamma_{W_H}+\gamma_{FC_{W_H}},$$

with the coefficient $\gamma_{FC_{H_W}}$ summarizing the potential synergies from simultaneous access to the three components. Note that these are synergies in addition to any synergies from pairwise interactions.

It follows that only when the complete and full specification (that is, with all the interactions) of model A and model B are estimated, then there is a relationship between the coefficients β in model A (left) and the coefficients β and γ in model B (right) as follows:

$$\beta_{FC} = \gamma_{FC}$$

$$\beta_{W} = \gamma_{W}$$

$$\beta_{H} = \gamma_{H}$$

$$\beta_{FC_W} = \gamma_{FC} + \gamma_{W} + \gamma_{FC_W}$$

$$\beta_{FC_H} = \gamma_{FC} + \gamma_{H} + \gamma_{FC_H}$$

$$\beta_{W_H} = \gamma_{W} + \gamma_{H} + \gamma_{W_H}$$

$$\beta_{FC_{HW}} = \gamma_{FC} + \gamma_{W} + \gamma_{H} + \gamma_{FC_W} + \gamma_{FC_H} + \gamma_{W_H} + \gamma_{FC_{W_H}}$$

It is also important to note that if the specification estimated is not the complete/full specification (that is, with all the interaction terms) then the relationship between the coefficients of model A and model B breaks down. For example, if in model B we construct a dummy that identifies whether the child has access to (any) two of the clusters (irrespective of which two) and run the regression with this dummy instead of the separate interaction dummies $A_{FC} * A_H$ and $A_{FC} * A_W$ and $A_H * A_W$, then the relations above are not going to hold.

Tables B.1 and B.2 present the results from estimating model B based on a linear probability model (LPM) with stunting status as the dependent variable. The advantages as well as the shortcomings of the LPM in

Table B.1 Synergies among the three drivers of nutrition in the pooled sample of countries

Variables	*No covariates*	*Including child, parental, and household controls*
Food/care determinant (FC)	–0.068***	–0.009
	(0.013)	(0.013)
WASH determinant (W)	0.010	0.032**
	(0.012)	(0.012)
Health determinant (H)	–0.104***	–0.048***
	(0.008)	(0.008)
Food/care and WASH	0.030	–0.024
	(0.026)	(0.026)
Food/care and health	–0.010	–0.009
	(0.018)	(0.017)
WASH and health	–0.047***	–0.024
	(0.016)	(0.016)
All three	0.010	0.039
	(0.034)	(0.033)
Observations	74,781	68,533

Source: World Bank staff estimates based on 33 recent DHS from Africa. See Table 2.1 for the list of countries and years. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level. Stratum is the lowest level of statistical representation of the DHS within a country, typically identifying regions and urban/rural areas within regions in a country.
The analyses include country fixed effects as well as the following child, parental, and household characteristics: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table B.2 Synergies in the pooled sample of countries based on the components of the three drivers of nutrition

Variables	*No covariates*	*Including child, parental, and household controls*
F: Child has adequate food intake	–0.040***	–0.028*
	(0.015)	(0.015)
C1: Immediate skin-to-skin contact	–0.008	–0.005
	(0.007)	(0.007)
C2: Age-appropriate breastfeeding	0.055***	0.057***
	(0.007)	(0.009)
W1: Improved non-shared sanitary facilities	–0.034**	–0.020
	(0.017)	(0.018)
W2: Improved water source	–0.006	0.007
	(0.007)	(0.008)
W3: Handwashing facility on site	–0.033***	–0.010
	(0.012)	(0.013)
W4: Percentage of households using open defecation in cluster	–0.048***	–0.073***
	(0.013)	(0.014)
W5: Disposal of feces	0.072***	0.050***
	(0.015)	(0.016)
H1: Had 4 or more prenatal checks	–0.050***	–0.045***
	(0.008)	(0.008)
H2: Birth assisted by trained professional	–0.055***	–0.043***
	(0.007)	(0.007)
H3: Child has been to at least one postnatal checkup	0.010	0.004
	(0.007)	(0.007)
H4: Vaccinations up to date	–0.092***	–0.020**
	(0.008)	(0.008)
H5: Child sleeps under a mosquito bed net	–0.022***	–0.015*
	(0.008)	(0.008)
Food/care and health		
F_H1	0.024*	0.021
	(0.014)	(0.014)
F_H4	–0.065***	–0.035**
	(0.015)	(0.015)
F_H5	–0.010	–0.003
	(0.015)	(0.014)
Food and WASH		
F_W1	0.024	–0.000
	(0.016)	(0.016)
WASH and health		
W1_H1	–0.013	0.009
	(0.014)	(0.014)
W1_H4	–0.018	–0.005
	(0.014)	(0.014)
W1_H5	–0.031**	–0.036**
	(0.014)	(0.014)
Observations	51,724	46,685

Source: World Bank staff estimates based on 26 recent DHS from Africa. See Table 2.1 for the list of countries and years. Cameroon, Republic of Congo, Gabon, and Niger have no information on handwashing facilities, Republic of Congo and Gabon have no information on disposal of feces, Ethiopia and Lesotho have no information on mosquito nets, and Mozambique has no information on postnatal checkups, and thus these countries are not part of the pooled components analyses. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.

Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level. Stratum is the lowest level of statistical representation of the DHS within a country, typically identifying regions and urban/rural areas within regions in a country.

Child, parental, and household characteristics consist of the following variables: dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

comparison to the Logit or Probit nonlinear are well known in the literature. The LPM is used because the coefficients of the LPM provide direct estimates of the marginal effects of the change in the probability of stunting associated with a change in any of the independent variables. A detailed comparison of the marginal effects estimated by the LPM models confirmed that they are practically identical in sign and size to the marginal effects obtained from the logit model reported in the body of the report.[3]

Table B.1, based on the child data pooled across the 33 countries, reveals that the results regarding synergies are not robust (that is, very sensitive to the specification estimated). For example, when child, parental, and household controls are excluded from the regression, there appear to some synergies between joint access to health and WASH. Access to WASH alone is not statistically significantly different from zero and access to health alone is associated with a 10.5 percentage point decrease in the probability of being stunted. However, access to health and WASH jointly is associated with an additional 4.5 percentage point decrease in the probability of being stunted that is statistically significant. However, when child, parental, and household controls are included as controls in the regression there do not appear to be any significant synergies from joint access to health and WASH or from any other combination of nutrition drivers. It is possible that a similar analysis based on country-level data may be able to shed more light on the presence of synergies.

Rather than searching for synergies associated with access to three drivers of nutrition, each of which consists of numerous components, Table B. 2 presents estimates based on the individual components of food/care, health, and WASH, along with interactions of selected pairs of components. The estimates in Table B.2 provide some spotty but more robust evidence in favor of synergies between adequate food intake and vaccinations (F_H4) and between improved non-shared sanitary facilities and sleeping under a mosquito net.

Endnotes

1. It is also assumed that $E\ (\varepsilon_i\ |A_{FC}, A_H, A_W) = 0$.
2. Note that an equivalent test for the presence of statistically significant synergies in the model estimated in Annex A is a test of the null hypothesis that $\beta_{jk} - (\beta_j + \beta_k) = 0$ against the one-sided alternative $\beta_{jk} - (\beta_j + \beta_k) > 0$. Although this test is fully equivalent, the alternative test carried out in this annex B is presented since it is more direct.
3. It should be noted, however, that the constant terms obtained from the LPM in the regressions including child, parental, and household characteristics, were consistently greater than 1. This is because the LPM does not constrain predicted probabilities (that is, the stunting rate of the reference group) to be between 0 and 1. The comparisons between the LPM and logit methods confirmed that the estimate of the constant term was the main difference between the two models, since the marginal effects obtained by the two methods were qualitatively the same.

ANNEX C

Stunting and the Three Drivers of Nutrition: Country-Specific Estimates

Table C.1 Stunting and the three drivers of nutrition within countries in SSA

	(1) *Angola*	(2) *Benin*	(3) *Burkina Faso*	(4) *Burundi*	(5) *Cameroon*	(6) *Chad*	(7) *Comoros*	(8) *Congo, Rep.*
F/C	–0.080*	–0.135**	0.001	0.005	0.014	–0.058*	0.029	–0.013
	(0.042)	(0.058)	(0.067)	(0.055)	(0.049)	(0.032)	(0.075)	(0.086)
W	0.016	0.091	0.021	–0.051	–0.008	–0.056	0.049	–0.065
	(0.047)	(0.097)	(0.133)	(0.041)	(0.030)	(0.056)	(0.060)	(0.099)
H	–0.011	0.029	0.014	–0.064*	–0.065**	–0.068**	–0.017	–0.039
	(0.036)	(0.026)	(0.022)	(0.034)	(0.029)	(0.029)	(0.048)	(0.033)
F/C & W	–0.025	0.262*		–0.037	–0.070	0.061		
	(0.120)	(0.136)		(0.053)	(0.088)	(0.094)		
F/C & H	–0.001	0.018	–0.035	–0.095**	0.022	–0.061	–0.108	–0.041
	(0.044)	(0.033)	(0.038)	(0.042)	(0.050)	(0.061)	(0.095)	(0.043)
W & H	–0.085*	–0.012	0.001	–0.077**	–0.082**	–0.000	–0.029	–0.137
	(0.050)	(0.049)	(0.048)	(0.038)	(0.036)	(0.061)	(0.057)	(0.097)
All 3	0.034	0.067	0.082	–0.094**	–0.018	–0.025	–0.152	
	(0.080)	(0.071)	(0.104)	(0.044)	(0.056)	(0.152)	(0.119)	
Observations	2,553	2,747	2,531	2,415	2,014	3,498	769	1,760

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.
All country -specific regressions include strata fixed effects as well as child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area. For Angola and Senegal, no information on mother's height is available and therefore not used as a covariate.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

table continues next page

Table C.1 Stunting and the three drivers of nutrition within countries in SSA *(continued)*

	(9) Côte D'Ivoire	*(10) Congo, Dem. Rep.*	*(11) Ethiopia*	*(12) Gabon*	*(13) Gambia, The*	*(14) Ghana*	*(15) Guinea*
F/C	0.038	–0.075**	0.021	0.056	–0.116*	–0.079	0.053
	(0.055)	(0.034)	(0.032)	(0.091)	(0.065)	(0.087)	(0.074)
W	–0.098	–0.024	–0.103	–0.190**	–0.031	0.111**	–0.091*
	(0.101)	(0.044)	(0.080)	(0.074)	(0.044)	(0.055)	(0.052)
H	–0.011	–0.056**	–0.043	0.044*	0.009	0.035	–0.005
	(0.032)	(0.023)	(0.047)	(0.026)	(0.037)	(0.041)	(0.027)
F/C & W		–0.087	–0.105		–0.178**	–0.061	0.234***
		(0.089)	(0.137)		(0.077)	(0.133)	(0.089)
F/C & H	0.052	–0.087**	–0.056	–0.028	0.026	–0.015	–0.104
	(0.066)	(0.039)	(0.061)	(0.067)	(0.052)	(0.049)	(0.068)
W & H	–0.041	–0.087**	0.083	–0.092	0.005	0.064	–0.034
	(0.057)	(0.040)	(0.076)	(0.057)	(0.041)	(0.046)	(0.058)
All three	–0.339***	–0.065	–0.223**		–0.084	0.047	–0.013
	(0.120)	(0.063)	(0.109)		(0.061)	(0.055)	(0.178)
Observations	1,288	3,163	3,440	1,288	1,293	996	1,265

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.
All country -specific regressions include strata fixed effects as well as child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area. For Angola and Senegal, no information on mother's height is available and therefore not used as a covariate.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table C.1 Stunting and the three drivers of nutrition within countries in SSA *(continued)*

	(16) Kenya	*(17) Lesotho*	*(18) Liberia*	*(19) Madagascar*	*(20) Malawi*	*(21) Mali*	*(22) Mozambique*
F/C	–0.030	–0.100	–0.024	–0.084	–0.166	0.070	–0.013
	(0.030)	(0.123)	(0.059)	(0.092)	(0.110)	(0.056)	(0.033)
W	–0.061	–0.185**	–0.009	0.111	–0.040	–0.069	0.001
	(0.043)	(0.090)	(0.130)	(0.103)	(0.055)	(0.056)	(0.041)
H	–0.053**	–0.166***	–0.033	–0.014	–0.059	–0.038	-0.036
	(0.023)	(0.059)	(0.039)	(0.034)	(0.043)	(0.029)	(0.022)
F/C & W	0.102*	–0.130		–0.223	0.036	–0.274	–0.103
	(0.057)	(0.160)		(0.268)	(0.068)	(0.212)	(0.102)
F/C & H	–0.081**	–0.219***	–0.067	0.030	0.018	0.059	–0.044
	(0.034)	(0.072)	(0.046)	(0.081)	(0.055)	(0.065)	(0.041)
W & H	–0.046	–0.136**	–0.061	0.223***	–0.015	–0.083	0.018
	(0.037)	(0.060)	(0.085)	(0.076)	(0.046)	(0.050)	(0.045)
All 3	–0.043	–0.211*	–0.079	0.039	–0.062	0.009	0.024
	(0.048)	(0.112)	(0.138)	(0.131)	(0.056)	(0.084)	(0.076)
Observations	3,359	540	1,303	1,629	1,921	1,522	3,729

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.
All country -specific regressions include strata fixed effects as well as child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area. For Angola and Senegal, no information on mother's height is available and therefore not used as a covariate.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table C.1 Stunting and the three drivers of nutrition within countries in SSA *(continued)*

	(23) Namibia	*(24) Niger*	*(25) Nigeria*	*(26) Rwanda*	*(27) Senegal*	*(28) Sierra Leone*	*(29) Tanzania*
F/C	0.071	0.061	–0.021	–0.006	0.013	0.078	–0.029
	(0.159)	(0.051)	(0.020)	(0.056)	(0.040)	(0.071)	(0.030)
W	–0.117	–0.040	–0.009	–0.027	0.004	0.225	–0.024
	(0.157)	(0.077)	(0.015)	(0.048)	(0.041)	(0.253)	(0.067)
H	–0.124**	–0.076***	–0.025	–0.023	–0.018	0.017	–0.026
	(0.051)	(0.028)	(0.019)	(0.045)	(0.026)	(0.034)	(0.022)
F/C & W	0.385*	0.254***	–0.033	–0.032	–0.086		–0.218*
	(0.230)	(0.098)	(0.026)	(0.056)	(0.100)		(0.121)
F/C & H	–0.260**	0.037	–0.035	–0.040	–0.003	–0.030	–0.075**
	(0.122)	(0.050)	(0.033)	(0.052)	(0.043)	(0.049)	(0.030)
W & H	–0.164*	–0.032	–0.068***	–0.030	–0.019	0.063	–0.083**
	(0.085)	(0.055)	(0.025)	(0.046)	(0.035)	(0.063)	(0.040)
All 3		–0.059	–0.005	–0.046	–0.018	–0.067	–0.149**
		(0.089)	(0.035)	(0.050)	(0.050)	(0.103)	(0.066)
Observations	386	1,736	9,252	1,355	2,410	1,480	3,719

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.
All country -specific regressions include strata fixed effects as well as child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area. For Angola and Senegal, no information on mother's height is available and therefore not used as a covariate.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table C.1 Stunting and the three drivers of nutrition within countries in SSA *(continued)*

	(30) Togo	*(31) Uganda*	*(32) Zambia*	*(33) Zimbabwe*
F/C	–0.012	0.046	–0.020	–0.027
	(0.053)	(0.061)	(0.036)	(0.062)
W	0.183*	–0.336**	–0.038	–0.094
	(0.106)	(0.131)	(0.043)	(0.072)
H	–0.055*	–0.132**	0.001	–0.122***
	(0.031)	(0.067)	(0.020)	(0.033)
F/C & W		0.117	–0.093	–0.080
		(0.228)	(0.069)	(0.101)
F/C & H	–0.040	–0.092	0.025	–0.190***
	(0.038)	(0.077)	(0.028)	(0.047)
W & H	–0.059	–0.124	0.018	–0.144***
	(0.060)	(0.095)	(0.036)	(0.038)
All 3	0.004	–0.127	–0.096*	–0.136***
	(0.121)	(0.121)	(0.055)	(0.050)
Observations	1,275	345	4,225	1,909

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.
All country -specific regressions include child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area. For Angola and Senegal, no information on mother's height is available and therefore not used as a covariate.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

ANNEX D

Stunting and the Three Drivers of Nutrition: Subpopulation-Specific Estimates

Table D.1 Stunting and the three drivers of nutrition for subpopulations within SSA

Variables	*Urban*	*Rural*	*Boys*	*Girls*	*B20*	*T20*	*Mother more educated*	*Mother less educated*
Food/care	0.001	–0.010	–0.030	0.011	–0.032	–0.094*	–0.008	–0.007
	(0.025)	(0.014)	(0.018)	(0.017)	(0.024)	(0.054)	(0.020)	(0.015)
WASH	0.009	0.040**	0.024	0.040**	0.037	0.011	0.016	0.035**
	(0.018)	(0.016)	(0.017)	(0.016)	(0.030)	(0.023)	(0.023)	(0.015)
Health	–0.042***	–0.050***	–0.063***	–0.032***	–0.067***	–0.042**	–0.030**	–0.058***
	(0.014)	(0.009)	(0.011)	(0.010)	(0.015)	(0.019)	(0.012)	(0.010)
Food/care and WASH	–0.015	0.005	0.006	–0.008	0.055	–0.035	0.006	–0.007
	(0.031)	(0.027)	(0.029)	(0.028)	(0.055)	(0.036)	(0.032)	(0.026)
Food/care and health	–0.067***	–0.063***	–0.073***	–0.059***	–0.087***	–0.046*	–0.058***	–0.069***
	(0.020)	(0.014)	(0.016)	(0.016)	(0.023)	(0.025)	(0.016)	(0.016)
WASH and health	–0.032*	–0.045***	–0.041**	–0.040**	–0.009	–0.042**	–0.042***	–0.028*
	(0.017)	(0.015)	(0.016)	(0.016)	(0.033)	(0.020)	(0.015)	(0.015)
All 3	–0.029	–0.061***	–0.048**	–0.040*	–0.071	–0.045*	–0.053***	–0.026
	(0.023)	(0.022)	(0.023)	(0.023)	(0.054)	(0.025)	(0.020)	(0.026)
Observations	19,751	48,782	34,273	34,260	15,496	10,900	22,059	46,474

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.

Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.

All regressions include country and year fixed effects as well as child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

table continues next page

Table D.1 Stunting and the three drivers of nutrition for subpopulations within SSA *(continued)*

Variables	*Low GNI*	*High GNI*	*Low Gini*	*High Gini*	*Low Tariff*	*High Tariff*	*Low Fragility*	*High Fragility*
Food/care	0.002	–0.026*	–0.002	–0.024*	–0.003	–0.042**	–0.067***	0.001
	(0.018)	(0.013)	(0.019)	(0.013)	(0.015)	(0.019)	(0.024)	(0.031)
WASH	–0.045*	0.051***	–0.056**	0.057***	0.043***	–0.038	–0.042	–0.019
	(0.025)	(0.014)	(0.026)	(0.013)	(0.014)	(0.025)	(0.035)	(0.030)
Health	–0.042***	–0.054***	–0.051***	–0.046***	–0.052***	–0.040***	–0.075***	–0.022
	(0.011)	(0.010)	(0.012)	(0.009)	(0.010)	(0.011)	(0.016)	(0.017)
Food/care and WASH	–0.100**	0.030	–0.079**	0.031	0.006	–0.059	–0.128*	–0.059
	(0.048)	(0.022)	(0.039)	(0.023)	(0.023)	(0.050)	(0.068)	(0.048)
Food/care and health	–0.077***	–0.056***	–0.079***	–0.059***	–0.064***	–0.072***	–0.106***	–0.018
	(0.018)	(0.015)	(0.019)	(0.014)	(0.014)	(0.020)	(0.028)	(0.028)
WASH and health	–0.056***	–0.031**	–0.039**	–0.044***	–0.034**	–0.060***	–0.102***	–0.011
	(0.018)	(0.015)	(0.017)	(0.016)	(0.014)	(0.018)	(0.023)	(0.024)
All 3	–0.098***	–0.008	–0.077***	–0.027	–0.045**	–0.043	–0.077**	–0.060*
	(0.026)	(0.021)	(0.022)	(0.024)	(0.019)	(0.031)	(0.034)	(0.033)
Observations	28,975	39,558	31,747	36,786	43,338	25,195	11,929	9,666

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.
All regressions include country and year fixed effects as well as child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table D.1 Stunting and the three drivers of nutrition for subpopulations within SSA *(continued)*

Variables	*Low starch*	*High starch*	*1st Wave*	*Non 1st Wave*	*Sahel regions*	*Non-Sahel regions*	*Landlocked*	*Non-Landlocked*
Food/care	–0.013	0.003	–0.000	–0.040***	–0.002	–0.016	0.022	–0.033***
	(0.013)	(0.023)	(0.016)	(0.015)	(0.024)	(0.015)	(0.023)	(0.012)
WASH	0.053***	–0.059*	0.049***	–0.048**	0.048***	–0.032*	–0.075**	0.050***
	(0.013)	(0.034)	(0.014)	(0.020)	(0.018)	(0.017)	(0.031)	(0.013)
Health	–0.053***	–0.029**	–0.047***	–0.053***	–0.077***	–0.036***	–0.052***	–0.048***
	(0.009)	(0.015)	(0.010)	(0.010)	(0.019)	(0.008)	(0.016)	(0.009)
Food/care and WASH	0.034	–0.108*	0.004	–0.026	0.004	–0.057*	–0.071	0.017
	(0.021)	(0.060)	(0.025)	(0.033)	(0.030)	(0.029)	(0.045)	(0.023)
Food/care and health	–0.073***	–0.035	–0.054***	–0.084***	–0.065*	–0.072***	–0.058***	–0.072***
	(0.014)	(0.022)	(0.017)	(0.015)	(0.035)	(0.012)	(0.022)	(0.014)
WASH and health	–0.052***	0.006	–0.027*	–0.067***	–0.022	–0.053***	–0.039**	–0.045***
	(0.015)	(0.022)	(0.016)	(0.014)	(0.029)	(0.012)	(0.019)	(0.014)
All 3	–0.029	–0.065*	–0.026	–0.079***	0.052	–0.086***	–0.089***	–0.024
	(0.021)	(0.034)	(0.024)	(0.020)	(0.042)	(0.017)	(0.023)	(0.022)
Observations	38,484	23,678	34,234	34,299	13,086	55,447	25,576	42,957

Source: World Bank staff estimates based on DHS data. See Table 2.1 for details. No information on mother's height is available for Angola or Senegal and therefore not part of the analyses with covariates. No information on dietary composition for Burundi, Comoros, or Democratic Republic of Congo and therefore not in the analyses grouped by dietary composition.
Note: Marginal effects are based on the coefficient estimates obtained from the logit model in equation (2). Robust standard errors in parentheses corrected for correlation at the cluster level.
All regressions include country and year fixed effects as well as child, parental, and household characteristics. These are dummy variables for age (in months), gender, multiple births and birth order, the age of the mother, the marital status of the mother, mother's education level (in years), mother's height (in cm), the number of household members, the number of children under 5 years of age, the household's wealth quintile, and whether the household lives in an urban/rural area.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

ANNEX E

A Behavioral Model of Child Health and Nutrition

This annex presents a household behavioral model regarding the child's health and nutrition that takes in to account the fact that many of the components of the underlying determinants of nutrition emphasized by the UNICEF model (the components of food, care, WASH, and health) are to a large extent choice variables in the household decision process.

Households are assumed to choose child health H, leisure L, and consumption of goods and services C, as if they are maximizing a household welfare function subject to the health production function constraint and budget constraint. Preferences are assumed to be characterized by the utility function,

$$U = U(H, L, C; X_h), \tag{1}$$

where X_h is a vector of household and parental characteristics including household size and age gender composition, the education level of the mother and of the household head. Child health and nutrition is generated by a production function,

$$H = F(Y, X_h, X_i, X_c, g), \tag{2}$$

where Y is a vector of health inputs such as nutrient intake, health care and hygiene practices, time spent by parents taking care of children, X_i is a vector of child characteristics such as age and gender, X_c is a vector of environmental factors that may have a direct impact on child health, such as water and sanitation facilities of the household and the community, and g is a vector summarizing all unobservable characteristics of the child, parents, household, and the community, all of which affect child health. In addition, the choices of households are assumed to be limited by their full income constraint,

$$P_c C + WL + P_Y Y = FI, \tag{3}$$

where P_c, W, P_Y are the price vectors of consumption goods, leisure, and health inputs, respectively, and FI is full income including the value of the time endowment of the household and non-labor income. In this framework, the reduced form function for child health is:

$$H = \Phi(X_h, X_i, X_c, FI, P_c, W, P_Y, g) \tag{4}$$

whereby the particular functional form of the function $\Phi(.)$ depends on the underlying functions characterizing household preferences and the health production function. The reduced form of expression (4) is described by the linear regression equation (5) below.

$$HAZ_i = \alpha + \beta_1 X_i + \beta_2 X_h + \beta_3 FI_h + \gamma Z_c + \eta_i, \tag{5}$$

where subscript i indexes children, and Z_c is the vector of community environmental factors including prices and wages, that is, $Z_c = \{X_c, P_c, W, P_Y\}$. In practice, the vector of community environmental variables can be treated as a cluster level or regional level fixed effect μ_c which absorbs the prices and wages common to all residents in that community or geographic area.

$$HAZ_i = \alpha + \beta_1 X_i + \beta_2 X_h + \beta_3 FI_h + \mu_c + \varepsilon_i. \tag{6}$$

ANNEX F

A Review of the Literature on the Impacts of Nutrition Sensitive Interventions on Stunting

This annex provides a brief survey of the available evidence on the relationship between child chronic undernutrition (stunting) and different nutrition-sensitive interventions in key sectors such as agriculture, social protection, water and sanitation (WASH). More complete reviews of nutrition-sensitive interventions can be found in Ruel, Alderman, and the Maternal and Child Nutrition Study Group (2013) and Galasso et al. (2017).

Nutrition-sensitive interventions are believed to be essential for achieving adequate access to the underlying determinants of nutrition by redirecting, improving, or adding marginal changes to normal sector operations to enhance the coverage and effectiveness of nutrition-specific interventions through the health sector (Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013). Thus, it is important to point out that the 'nutrition sensitivity' of a sector-led project can be enhanced simply by improving its targeting to geographic areas and populations therein with high stunting prevalence. The literature surveyed does not distinguish in any systematic way between the impacts on height or stunting associated with access to the service of a given sector increasing access to the underlying determinants of nutrition, that is, the redirecting or better targeting of normal operations, from the improvement or addition of marginal changes to enhance the effectiveness of normal operations. The latter, in principle, would involve a comparison of the nutritional outcomes between a group of children exposed to improved or added changes to the normal operations of a project and a group of children exposed to the normal operations of a project that is not necessarily nutrition sensitive. The randomized control trial (RCT) design of conditional or unconditional cash transfer programs, where the most reliable evidence about the potential impact of nutrition-sensitive interventions originates from, typically conflates access with nutrition sensitivity. This is because they evaluate the impacts of a package of interventions including components that are indeed nutrition sensitive relative to the control group which does not have access to the package at all.

With these considerations in mind, interventions in agriculture can affect nutrition outcomes through several potential pathways: (a) increased productivity in agriculture may result in higher agricultural income per capita which, as the previous section documented, is associated with reduced stunting.; (b) higher agricultural production may lower food prices facilitating improved access to food; (c) higher household income, especially income controlled by female household members, is likely to have positive effects on nutritional outcomes; and (d) more empowered women potentially leading to enhanced nutritional outcomes.

In addition to the indirect impacts of interventions in the agricultural sector channeled through income, specific nutrition-sensitive interventions in the agricultural sector can potentially have higher and more direct impacts on maternal and child nutrition. These include the promotion of dietary diversity to be accomplished through interventions such as home gardens, homestead food production, and healthy indigenous foods; biofortification, food fortification, such as cereals, vegetable oils, milk, and market-based food products; the improved efficiency of agricultural tasks performed by women, which provides more opportunities for mothers, especially, to devote more time in the rearing and stimulation of their children;

and building storage facilities for crops such as maize, cotton seed, peanuts, and tree nuts intended to minimize exposure to aflatoxin toxins that have been shown to be associated with child growth and development (Gong et al. 2004).

Overall, the evidence on the effectiveness of nutrition-sensitive interventions in the agricultural sector is very scarce. The meta-analysis by Massett et al. (2012) concluded that there are too few well-designed studies to draw any strong conclusions about the impact of home gardens on nutritional status. Regarding biofortification, the available evidence proves only its effectiveness on the increase in vitamin A intake for a specific type of agricultural products in limited countries, but the effect of biofortification on nutritional outcomes is yet to be known (Ruel, Alderman, and the Maternal and Child Nutrition Study Group 2013).

Nutrition-sensitive interventions in the social protection sector include conditional and/or unconditional cash transfer (CCT/UCT) programs, school feeding, in-kind food distributions, and emergency transfer programs. Other interventions which can be more nutrition-sensitive are public works, especially the increase of women's participation in the public works and the nutritional education program as work requirements could have a positive effect on nutritional outcomes; insurance and microfinance, to smooth consumption over time; and community-based programs to strengthen nutrition knowledge and capacity.

The evidence of the effectiveness of CCT programs on nutritional outcomes is mixed. While there is solid evidence based on RCTs that the transfers received by CCT program beneficiaries have a significant impact on numerous inputs critical to increasing human capital (for example, school attendance, attainment, health, and consumption) (for example, Skoufias 2005), the evidence on the impacts on child stunting is still scarce and sorely needed because CCT programs provide a natural platform for the scale-up of nutrition-sensitive interventions. For example, in Mexico's original CCT program PROGRESA (later renamed Oportunidades/PROSPERA) the program's cash transfers were given to the mothers in the households, on the premise that this would increase the autonomy of mothers in decision making and thus lead to greater investments in children. Benefits were provided on the condition that children attended school regularly and made regular visits to health centers. Families with pregnant women, lactating mothers, and younger children (4 months to 2 years) were also provided nutritional supplements with essential micronutrients. In addition, regular information and training sessions were held in the beneficiary communities to train participants on proper hygiene, proper cooking methods, appropriate child feeding and breastfeeding practices, and feeding during pregnancy (Table E.1). Given that all these services were components of the benefits package that also included a regular cash transfer it was not possible for the program evaluation to isolate the impact of the nutrition-sensitive component of the program from the monetary transfer of the program.

A recent review using pooled estimates from a variety of CCT and UCT programs, mostly from Latin America, was not able to confirm any statistically significant effect of either CCT or UCT on children's height (Manley, Gitter, and Slavchevska, 2012). Nevertheless, the increases in coverage of the poorer segments of the population in African countries and the documented increases in health, education, and nutrition-related inputs associated with these programs suggest that these types of social protection programs have a great potential to contribute to the reduction of stunting in the medium to long term. Some other forms of social protection programs, such as in-kind transfers, emergency transfers, and insurance, are found to be associated with better nutritional outcomes, although again the evidence is limited. School feeding programs in developing countries are found to have small but positive effects on children's health for some cases, especially for weight.

Nutrition-sensitive interventions in the WASH sector include handwashing with soap, improved sanitation, improved water supply, and deworming. WASH interventions can affect nutrition outcomes through several potential pathways, which are (a) reduced fecal contamination which leads to the reduction in diarrheal disease; (b) reduced fecal contamination which leads to the reduction in enteric infections; (c) reduced exposure and infection with protozoa and helminth infections; (d) reduced anemia; (e) reduced costs and time in fetching water and treating sick children; and (f) a direct link between WASH and undernutrition.

Numerous studies have analyzed and found the link between WASH and undernutrition, through non-experimental, observational, and experimental methodology. However, evidence of the effectiveness of

WASH interventions directly (not through the reduction of infections) on stunting is scarce and the results are mixed (see Table E.1 for more details). A meta-analysis of several evaluation studies shows that handwashing with soap, improved sanitation, and improved water supply reduces the incidence of diarrhea (Cumming and Cairncross 2016). There is also evidence that the repeated incidence of diarrhea itself contributes to stunting among young children. Although there are some studies that show the association between enteric infection and stunting, it has not been clear if the infection causes the stunting or the other way around. Because the enteric infection can be mitigated by the cleanliness of household environments, some studies evaluate the association between household environment/sanitation behavior and stunting. But results are mixed. Handwashing might not be sufficient to reverse enteric infection. Some studies have shown an association between water and sanitation interventions and nutritional outcomes but the evidence is still scarce. Deworming medication can reduce the protozoa and helminth infections, but it is only a short-term solution. A recent study (Croke et al. 2017) found that deworming has no impact on nutritional outcomes. Improved sanitation also reduces the risks of infection, which can complement deworming and health education. It is also found that reducing caregivers' time spent on fetching water lowers diarrhea incidence and improves nutritional outcomes among children, although the mechanisms are not clearly identified.

Nutrition-sensitive interventions in Early Childhood Development include maternal and child nutrition interventions, psychosocial stimulation, and responsive parenting, and interventions to alleviate poverty, food insecurity, maternal depression, and gender inequality. A review of early childhood development interventions reveals little evidence that stimulation has a direct and positive effect on nutrition outcomes on its own. This may not be surprising, since the main effect of these interventions is to create synergy effects between early childhood development and nutrition interventions on nutritional outcomes. Overall, results are mixed again. On one hand, some studies find that the joint provision of child simulation and food supplementation has a positive effect on cognitive development of children, and sometimes on their growth. On the other hand, other studies do not find any synergy effects. Maternal depression might affect the nutritional outcomes of children and evaluations are on their way. Related to the mother's status, women's empowerment is found to have a positive effect on children's nutritional outcome.

Table F.1 Summary of the Impacts of Nutrition-Sensitive Interventions (by Sector) on Stunting

Type of Nutrition-Sensitive Intervention	*Author (year)*	*Main Findings*
	AGRICULTURE	
	Berti, Krasevek, and Fitzgerald (2004)	Mixed results in terms of improving nutritional status
	Leroy et al. (2008)	Impact on nutritional status mixed and unconvincing
Home gardens, homestead food production	Massett et al. (2012)	Little or no impact on anthropometry, attributed by author to small sample. More impact on acute (underweight) than chronic undernutrition (stunting). Too few well-designed studies exist to draw any strong conclusions about agriculture's impact on nutritional status.
	Girard et al. (2012)	Limited evidence of impact on maternal or child anthropometry. Emerging patterns: projects with impacts on anthropometry focused on production of foods rich in micronutrients, energy and protein (for example, orange-flesh sweet potatoes, legumes, and animal source foods); no growth impacts in projects promoting only fruit/vegetables.
Biofortification, food fortification	Ruel, Alderman, and the Maternal and Child Nutrition Study Group (2013)	Present evidence on biofortification is only on that breeding for micronutrients is feasible, and on its efficacy. However, the effect of the biofortification on nutritional outcomes is yet to be known.
Storage facilities for crops to prevent aflatoxin	Gong et al. (2002, 2004)	Striking association (though not causation) between exposure to aflatoxin in children and both stunting (a reflection of chronic malnutrition) and being underweight (an indicator of acute malnutrition).
	SOCIAL SAFETY NETS	
CCT	Sánchez, Melendez, and Behrman (2016)	Juntos program, large-scale CCT implemented in Peru since 2005, has an impact on nutritional status outcomes (Andersen et al. 2015). Juntos had a positive impact on nutrition only for those exposed during the first three years of life.
	Behrman and Hoddinott (2005)	Nutritional supplements by PROGRESA in Mexico had significant effects on HAZ scores for children ages 12–36 months, but not for children ages 36–48 months.
	Berhane, Hoddinott, and Kumar (2017)	No evidence of positive effects of Ethiopia's Productive Safety Net Program on stunting
School feeding	Kristjansson et al. (2007)	For weight, school meals increase weight in low-income countries, but the results were mixed in higher-income countries. For height, results were mixed; height gain was greater for younger children.
UCT	Manley, Gitter, and Slavchevska (2012)	Absence of overall effect of both UCTs and CCTs on child nutritional status
In-kind food distributions	Ruel et al. (2008)	Distributions to all mothers and children within the first 1000 days had greater effect on child growth than did targeting of underweight children under 5.
Emergency transfer	Huybregts et al. (2012)	Adding ready-to-use supplementary food to a general food distribution has positive effects on height-for-age.
Insurance	Lu et al. (2016)	Little research has been conducted to investigate the role of community-based health financing in improving the nutritional status of children in resource-limited settings. This study provides evidence of the effectiveness of health insurance in improving child nutrition status.
Microfinance	Orton et al. (2016)	Membership in microfinance program is associated with lower stunting.
	WASH	
Handwashing with soap, disposal of child's feces	Langford, Lunn, and Panter-Brick (2011)	Handwashing is not enough to reverse enteric infection and growth stunting.
Improved sanitation	Esrey (1996), Checkley et al. (2004), Merchant et al. (2013), Fink, Günther, and Hill (2011), Spears, Ghosh, and Cumming (2013)	Non-experimental studies show that water and sanitation interventions are associated with lower diarrhea incidence and better nutrition outcomes.

Table F.1 Summary of the Impacts of Nutrition-Sensitive Interventions (by Sector) on Stunting *(continued)*

	WASH	
Type of Nutrition-Sensitive Intervention	*Author (year)*	*Main Findings*
	Checkley et al. (2008)	Repeated episodes of diarrhea in young children contribute to growth stunting.
	Lin et al. (2013)	Observational study shows association between household environment cleanliness (access to water, sanitation, and so on) and child height and weight.
	Alzua et al. (2015)	Community-led sanitation intervention, which reduces the open-defecation, has positive effect on height and nutrition outcomes.
	Quattri and Rand (2014), Quattri, Smets, and Inthavong (2014), Quattri, Smets, and Nguyen (2014)	Negative correlation between the ratio of open defecation/unimproved sanitation and height-for-age
	Dangour et al. (2013), Du Preez et al. (2010, 2011), Luby et al. (2004, 2006), McGuigan et al. (2011)	Experimental studies find significant effect of water and hygiene interventions on height for age, but not on weight for age.
	Chase and Ngure (2016)	Experimental evidence on water supply improvement and sanitation is insufficient. Recent studies are in the process of evaluating the nutritional impacts of WASH interventions.
	Cumming and Cairncross (2016)	The evidence reviewed suggests that poor WASH conditions have a significant detrimental effect on child growth and development resulting from sustained exposure to enteric pathogens but also due to wider social and economic mechanisms.
Deworming	Croke et al. (2017)	There is 'substantial evidence' that mass deworming has no impact on weight or other child outcomes. This has led some to question the WHO policy and the literature on long-run impacts.
	EARLY CHILD DEVELOPMENT	
Type of Nutrition-Sensitive Intervention	*Author (year)*	*Main Findings*
Maternal and child nutrition interventions, psychosocial stimulation, and responsive parenting	Grantham-McGregor et al. (1991)	The combination of child stimulation and food supplementation has positive effects on cognitive development but not on growth.
	Nahar et al. (2009)	The combination of stimulation and home visits to standard nutrition and health care for severely malnourished children improved development outcomes and weight for age.
	Aboud and Akhter (2011)	The combination of iron-fortified micronutrient powders and informal nutrition and child development education program improved weight gain and weight for age.
	Yousafzai et al. (2012)	No evidence of synergy effect between nutrition and stimulation intervention on nutritional outcomes.
	Bentley et al. (2011)	Few studies show the association between responsive feeding and nutritional outcomes.
Maternal depression	Tripathy et al. (2010), Rahman et al. (2008)	Currently at the stage of scaling up the interventions for maternal depression to evaluate its impact on nutritional outcomes
Women empowerment, gender inequality	Vir (2016)	Non-experimental studies found that gender inequality, poor empowerment of women, and poor decision-making powers adversely influence socioeconomic status and purchasing power, age of marriage and conception, choice of spacing between pregnancies, level of education, and experience of domestic violence, which in turn impact on women's status with serious implications on rate of childhood stunting.

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