Are Poor Individuals Mainly Found in Poor Households? Evidence Using Nutrition Data for Africa

Caitlin Brown, Martin Ravallion and Dominique van de Walle[1]

Abstract: Antipoverty policies in developing countries often assume that targeting poor households will be reasonably effective in reaching poor individuals. We question this assumption. To do so, we use nutritional status as a proxy for individual poverty. Our comprehensive assessment for Sub-Saharan Africa reveals that undernourished women and children are spread quite widely across the distribution of household wealth and consumption. Roughly three-quarters of underweight women and under-nourished children are not found in the poorest 20% of households, and around half are not found in the poorest 40%. The mean joint probability of being an underweight woman and living in the poorest wealth quintile is only 0.03. Countries with higher overall rates of undernutrition tend to have a higher share of undernourished individuals in non-poor households. The results are consistent with evidence of substantial intra-household inequality.

Keywords: Undernutrition, health, poverty, targeting, Africa

JEL: I14, I32, I38

[1] Brown and Ravallion are with the Department of Economics, Georgetown University, and van de Walle is with the Development Research Group, World Bank. The authors are grateful to the World Bank's Strategic Research Program for funding assistance. Helpful comments were received from Harold Alderman, Arthur Alik-Lagrange, Emanuela Galasso and Adam Wagstaff. These are the views of the authors and need not reflect those of their employers.

1. Introduction

While it is widely appreciated that poverty is an individual deprivation, household aggregate data are almost invariably used to infer individual poverty. It is almost always assumed that each individual within the household has the same level of economic welfare as measured by household aggregate consumption per person (or per equivalent single adult). An array of antipoverty programs, now found almost everywhere, are targeted on this basis, though typically using readily available proxies for household consumption or income per person.[2] Partly in response to concerns about high chronic undernutrition in certain regions, including Africa, there is an expanding effort at social protection in developing countries.[3] This effort is typically focused on transfers targeted to poor families.[4] For its part, the World Bank has made reaching poor families—as often identified by the poorest two quintiles of people based on household consumption per person—the main objective of its social protection operations.

Reaching deprived individuals using antipoverty programs that explicitly target poor households is an attractive option for three reasons. First, there is a data constraint, namely that standard data sources do not allow us to measure individual consumption. Second, interventions at the individual level may be seen to be paternalistic and intrusive (as they require intervention within families) and may well be costly (to the extent that they rely on fine targeting, constrained by the fact that individual deprivations are not comprehensively observed in large populations). Third, a large literature has documented that poorer households in terms of consumption, income or wealth are more likely to include deprived individuals.[5] Aggregate household resources constrain consumption for all household members. For these reasons, it is not surprising that, in practice, many social policies hope to reach deprived individuals by targeting poor households, or (more commonly) households with characteristics known to be associated with poverty.[6]

However, the existence of a household wealth effect on individual welfare does not imply that targeting poor households will be very effective in reaching poor individuals. A growing body of

[2] On these programs in developing countries see Coady et al. (2004), Fiszbein and Schady (2010), Del Ninno and Mills (2015), and Ravallion (2016, Chapter 10).
[3] For evidence on this point see Ravallion (2016, Chapter 10).
[4] See, for example, the various case studies in Del Ninno and Mills (2015). Many cash transfers aiming to improve child nutrition are paid directly to women in targeted poor households.
[5] The evidence is reviewed in Ravallion (2016, Chapter 7). The present paper will return to the literature.
[6] An overview of the programs found in practice is given in Ravallion (2016, Chapter 10) and Ruel et al. (2013).

empirical evidence casts doubt on that assumption. Relevant evidence includes:[7] (i) evidence that rejects a unitary model of the household, suggesting new sources of inequality within households; (ii) studies explaining the 'missing women' phenomenon; (iii) evidence of discrimination against certain household members such as orphans and widows; and (iv) evidence of unequal exposure to transitory shocks. Heterogeneity in factors influencing individual poverty can also mean that transfers to poor households often miss deprived individuals. It is important for policy makers to know whether standard household data sources can be relied upon to also reach poor individuals.

This paper tries to throw light on how well widely-used household-based measures perform in identifying disadvantaged individuals. Are we reaching such individuals adequately by simply targeting "poor" households? Or do many of them live in households that are not identified as poor? Is it harder or easier to reach vulnerable women and children using household data in settings in which the incidence of individual level disadvantage is high or average income is low?

Missing data on individual-level poverty present a significant hurdle to examining these issues. However, there is one dimension of individual welfare that can be observed in many surveys, namely nutritional status as indicated by anthropometric measures. Undernutrition can stem from inadequate caloric intakes or deficiencies in protein or micronutrient intakes, or from illness that impedes nutritional absorption. Such nutritional deprivations are of direct and immediate concern, and there is also evidence of longer-term social and economic costs, especially of low-birth weight and chronic undernutrition in childhood. Although nutritional status admittedly represents only one dimension of individual poverty there can be no doubt that it is an important dimension. It is also frequently used as a proxy for individual welfare.

The paper uses undernutrition as the measure of individual welfare to explore the questions posed above. We use data for 30 countries in sub-Saharan Africa (SSA), where chronic undernutrition among children is a major policy concern. The latest data at the time of writing indicate that the count of stunted children in SSA has risen by 12.5 million since 1990. The incidence of child stunting in SSA today is probably the highest of any of the standard geographic groupings of countries.[8] We draw on anthropometric data for 390,000 women and children from the Demographic and Health Surveys (DHS). These data can be used to identify nutritionally vulnerable women and children. The DHS also include a

[7] We provide references on these points later.
[8] These observations are from the World Bank's website on nutrition and the latest available estimates compiled by UNICEF. Historically, South Asia has been the region with highest incidence but that region has been making greater progress than SSA in this respect. Also see the discussion in Smith and Haddad (2015). Differences in population growth also affect this shift to SSA of the global share of the undernourished.

household wealth index based on a household's assets and living conditions. We use this index as a proxy for household wealth. However, aggregate consumption may well be a better predictor of individual welfare (and nutritional status) than the DHS wealth index, which (for example) may not respond quickly to shocks. Wherever possible, we complement the DHS data with good-quality nationally-representative household consumption surveys from the World Bank's Living Standards Measurement Study (LSMS).

We acknowledge that nutritional status is not all that matters to individual welfare; our findings may not hold for other dimensions of individual poverty. Yet, in the absence of better individual poverty measures, and given considerable evidence of unequal intra-household allocation of resources, it is important to investigate this issue. Our results are also relevant to policy makers who are specifically interested in reaching undernourished individuals viewed as a health deprivation. There are various forms of direct interventions with the aim of improving nutrition, including direct nutrition supplementation and promoting better health practices.[9] Many of these are implemented through health clinics and delivery points other than the household. However, there is a growing interest in doing so more through household-based policies—by integrating nutrition programs within anti-poverty policies more broadly. We throw light on whether this might work.

Our principle finding is that, although the incidence of undernutrition tends to be higher in poorer households, the nutritional deprivations are spread quite widely through both the wealth and consumption distributions, such that the joint probability of being an underweight woman or child and living in the poorest household wealth quintile is low. This also holds when we use an augmented regression to control for various individual- and household-level factors which may influence nutritional outcomes. Our results point to the need for broad coverage in efforts to address undernutrition and, by extension, individual poverty, rather than subsuming this problem within household targeted antipoverty interventions. Data availability limits how far we can go in explaining our findings, but we point to evidence suggesting that intra-household inequality may well be a major factor.

The following section considers relevant arguments and evidence from the literature. Section 3 outlines a simple theoretical model to help understand the relevant aspects of the joint distribution of household poverty and individual undernutrition. Section 4 then reviews the data we shall be using. Section 5 presents the main findings, while Section 6 tests robustness to allowing for a wider range of covariates. Section 7 concludes.

[9] See for example the package of nutritional interventions described in Bhutta et al. (2013).

2. Insights from the literature

Several strands of the literature have bearing on how effective household poverty data can be expected to be in revealing the presence of poor individuals. Here we summarize relevant arguments and evidence.

A body of research on the economics of the household has focused on the wealth effect on nutritional status, i.e., how much nutrition improves as a household's economic welfare—income, consumption or wealth—rises. One strand of this literature has estimated income elasticities of demand for food and (hence) nutrition; an influential early example is Behrman and Deolalikar (1987). Rather than focus on food consumption, as in consumer demand studies (such as Pitt, 1983), other work has instead studied the income effect on nutritional adequacy, taking account of requirements for good health and normal activities in society. A low income elasticity of demand for food can be consistent with a high responsiveness of nutritional adequacy to income gains, since even small gains in nutritional intakes can make a big difference at low levels (Ravallion 1990, 1992).[10]

New evidence on this topic has emerged from analyses of the many micro data sets (including the DHS) that have become available to researchers over the last 20 years or so. A limitation of the DHS is that the surveys have not included the questions needed to measure consumption or income. (At the same time, most surveys of the LSMS-type have not included anthropometrics.) The DHS wealth index was developed to help address this deficiency (Filmer and Pritchett 2001). Some studies have argued that the DHS wealth index is a good predictor of various human capital and other outcomes (Filmer and Pritchett 1999, 2001; Filmer and Scott 2012; Sahn and Stifel 2003; Petrou and Kupek 2010). For example, on comparing DHS wealth indices, Filmer and Scott (2012, p. 359) conclude that "…inferences about inequalities in education, health care use, fertility and child mortality, as well as labor market outcomes, are quite robust." Similarly, Sahn and Stifel (2003, p. 463) argue that their version of the wealth index "…is a valid predictor of a crucial manifestation of poverty—child health and nutrition." However, other studies have been less supportive and have found only seemingly modest correlations between nutritional, health and other outcomes and wealth indices (Hong and Hong 2007; Zere and McIntyre 2003; Howe et al. 2009). Different data sets can tell different stories here, so a comprehensive look at the evidence across multiple countries is needed.

[10] While it is not an issue taken up here, it is now well recognized that nutritional intakes can also be too high from the point of view of good health and normal activity levels. A strand of the literature has focused on obesity and its relationship to wealth in both rich and poor countries; for a review see Ravallion (2016, Chapter 7).

A strand of the literature has used the DHS wealth index to measure inequalities in child nutritional status, mainly using the concentration curve which gives the share of undernourished children living in the poorest x% of households based on the wealth index (Kakwani et al., 1997; Wagstaff and Watanabe 2000; Wagstaff et al., 2014; Bredenkamp et al., 2014).[11] A widely-used measure based on this curve is the concentration index, given by twice the area between the curve and the diagonal (analogous to the Gini index). A key finding from this literature of relevance here is that the concentration indices for child stunting and wasting in developing countries are almost invariably negative. A typical conclusion found in this literature is that "Unsurprisingly, in all countries, undernutrition is concentrated among the poor." (Bredenkamp et al., 2014, p.1330). Such assessments appear to support the common, but often implicit, assumption among social policy makers that targeting poor households will be effective in reaching undernourished individuals. However, the concentration indices are rarely more negative than -0.3, with median values typically around -0.15 to -0.10 (depending on the measure of undernutrition).[12] While this confirms that children from wealthier households tend to be better nourished (given that the index is negative), it also suggests that there is quite wide dispersion of undernutrition across wealth strata. We study this dispersion, focusing on its implication in the context of efforts to use household poverty data to target undernourished individuals.[13]

A number of recent papers review the existing evidence on the nutritional impacts of income growth and income support to poor households. On the first, as already noted, several papers find low income effects, particularly in the short-term (Grogan and Moers 2016; Haddad et al. 2003; Smith and Haddad 2015). With respect to the second, Alderman (2015) and Ruel and Alderman (2013) conclude that social safety nets targeting poor households with food or cash transfers (whether conditional or unconditional) have generally had limited impacts on children's nutritional status. The papers speculate that this may be because the targeted households are not those that have young children in the right age range. They do not question the practice of targeting poor households to reach undernourished individuals. Manley et al. (2013) undertake a systematic review and meta-analysis on conditional and unconditional cash transfers and child nutrition and come to similar conclusions.

A relevant concern is the existence of intra-household inequality. The unitary model of the household (characterized by a single utility function) has found little support empirically, and various

[11] There has been far less focus on inequalities in malnutrition among women.

[12] The online addendum to Bredenkamp et al. (2014) provides concentration indices across 80 developing countries for child undernutrition using the wealth index as the ranking variable. The median for stunting is -0.15.

[13] We do not use the concentration index here as there is greater interest in this context in points on the concentration curve.

alternatives have been proposed (as reviewed by Chiappori and Mazzocco, 2015, and Baland and Ziparo, 2017). These alternative models permit new sources of inequality within households, such as in reservation utility levels. An extensive literature details intra-household inequalities in resource allocations and outcomes (as reviewed in World Bank 2012). There are two direct policy implications: targeting poor households may well miss some significantly disadvantaged individuals and targeted households may not allocate the benefits to the neediest within the household. This paper addresses the first issue.

It is well recognized in principle that household-level consumption or income-based measures don't allow for inequality within the household. There is also (largely qualitative) evidence that certain individuals are poor and/or vulnerable, but do not live in households that would normally be considered poor and so are hidden from view in standard data sources on poverty. Differentiation between men and women has been widely documented in human capital, legal protection, constraints stemming from social norms, roles and responsibilities, and control over resources (Ezememari et al. 2002). For Africa, there is evidence that household shocks affect men and women differentially, with women bearing the brunt of negative shocks (Rose 1999; Dercon and Krishnan 2000). Such differentiation can be expected to have consequences for measures of poverty and inequality. In an important early example, Haddad and Kanbur (1990) find that such measures for the Philippines are appreciably underestimated using standard household-level data, although the "profiles"—the comparisons of these measures across sub-groups such as urban and rural areas—were found to be quite robust. Using a survey for Senegal that (unusually) collected a relatively individualized measure of consumption, Lambert et al. (2014) find significant inequalities within the household and a sizeable gender gap in consumption. Using the same data, De Vreyer and Lambert (2016) estimate that about one in eight poor individuals live in non-poor households. Using anthropometric data, Sahn and Younger (2009) find that about half of country-level inequality in the Body-Mass Index is within households rather than between them.

Other work has emphasized the poverty of specific types of individuals. Recent research on Mali confirms that widows—most of whom are absorbed into male headed households and can be quite young—experience significantly lower levels of individual (non-income) welfare indicators than women of other marital statuses, and that the disadvantage persists through remarriage (van de Walle 2013). There is also a large literature on orphans in the context of AIDS deaths, and the disadvantages they may face, particularly in schooling (Bicego et al. 2003; Case et al. 2004; Evans and Miguel 2007). While it may well be more likely that these disadvantaged groups live in relatively poor households, they may also be spread quite widely across the wealth distribution.

There are other sources of heterogeneity in individual health and nutrition at given levels of household wealth. Wagstaff (2003) finds large differences across developing countries in the incidence of underweight and stunted children even if one controls for wealth as best one can. Wagstaff found in addition that these differences are negatively correlated with public health spending per capita. This is consistent with other findings suggesting that cross-country differences in public health spending matter more for the poor than for others (Bidani and Ravallion 1997). The well-off are better able to protect their children's nutrition and health status from weak public provisioning and poor health environments. However, the powerful role of complementarities and externalities in water, sanitation and hygiene means that the better off also remain vulnerable to these deficiencies (Duflo et al. 2015; Ngure et al. 2014). Cross- country comparisons of stunting incidence have also pointed to the role played by access to health-related infrastructure (such as water and sanitation facilities) in addition to household characteristics such as food availability and maternal schooling (Smith and Haddad 2015).

In the light of these studies, prevailing methods of measuring poverty and designing antipoverty policies using the household as the unit of observation may be inadequate. Economists and policymakers have traditionally looked at poverty and vulnerability using the household as the unit of observation. The gold standard for measuring poverty has long been household-based consumption normalized for household size and (possibly) demographic composition. In the absence of data on such poverty indicators and the costs of collecting them for the whole population, it has become common in policy making to use proxy-means-testing (PMT) and other methods such as community-based targeting to target anti-poverty programs.[14] A number of studies have assessed how well PMT does in targeting poor households (Brown et al. 2016; Alatas et al. 2012; Kidd and Wylde 2011). But there has been little attention to how well such methods identify disadvantaged individuals.

3. An expository model

An important point that has not received adequate attention in the literature on antipoverty policies is that heterogeneity in individual economic welfare at any given level of aggregate household welfare can restrict the scope for reaching vulnerable women and children using household poverty data.

[14] Using more easily observed correlates of consumption or income such as assets and household characteristics, PMT uses the predicted values from multivariate regressions for consumption or income.

And this is the case even when there is a strong household income effect on individual welfare. To anticipate our empirical work, we shall identify individual welfare by nutritional status.

We elaborate this point in a simple expository model. The nutritional attainments of an individual (adult woman or child) are denoted *n*, while the wealth of the household to which that individual belongs is *w*. To keep notation simple, we can assume that *n* and *w* are both normalized by appropriate cut-off points (stipulated nutritional thresholds or poverty lines) such that a person is undernourished if (and only if) $n<1$ and a household is poor if $w<1$. These two random variables have a (continuous) joint density $f(n, w)$.

As discussed in the prior section, the relationship between the two variables depends on a number of factors, including intra-household inequality, the local health environment (including water and sanitation), access to relevant health and nutritional knowledge, and child care. To keep our expository model simple, we collapse the heterogeneity into one composite factor denoted ε, which we can take to be scaled such that it is bounded below by zero and above by unity. For concreteness, we might suppose that ε is the share of the household's total nutritional intake devoted to other household members. The expected value of individual nutritional status given *w* and ε is:

$$E(n|w,\ \varepsilon) = n(w,\ \varepsilon) \quad (1)$$

It is assumed that the function $n(.)$ is strictly increasing in *w*—the slope of this function with respect to *w* is the aforementioned wealth effect on undernutrition—and that the function is strictly decreasing in ε at given *w*. (Continuing the previous example, we can have the special case $n(.) = (1-\varepsilon)\phi(w)$ where $\phi(w)$ is aggregate household nutrition when wealth is *w*.)

Motivated by the existence of a wealth effect on nutritional attainments, it is understandable that a policy maker may be drawn to targeting wealth-poor households so as to reach nutritionally-deprived individuals. However, the common finding in the literature reviewed in Section 2 that the expected value of nutritional status rises with wealth does not necessarily mean that household wealth will provide a reliable indicator of individual outcomes for the purposes of policy. It makes more sense to focus on the conditional probability distribution $\Pr(w<1|n<1)$, i.e., the probability of living in a wealth poor household given that one is undernourished. By well-known properties of conditional probabilities:[15]

[15] Alternatively, one might calculate $\Pr(n<1|w<1)$. However, focusing on $\Pr(w<1|n<1)$ seems to accord more directly with the relevant question for policy purposes. Of course the two conditional probabilities are linked by Bayes' theorem. Readers can back out $\Pr(n<1|w<1)$ from our results below.

$$\Pr(w<1|n<1)=\frac{\Pr(n<1,w<1)}{\Pr(n<1)} \qquad (2)$$

The numerator is the joint probability of being both undernourished and living in a poor household, and the denominator is the marginal probability of being undernourished, i.e., the overall rate of undernutrition.[16] In Section 5 we study how the conditional probability in (2) varies across countries.

Another question of interest is how the conditional probability varies with the overall rate of undernutrition. Note that a higher $\Pr(n<1)$ can come with a change in the numerator of (2), so that it cannot be presumed that the conditional probability will fall. To see why, suppose that there is a change in the joint distribution $f(n,w)$, such that $\Pr(n<1)$ increases. Furthermore, suppose that the joint probability increases for all points with *n*<1 and *w*<1, while the opposite happens at all other points in the (*n*, *w*) space. In this case it is clear that the joint conditional probability must also increase along with the marginal, with a theoretically ambiguous implication for the conditional probability.

We can now readily see how heterogeneity can confound a policy maker's ability to reach undernourished individuals using only household data. Let w^* denote the minimum level of wealth that is needed to not be undernourished given ε, i.e., $n(w^*,\ \varepsilon)=1$. Plainly, w^* is a strictly increasing function of ε, which we write as $w^*(\varepsilon)$.[17] Then we have:

$$\Pr(w<1|n<1)=\Pr(w<1|w<w^*(\varepsilon)) \qquad (3)$$

Now consider the lower and upper bounds of ε. We assume that the wealth-poverty line is set such that nutritional status is deemed to be adequate for someone at that line when $\varepsilon=0$. For example, when intra-household inequality is the source of heterogeneity, a fair division of food should allow all those living in households around the poverty line to be adequately nourished. Then $w^*(0)\le 1$ and $\Pr(w<1|w<w^*(0))=1$. That is, targeting the wealth poor when there is no intra-household inequality assures that one reaches all those households with undernourished individuals. By contrast, given that w^* is an increasing function of ε, when ε approaches its maximum value, a high level of household wealth will be needed to assure that enough of the household's resources "trickle down" to avoid undernutrition in women and children. (This is clear if one considers again the example when ε

---

[16] More precisely $\Pr(n<1,w<1)\equiv\int_0^1\int_0^1 f(n,w)dndw$ and $\Pr(n<1)\equiv\int_0^1\int_0^\infty f(n,w)dwdn$.

[17] For example, if $n=(1-\varepsilon)\phi(w)$ then $w^*=\phi^{-1}[(1-\varepsilon)^{-1}]$.

represents intra-household inequality.) Specifically, $w^*(1) = w^{\max}$ and $\Pr(w < 1 \mid w < w^{\max}) = \Pr(w < 1)$. By invoking continuity, it is clear that $\Pr(w < 1 \mid n < 1)$ must be a non-increasing function of ε over (0, 1) and strictly decreasing for some sub-intervals. As ε approaches its upper limit, the probability of reaching undernourished individuals by targeting poor households is no higher than the overall poverty rate.

This model formalizes the intuition that heterogeneity, such as due to intra-household inequality or the local health environment, diminishes the scope for reaching poor individuals by targeting poor households. But how much does this matter empirically? Is the wealth effect on individual nutritional status strong enough to allow satisfactory targeting of vulnerable women and children? The rest of this paper addresses these questions.

4. Data

Our data are drawn from the Demographic Health Surveys (DHS) and the LSMS. We use the most recent DHSs available.[18] Table 1 lists the countries included in our analyses and the year of each survey.

Individual nutritional outcomes: We study the nutritional outcomes of women and children. For women, the two variables we employ are the body mass index (BMI) (also known as the Quetelet index), defined as a woman's weight (in kilograms) divided by her height (in meters) squared, and an indicator for being underweight, which is set equal to one if a woman's BMI is lower than 18.5 and zero otherwise. The DHS excludes values of BMI that are smaller than 12 and greater than 60 on the grounds that these are almost certainly measurement errors. We do the same for the consumption surveys. BMI is computed by the DHS for samples of women aged 15 through 49. For the LSMS surveys we restrict women to the same age range. We exclude all women who report being pregnant at the survey date.[19, 20] On average, pregnant women represent approximately 10 percent of all women aged between 15 and 49. The addendum gives the pregnancy incidence for each country in the DHS dataset.

[18] Several countries had to be excluded due to older survey data that did not contain many of the key variables needed, namely the Central African Republic, Chad, Comoros, Madagascar, Sao Tome and Principe, and South Africa.
[19] Unfortunately, we are unable to exclude pregnant women for Tanzania's consumption survey as it did not ask women whether they were pregnant.
[20] We also dropped observations with missing values for any variables used in the paper, such that sample sizes are consistently the same and comparable throughout the paper. However, we tested the effect of relaxing this constraint and found that it makes negligible difference to the results.

For children, we use the z-scores for height-for-age (stunting) and weight-for-height (wasting).[21] These anthropometric data are measured for all children aged under 5 in the DHS and LSMS surveys. We then create our measure for stunting (low height-for-age) and wasting (low weight-for-height). A child is deemed to be stunted if his height-for-age z-score is two standard deviations below the median of the reference group; wasting is defined similarly using weight-for-height. Stunting and wasting, while both considered indicators of undernutrition, have different causes and effects. Stunting is an indicator of persistent, longer-term, chronic undernutrition from which it is much harder for a child to recover. Compared to wasting, it is known that stunting has adverse longer term consequences for child development.[22] Wasting tends to be more responsive to short-term (possibly seasonal) food deprivations or illnesses.

Tables 2 and 3 give the summary statistics for the nutritional outcomes for women and children using the DHS and LSMS.[23] Focusing on the larger sample of countries available in the DHS and taking population-weighted averages, we find that 11% of adult women are underweight, while 32% of children are stunted and 9% are wasted (similar numbers are found for children in the LSMS). Across countries, a higher incidence of underweight women is associated with a higher incidence of wasted children (r=0.40, significant at the 5% level[24]). The correlation between women's and children's nutritional status is weaker for stunting (r=0.14).[25] This is what we would expect if a woman being underweight and her children being wasted are caused by similar short-term shocks, while stunting is a more long-term condition.

Table 4 provides summary statistics for selected other indicators that have been identified in past work as relevant to nutritional outcomes, specifically GDP per capita, the national poverty rate, the female literacy rate, and access to improved water and sanitation facilities. Table 5 gives the correlation matrix for the three nutritional indicators from Table 2 and the five country-level indicators from Table 4. GDP and FLR are both negatively correlated with the nutritional indicators, as is access to water and sanitation. For GDP, the correlation is only statistically significant for stunting (r= -0.54). The FLR has

---

[21] These variables are already constructed in the DHSs. For the consumption surveys we use the Stata command zscore06 to convert height and weight values into a standardized value.
[22] See, for example, Walker et al. (2007) and Hoddinott et al. (2008).
[23] There are some discrepancies in the means between the two datasets, much of which is likely to do with the timing of the surveys, although differences in sample selection and measurement may also be contributing.
[24] For prob.= 0.05, the critical value of the correlation coefficient is 0.306.
[25] This weak correlation between wasting and stunting is not surprising (Victora 1992). Although there is some evidence that wasting in early childhood can cause subsequent stunting (Richard et al. 2012), the fact that stunting is a longer-term condition while wasting tends to be more transient points to different causative factors.

a large and significant negative correlation with the wasting rate (r= -0.73), but the correlations are not statistically significant for underweight women or stunted children. The poverty rate is strongly correlated with stunting (r= 0.71). Water access is correlated with stunting (r= -0.33), while sanitation access is correlated with wasting (r= -0.31). Of course, these are only simple (pair-wise) correlations and may be deceptive. For example, if one regresses the stunting rates in Table 3 on both GDP and the poverty rate, only the latter is statistically significant.[26] In other words, the negative correlation between stunting incidence and GDP is due to an omitted variable bias, given that GDP is (negatively) correlated with poverty incidence, which is a strong covariate of the incidence of stunting.

For a subset of countries the DHS also collected data on adult male anthropometrics which provide an insight into the extent of intra-household inequality. Table 6 provides summary statistics on the incidence of undernutrition for women and children stratified according to whether the male head of household is underweight or not. We see that the incidence of undernutrition among women and children is lower when the male head is adequately nourished. However, substantial inequality in nutritional status is also evident, and the gender inequality goes in both directions. The majority of women in households where the male head is underweight are not undernourished, and there is a high incidence of undernutrition among women and children in households where the male head is not underweight. Table 6 also gives (in parentheses) the proportions of undernourished women and children found in the two groups of households, identified by whether the male head is underweight or not. (Note that the proportions sum to unity horizontally.) We see that the bulk of underweight women (74%) are found in households where the male head is not underweight and similarly for stunted (80%) and wasted (53%) children.

Wealth and other covariates: When we say that a household is "wealth-poor" we are referring to the DHS wealth index within a given country. The wealth index is constructed by taking variables relating to a household's assets (including consumer durables) and amenities, including materials used for housing construction and its access to water and sanitation. These variables are then aggregated into an index using factor-analytic methods, with the wealth index being identified as the first principal component of the data. The DHS wealth index comes as a z-score, i.e., standardized with mean zero and standard deviation of unity. So the index is country specific—not intended to be comparable across countries.

[26] Using our estimates from Tables 2 and 4 to regress the log of the stunting rate on the log of GDP plus the log of the poverty rate, it is readily verified that the regression coefficients are -0.09 (s.e.= 0.06) and 0.42 (s.e.= 0.12) respectively.

We focus on the poorest 20% and 40% of households based on the wealth index. These are arbitrary choices, although the 40% figure does coincide fairly closely with the overall poverty rate found for SSA using the World Bank's international line.[27] The 20% figure allows us to focus more on the lower part of the wealth distribution. We also provide key results for the full range of the distribution.

It should not be forgotten that the DHS wealth index is a proxy, not a direct measure of wealth. The index focuses on durable and productive asset wealth rather than labor or education wealth, arguably the main assets of many among the poor. When compared to the results of a full-blown consumption survey, the DHS index will undoubtedly count as poor some who are not (often called "inclusion errors") and count as non-poor some of those who are in fact poor ("exclusion errors"). In practice, policy makers targeting poor households almost never have access to accurate measures of wealth or consumption for the population as a whole, and must rely instead on a relatively small number of indicators, such as those embodied in the DHS index. Nonetheless, we also conduct the analysis using household consumption per capita for the sub-set of countries for which this is feasible. Surveys that contain detailed household consumption data as well as anthropometrics for women and children are not common, but some do exist including within the LSMS (specifically the LSMS Integrated Surveys on Agriculture) as listed in Table 1.[28] The consumption variable is spatially deflated and expressed in per capita terms.

In an attempt to test whether controlling for additional information, including education and labor assets, enhances predictive power, we draw on household and individual covariates from both surveys. Variables based on the consumption surveys are constructed to be as similar as possible to those used in the DHS data.

The statistical addendum provides summary statistics for the wealth index and other key variables that are typically included in the index or are standard in proxy-means-testing for each country. Descriptive statistics for the variables from the consumption surveys are also shown in the addendum. Overall, means match reasonably well between the two datasets, though with some differences among the asset variables.

---

[27] Using the World Bank's international line of $1.90 a day at 2011 purchasing power parity, 43% of the population of Sub-Saharan Africa are found to be poor in 2013 (based on PovcalNet).

[28] Only the consumption survey from Ghana is not one of the Integrated Surveys on Agriculture within the LSMS.

5. Individual outcomes and household wealth

Wealth effects on nutritional status: Figure 1 plots the incidence of the three anthropometric indices of undernutrition against percentiles of the household wealth-index distribution. For women, we plot incidence for all women 15 to 49 years of age, and for women 20 to 49 years of age, given that younger women typically have a lower BMI. The wealth effect—whereby nutritional status improves with a higher DHS wealth index—is generally evident. However, aside from child stunting, the wealth effect is clearly weak in most countries. The incidence of being underweight is slightly higher for younger women, although the relationship with household wealth is very similar. Child wasting in some countries shows little or no sign of the wealth effect (notably Gabon, Gambia, Senegal, Sierra Leone and Swaziland). Figure 2 gives the corresponding graphs using household consumption per capita. Similar comments apply.

The overall strength of the household wealth effect for each country can be assessed by regressing the standardized values for nutritional status (that is, the z-score for women's BMI and height-for-age and weight-for-height z-scores for children) on the wealth index, which (as noted) is also a z-score. The regression coefficient gives the number of standard deviations of the nutritional indicator attributed to a one standard deviation increase in wealth. Table 7 gives results using the DHS, and also the analogous results using standardized consumption z-scores from the LSMS. Although the estimated wealth effects are statistically significant in almost all cases (the exceptions are for child wasting in a few countries), the coefficients appear to be generally quite low; for women's BMI the mean regression coefficient is 0.26, while it is 0.29 for the height-for-age z-score and only 0.09 for weight-for-height. Even for the countries where the wealth effect on child stunting is highest (Burundi, Cameroon and Nigeria), a one standard deviation increase in wealth is only associated with a 0.5 standard deviation increase in the incidence of child stunting. And for about half the countries, the wealth effect on stunting is less than 0.3 standard deviations.

However, these results cannot tell us much about the efficacy of household wealth in predicting the incidence of undernourished individuals. Low wealth effects such as evident in Table 7 need not imply that the incidence of undernutrition is unresponsive to income or wealth differences (as demonstrated in Ravallion, 1990). Also, as shown in Section 3, even if household wealth and individual nutritional status are correlated it does not follow that a large proportion of undernourished individuals will be found in the lower ends of the wealth distribution.

Conditional and joint probabilities: Figure 3 gives the cumulative share of undernourished individuals by cumulative household wealth percentile ranked from the poorest up, i.e., the concentration curves. The greater the degree of concavity (meaning that the concentration curve is further above the 45-degree line) the more undernourished individuals tend to be concentrated in the poorer strata of household wealth. Similarly, Figure 4 displays the concentration curves using household consumption per person as the ranking variable.

We see in Figure 3 that there is marked concavity for some countries, notably Cameroon (for all three indicators), Congo, Gabon and Ghana (for stunting), Gabon, Kenya, Uganda, Zambia and Zimbabwe (for underweight women). However, in most cases the curves tend to be fairly close to the diagonal line. The curve for underweight women tends to be above that for children in about half the countries, though otherwise there is little sign of a clear ranking of the three indicators.

For the rest of this discussion we focus on the points on the concentration curves corresponding to the poorest 20% and 40% of the household wealth index. Table 8 presents the proportion of undernourished women and children who fall into the bottom 20 and 40 percent. Given the wealth effect on nutritional status, the values for underweight women and stunted children are generally bounded below by $\Pr(w<1)$ (either 0.2 or 0.4). The only exceptions are for child wasting in Gambia, Senegal, Sierra Leone and Swaziland, where the wealth effect is not evident (Figure 1).

What is striking about the results in Table 8 is how close the conditional probabilities are to $\Pr(w<1)$. For 20 of the 30 countries less than 30% of underweight women are found in the poorest 20% of households. This is true for 25 and 26 countries with regard to stunted and wasted children (respectively). On average, roughly three-quarters of underweight women and undernourished children are <u>not</u> found in the poorest 20% of households when judged by household wealth. And about half of underweight women and under-nourished children are not found in the poorest 40% of households.

The countries with a higher percentage of undernourished women in the poorest strata of households tend to also have a higher proportion of wasted children in that group; the correlation coefficients are 0.50 and 0.41 for the poorest 20% and 40% respectively. However, this is not the case for stunted children; the corresponding correlation coefficients are -0.01 and 0.07. There is only one country (Cameroon) where more than 30% of individuals are found in the poorest 20% for all three nutritional indicators.

Table 9 provides the same statistics using the consumption indicator, with very similar results. Overall, about two thirds of undernourished women are not found in the poorest 20% of households based on consumption per person, while about half of them are not found in the poorest 40%. For children, we find that about three-quarters of stunted children are not found in the poorest 20%, and similarly for wasted children. More than half of wasted and stunted children are not found in the poorest 40%.

On combining Tables 2 and 8, we can use equation (2) to infer the joint probabilities of being both undernourished and wealth-poor, $\Pr(n < 1, w < 1)$. The empirical values for the DHS data are given in Table 10. For underweight women and the poorest 20%, the joint probability is under 0.04 for 22 countries. The mean joint probability of a woman being underweight and living in the poorest 20% of households is only 0.03, rising to 0.06 for the poorest 40%. For child wasting the probabilities are even lower than for underweight women, at under 0.02 for two thirds of all countries. The joint probabilities are higher for stunting, with a mean of 0.08 and 0.16 for the poorest 20% and 40%, respectively. While for child stunting the probabilities span a wider range, it remains that all but two are under 0.1 for the poorest 20%.

As expected, the joint probabilities tend to be positively correlated with the marginals; the bottom row of Table 10 gives the correlation coefficients. The table also gives the OLS elasticities across countries (regression coefficients of the log joint probability on the log marginal probabilities). The elasticities are all less than unity. So a higher rate of undernutrition should reduce the conditional probability. On balance, we find that countries with a higher overall incidence of women's undernutrition or a higher incidence of child undernutrition (whether stunting or wasting) tend to have a higher share of these disadvantageous outcomes among the "non-poor" based on wealth. Table 11 shows the correlations between the conditional probabilities. For women's undernutrition, the correlation coefficient between the share of undernourished women in the poorest 20% of households and the overall incidence of underweight women is -0.31, while for the poorest 40% it is -0.22. For child stunting the corresponding correlations are -0.47 and -0.56, while for wasting they are -0.24 and -0.26. However, not all of these correlations can be considered statistically significant at a reasonable level. The correlations are only significant at the 5% level for the share of underweight women in the poorest 20% and for stunting. Figures 5, 6 and 7 plot the values from Tables 2 and 8 for the incidence of underweight women, stunting and wasting respectively, highlighting the negative relationship between the joint and marginal probabilities.

These results suggest that when relatively few women or children are undernourished in a country one tends to find them more concentrated in relatively poorer households. Conversely, when there are many undernourished women and children one tends to find them more widely spread across the household wealth distribution. From a policy perspective, these results suggest that targeting relatively poor households will tend to work less well in reaching vulnerable women and children in countries where the overall problem of undernutrition is greater.[29]

Covariates of the conditional probabilities: We examine the correlations with three variables, GDP per capita, the female literacy rate (Table 2) and the wealth-index effect (Table 7). We can think of these as shift parameters of the joint probability density of wealth and nutrition. GDP and the FLR are of obvious interest. The wealth effect is less obvious. In this context, the wealth-index effect can be interpreted as a measure of the extent of nutritional inequality by wealth, and the expectation is that a steeper wealth effect would be associated with a greater concentration of undernutrition in wealth-poor households.

Table 11 gives the correlation coefficients among the conditional probabilities as well as those with the other social and economic indicators from Table 4. The conditional probabilities are positively correlated with the relevant wealth effects. For underweight women we find that r= 0.64 and 0.71 for 20% and 40% respectively. For stunting, the corresponding correlations with the wealth effects for height-for-age are 0.39 and 0.44, while for wasting they are 0.47 and 0.64. The positive correlation of the conditional probabilities with the wealth effects is also found on using regressions to control for the other summary statistics in Table 4, and these partial correlations are statistically significant in most cases.[30]

We find that the shares of stunted children found in wealth-poor households are quite strongly positively correlated with GDP per capita (r=0.77 for the poorest 20% and r=0.67 for 40%), but this is not the case for underweight women (r=-0.01 and r=-0.17 respectively) or wasted children (r=-0.20 and r=-0.21 respectively). All six measures of the shares of nutritionally vulnerable women and children are positively correlated with the female literacy rate, though not all are statistically significant; r=0.31 and 0.30 for underweight women and the poorest 20% and 40% respectively, while r=0.42 and 0.34 for stunted children and r=0.20 and 0.15 for wasted children. There are no significant correlations with access to water and sanitation. Nor did the regressions reveal any sign of significant partial correlations with water and sanitation, holding constant either the marginal probability, the wealth-index effect or the

[29] This is also evident in the data for stunting in Africa assembled by Bredenkamp et al. (2014) (see the Africa data points in their Figure 1), although across all developing countries Bredenkamp et al. find that inequalities in stunting are greater in countries where stunting is more prevalent. Evidently Africa is different in this respect, though the reason is unclear.

[30] For the shares of underweight women and stunted children in the poorest 20% the partial correlations are only significant at about the 10% level, while they are significant at the 5% level in all other cases.

combination of the other non-nutritional variables in Table 4. This suggests that other factors besides the health environment may well be playing a more important role, including intra-household inequalities.

6. Augmented regressions

Introducing other household-level factors may enhance power for predicting individual outcomes. There may also be a problem with the weights used in constructing the wealth index; for example, the index may not adequately adjust for economies of scale in consumption. Finally, adding basic individual-level variables such as age and marital status for women may enhance targeting capability.[31] To test these conjectures we augment wealth with such household- (and individual-) level variables. The augmented regressions can be expected to perform similarly to the widely-used PMT method based on the predicted values of regressions calibrated to survey data (Section 2).

To motivate the augmented regressions, we can start by thinking of a simple regression of nutritional outcomes on the wealth index:

$$y_{ijm} = \alpha_m + \beta_m w_{jm} + \varepsilon_{ijm} \qquad (4)$$

where y_{ijm} is the nutritional indicator for individual i in household j in country m and w_{jm} is the household wealth index. Call this Model 1. Since the expected value of nutritional status tends to improve with wealth (the aforementioned wealth effect) rankings in terms of the predicted values from these regressions are very similar to those we have seen already. Model 2 augments (4) to contain household-level variables x_{jm}, giving:

$$y_{ijm} = \alpha_m + \beta_m w_{jm} + \gamma_m x_{jm} + \varepsilon_{ijm} \qquad (5)$$

The vector x_{jm} includes the separate components of the wealth index (essentially to allow a re-weighting of the index), as well as other household-level variables such as size and composition, and characteristics of the head. Dummies for survey month and region of residence are also entered as controls. Finally, Model 3 adds the observable individual-level variables, z_{ijm}:

$$y_{ijm} = \alpha_m + \beta_m w_{jm} + \gamma_m x_{jm} + \delta_m z_{ijm} + \varepsilon_{ijm} \qquad (6)$$

For the incidence of underweight women, the individual-level attributes include the woman's age (BMI tends to increase as women age), education and marital status. For children, age, gender, and characteristics of the child's mother are included. To avoid *ad hoc* functional form assumptions, age

[31] Recent research has argued that widows and remarried women often fare poorly when compared to married once women (Anderson and Ray 2016; Djuikom and van de Walle 2017).

and education variables as well as household size are broken into categories each of which is entered as a dummy variable. OLS is used to estimate each model, with standard errors clustered at the PSU. (The Addendum gives the actual regressions.)

As discussed above, in the event that household wealth is simply a poor indicator of nutritional outcomes, we also use household per capita consumption. For the relevant subset of countries we estimate the regressions using household consumption per person (with, as noted in Section 4, some slight variations in the variables included in x_{jm} and z_{ijm}). The results were similar; details are found in the Addendum.

Tables 12 and 13 present the results for Models 2 and 3 for underweight women and undernourished children respectively. The tables give the proportion of undernourished individuals who fall into the poorest 20% and 40% of the distribution of the predicted values based on wealth and (unlike prior tables) the additional covariates. We find that, on average, 32% of underweight women are found in the poorest 20% based on the predicted values from Model 2 (Table 12), as compared to 28% using only the household wealth index (Table 8). Focusing instead on the poorest 40%, the proportion rises to 56% using Model 2, as compared to 51% using wealth alone. Adding the individual variables (Model 3) we now find that (on average) 37% of underweight women are found in the poorest 20% in terms of the predicted values, rising to 61% for the poorest 40%. Similar improvements are evident for both stunting and wasting in children (comparing Tables 13 and 8).

However, it is clear that these augmented regressions still do a poor job at identifying undernourished individuals within households. While the predictive power is improved, it is not enough to change our conclusion that targeting based on the available household poverty data misses a large share of undernourished women and children.

7. Conclusions

There are multiple constraints on effective policy interventions in practice. Here we have focused on a key informational constraint, and asked whether household poverty might provide a reliable guide for policy efforts trying to reach deprived individuals, as indicated by anthropometric measures of undernutrition, recognizing that poverty is an individual characteristic. We do not claim that information is the only constraint. Even if undernourished women and children are almost solely found in wealth- or consumption-poor households, other factors such as the local health environment can play an important role in determining policy effectiveness.

We have focused on just one dimension of individual deprivation. Individual welfare clearly depends on more than nutritional status, and we cannot rule out the possibility that household-level data are more revealing for other non-nutrition dimensions. That said, undernutrition is an undeniably important dimension of individual poverty and it has long played a central role in the measurement of poverty using aggregate household data. This dimension of welfare is also emphasized by policy makers concerned with reducing both current and longer-term poverty. The mounting evidence on the longer-term costs of stunting in young children adds force to that emphasis.

A great deal has been learnt about the socioeconomic differentials in individual health and nutrition from micro data, typically using cross-tabulations or regressions. This knowledge is valuable. However, there is a risk that the differentials in mean attainments often found between rich and poor households lead policy makers to be overly optimistic about the scope for reaching vulnerable individuals using only household-level data. Standard poverty data make *ad hoc* assumptions about equality within households. Persistent effects of intra-household inequality on health and nutrition may not be evident in these measures. Just how adequate household-level data are for the policy purpose of reaching vulnerable women and children has been unclear.

To help improve our knowledge about this constraint on policy, the paper has provided a comprehensive study for 30 countries in Sub-Saharan Africa. We find a reasonably robust household-wealth effect on individual undernutrition indicators for women and children. Nonetheless, on aggregating across the 30 countries studied here, about three-quarters of underweight women and under-nourished children are not found in the poorest 20% of households when judged by the household wealth index in the Demographic and Health Surveys. A similar pattern is found in the available household surveys that allow a comparison of individual nutritional measures with an estimate of the household's consumption per person, which is clearly the most widely used welfare metric in measuring poverty in developing countries. Adding other household variables—interpreted as either a re-weighting of the DHS wealth index or as supplementary variables—improves the performance of household data in this respect, but we still find that a large share of undernourished individuals are not among those predicted to be undernourished based on household variables. It is clear from this study that to have any hope of reaching undernourished women and children, policy interventions in this setting will either require much more individualized intra-household information or they will need to be nearly-universal in coverage.

This dispersion of undernourished individuals across the distributions of household wealth and consumption entails that countries with a higher overall incidence of undernutrition tend to be countries where a larger share of the undernourished are found in non-poor families. This suggests that the need for broad coverage in social policies (rather than policies finely targeted to poor households) is especially great in countries with a high incidence of undernutrition. Rather than folding nutrition schemes into household-targeted antipoverty programs in such countries, emphasis should be given to nutritional interventions with near universal coverage, such as comprehensive school feeding (with explicit nutrition supplementation), maternal health care and universal sanitation services.

In addition to documenting the limitations of relying on household poverty data to reach nutritionally deprived individuals, we throw some light on why those limitations are so severe. For the subset of countries for which we also know adult male BMI, we have shown that the extent of intra-household inequality entails that the bulk of underweight women and undernourished children are found in households where the male head appears to be adequately nourished. In exploring the cross-country patterns we find that richer countries (in terms of GDP per capita) within Africa tend to have child stunting more concentrated among the wealth-poor, suggesting greater scope in those countries for targeting wealth-poor households as a means of reaching children with longer-term nutritional deficiencies. But this is not so for child wasting. In countries with a higher female literacy rate one tends to find a greater concentration of underweight women in poor wealth strata. By contrast, female literacy has little power for predicting whether children's undernutrition is more concentrated among the wealth poor. There is no sign that countries with lower average access to improved water and sanitation tend to have undernourished women and children more concentrated among the wealth poor; while there is little doubt that improved water and sanitation makes for better nourished people, intra-household inequalities appear to be a more plausible explanation for our main findings on the relationship with household wealth than these aspects of the health environment. In all cases, the size of the wealth effect—how much undernutrition falls as the wealth index rises—is a significant predictor of how effectively one can expect to identify nutritionally-disadvantaged individuals by targeting poor households. However, as we have also emphasized, it is better to focus directly on the relevant conditional probabilities for this purpose, rather than the wealth effect.

References

Alatas, Vivi, Abhijit Banerjee, Rema Hanna, Benjamin Olken and Julia Tobias. 2012. "Targeting the Poor: Evidence from a Field Experiment in Indonesia," *American Economic Review* 102(4): 1206-1240.

Alderman, Harold. 2015. "Leveraging Social Protection Programs for Improved Nutrition: Summary of Evidence Prepared for the Global Forum on Nutrition-Sensitive Social Protection Programs, 2015," *Available at SSRN 2831575* (2015).

Anderson, Siwan, and Debraj Ray. 2010. "Missing Women: Age and Disease," *Review of Economic Studies* 77(4): 1262-1300.

_____________ and _________. 2015. "Missing Unmarried Women," NBER Working Paper 21511.

Baland, Jean-Marie, and Roberta Ziparo, 2017, "The (In)-efficiency of Intra-household Bargaining in Poor Countries," mimeo, University of Namur.

Behrman, Jere, and Anil Deolalikar. 1987. "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India," *Journal of Political Economy* 95: 108-138.

Bhutta Zulfiqar, Jai Das, Arjumand Rizvi, Michelle Gaffey, Neff Walker, Susan Horton, Patrick Webb, Anna Lartey, and Robert Black. 2013. "Evidence-Based Interventions for Improvement of Maternal and Child Nutrition: What Can be Done and at What Cost?" *Lancet* 382(9890): 452-77.

Bicego, George, Shea Rutstein, and Kiersten Johnson. 2003. "Dimensions of the Emerging Orphan Crisis in Sub-Saharan Africa," *Social Science and Medicine* 56(6): 1235-1247.

Bidani, Benu and Martin Ravallion. 1997. "Decomposing Social Indicators Using Distributional Data," *Journal of Econometrics* 77(1): 125-140.

Bredenkamp, Caryn, Leander R Buisman and Ellen Van de Poel. 2014. "Persistent Inequalities in Child Undernutrition: Evidence from 80 Countries, from 1990 to Today," *International Journal of Epidemiology* 43(4): 1328–1335

Brown, Caitlin, Martin Ravallion and Dominique van de Walle. 2016. "A Poor Means Test? Econometric Targeting in Africa," NBER Working Paper 22919.

Case, Anne, Christina Paxson and Joseph Ableidinger. 2004. "Orphans in Africa: Poverty and School Enrollment," *Demography* 41(3): 483-508.

Chiappori, Pierre-Andre, and Maurizio Mazzocco. 2015. "Static and Intertemporal Household Decisions," mimeo, Department of Economics, Columbia University.

Coady, David, Margaret Grosh and John Hoddinott, 2004, *Targeting Transfers in Developing Countries: Review of Lessons and Experience*, Washington D.C.: World Bank.

Del Ninno, Carlo and Bradford Mills. 2015 (Eds.). Safety Nets in Africa: Effective Mechanisms to Reach the Poor and Most Vulnerable. The World Bank, Washington D.C.

Dercon, Stefan and Pramila Krishnan. 2000. "In Sickness and in Health: Risk Sharing within Households in Rural Ethiopia," *Journal of Political Economy* 108(4): 688-727.

De Vreyer, Philippe, and Sylvie Lambert. 2016. "Intra-household Inequalities and Poverty in Senegal," mimeo, Paris School of Economics.

Djuikom, Marie Albertine and Dominique van de Walle. 2017. "Marital Shocks and Women's Welfare in Africa," mimeo, World Bank, Washington, DC

Duflo, Esther, Michael Greenstone, Raymond Guiteras and Thomas Clasen. 2015. "Toilets can Work: Short and Medium Run Health Impacts of Addressing Complementarities and Externalities in Water and Sanitation," NBER Working Paper 21521.

Evans, David and Edward Miguel. 2007. "Orphans and Schooling in Africa: A Longitudinal Analysis," *Demography* 44(1): 35-57.

Ezememari, Kene, Nazmul Chaudhury and Janet Owens. 2002. "Gender and Risk in the Design of Social Protection Interventions," Social Protection Discussion Paper Series No. 0231, World Bank, Washington, DC.

Filmer, Deon and Lant Pritchett. 2001. "Estimating Wealth Effects Without Expenditure Data—or Tears: An Application to Educational Enrollments in States of India." *Demography* 38(1): 115-132.

Filmer, Deon and Lant Pritchett. 1999. "The Effect of Household Wealth on Educational Attainment: Evidence from 35 Countries." *Population and Development Review* 25(1): 85-120.

Filmer, Deon and Kinnon Scott. 2012. "Assessing Asset Indices." *Demography* 49(1): 359-392.

Fiszbein, Ariel, and Norbert Schady, 2010, *Conditional Cash Transfers for Attacking Present and Future Poverty*, World Bank, Washington DC.

Grogan, Louise and Luc Moers. 2016. "Wealthier is not Healthier in Sub-Saharan Africa." Mimeo, University of Guelph.

Haddad, Lawrence and Ravi Kanbur. 1990. "How Serious is the Neglect of Intra-Household Inequality?" *Economic Journal* 100: 866-881.

Haddad, Lawrence, Harold Alderman, Simon Appleton, Lina Song, and Yisehac Yohannes. 2003. "Reducing Child Malnutrition: How Far Does Income Growth Take Us?" *World Bank Economic Review* 17(1): 107-131.

Hoddinott, John, John Maluccio, Jere Behrman, Rafael Flores, and Reynaldo Martorell, 2008, "Effect of a Nutrition Intervention During Early Childhood on Economic Productivity in Guatemalan Adults," *Lancet* 371:411–6.

Hong, Rathavuth and Rathmony Hong. 2007. "Economic Inequality and Undernutrition in Women: Multilevel Analysis of Individual, Household, and Community Levels in Cambodia." *Food and Nutrition Bulletin* 28(1): 59-66.

Howe, Laura, James Hargreaves, Sabine Gabrysch, and Sharon Huttly. 2009. "Is the Wealth Index a Proxy for Consumption Expenditure? A Systematic Review." *Journal of Epidemiology and Community Health* 63(11): 871-877.

Kakwani, Nanak, Adam Wagstaff and Eddy van Doorslaer. 1997. "Socioeconomic Inequalities in Health: Measurement, Computation and Statistical Inference," *Journal of Econometrics* 77(1): 87-103.

Kidd, Stephen and Emily Wylde. 2011. "Targeting the Poorest: An Assessment of the Proxy Means Test Methodology," AusAid Research Paper, AusAid, Canberra.

Lambert, Sylvie, Martin Ravallion and Dominique van de Walle. 2014. "Intergenerational Mobility and Interpersonal Inequality in an African Economy," *Journal of Development Economics* 110: 327-344.

Madise, Nyovani, Zoe Matthews, and Barrie Margetts. 1999. "Heterogeneity of Child Nutritional Status between Households: A Comparison of Six Sub-Saharan African Countries." *Population Studies* 53(3): 331-43.

Manley, James, Seth Gitter, and Vanya Slavchevska. 2013. "How Effective are Cash Transfers at Improving Nutritional Status?" *World Development* 48: 133-155.

Ngure, Francis, Brianna Reid, Jean Humphrey, Mduduzi Mbuya, Gretel Pelto and Rebecca Stoltzfus. 2014. "Water, Sanitation and Hygiene (WASH), Environmental Enteropathy, Nutrition, and Early Child Development: Making the Links,"" *Annals of the New York Academy of Sciences* 1308(1): 118-128.

O'Donnell, Owen, Eddy van Doorslaer, Adam Wagstaff and Magnus Lindelow. 2008. Analyzing Health Equity Using Household Survey Data, World Bank.

Petrou, Stavos, and Emil Kupek. 2010. “Poverty and Childhood Undernutrition in Developing Countries: A Multi-National Cohort Study,” *Social Science and Medicine* 71: 1366-1373.

Pitt, Mark. 1983. “Food Preferences and Nutrition in Rural Bangladesh,” *Review of Economics and Statistics* LXV: 105-114.

Ravallion, Martin. 1990. “Income Effects on Undernutrition,” *Economic Development and Cultural Change* 38: 490-515.

Ravallion, Martin. 1992. “Does Undernutrition Respond to Incomes and Prices?: Dominance Tests for Indonesia,” *World Bank Economic Review* 6: 109-124.

Ravallion, Martin. 2009. “How Relevant is Targeting to the Success of the Antipoverty Program?” *World Bank Research Observer* 24(3): 205-231.

Richard, Stephanie, Robert Black, Robert Gilman, Richard Guerrant, Gagandeep Kang, Claudio Lanata, Ka˚re Mølbak, Zeba Rasmussen, Bradley Sack, Palle Valentiner-Branth, William Checkley, and Childhood Infection and Malnutrition Network. 2012. “Wasting is Associated with Stunting in Early Childhood,” *Journal of Nutrition: Nutritional Epidemiology* 142: 1291–1296.

Rose, Elaina. 1999. “Consumption Smoothing and Excess Female Mortality in Rural India,” *Review of Economics and Statistics* 81(1): 41-49.

Ruel, Marie, Harold Alderman, and Maternal and Child Nutrition Study Group. 2013. "Nutrition-sensitive Interventions and Programmes: How can they Help to Accelerate Progress in Improving Maternal and Child Nutrition?" *The Lancet* 382: 536-551.

Sahn, David and David Stifel. 2003. “Exploring Alternative Measures of Welfare in the Absence of Expenditure Data.” *Review of Income and Wealth* 49: 463–489.

Sahn, David and Stephen Younger. 2009. “Measuring Intra-Household Health Inequality: Explorations Using the Body Mass Index.” *Health Economics* 18: S13-S36.

Smith, Lisa and Lawrence Haddad. 2015. “Reducing Child Undernutrition: Past Drivers and Priorities for the Post-MDG Era,” *World Development* 68: 180-204.

van de Walle, Dominique. 2013. “Lasting Welfare Effects of Widowhood in Mali.” *World Development* 51: 1-19.

Victora, Cesar. 1992. “The Association between Wasting and Stunting: An International Perspective.” *Journal of Nutrition* 122(5): 1105–10.

Wagstaff, Adam. 2003. “Child Health on a Dollar a Day: Some Tentative Cross-country Comparisons.” *Social Science and Medicine* 57(9): 1529-38.

Wagstaff, Adam, Caryn Bredenkamp, and Leander Buisman. 2014. "Progress on Global Health Goals: Are the Poor Being Left Behind?" *World Bank Research Observer* 29(2): 137-162.

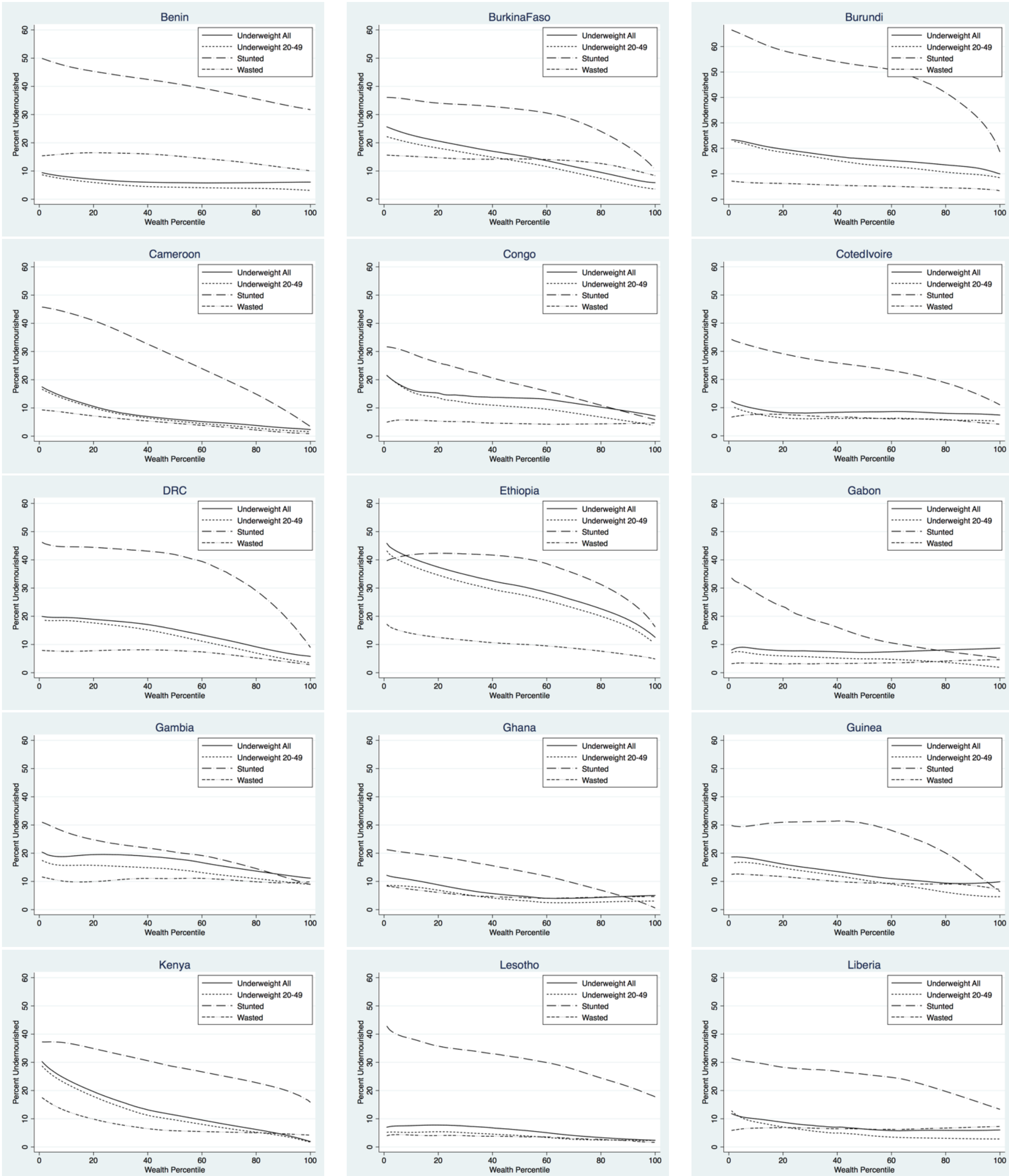
Wagstaff, Adam and Naoko Watanabe. 2000. "Socioeconomic Inequalities in Child Malnutrition in the Developing World." Policy Research Working Paper 2434, World Bank.

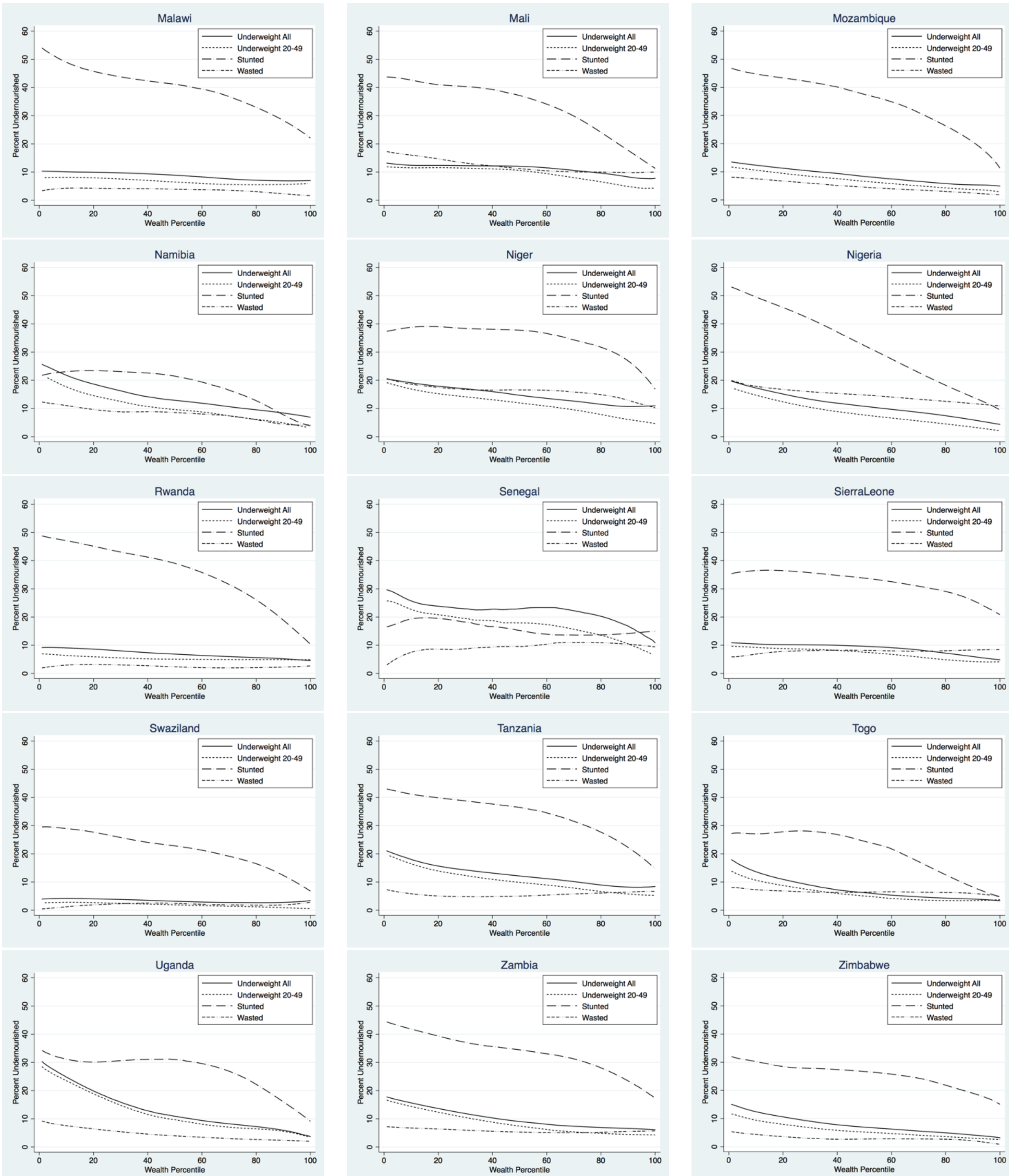
Walker, Susan, Theodore Wachs, Julie Gardner, Betsy Lozoff, Gail Wasserman, Ernesto Pollitt, and Julie Carter. 2007. "Child Development: Risk Factors for Adverse Outcomes in Developing Countries." *Lancet* 369 (9556): 145–57.

World Bank. 2012. *World Development Report 2012: Gender Equality and Development*. Washington, DC

Zere, Eyob, and Diane McIntyre. 2003. "Inequities in Under-five Child Malnutrition in South Africa." *International Journal for Equity in Health* 2 (1): 1.

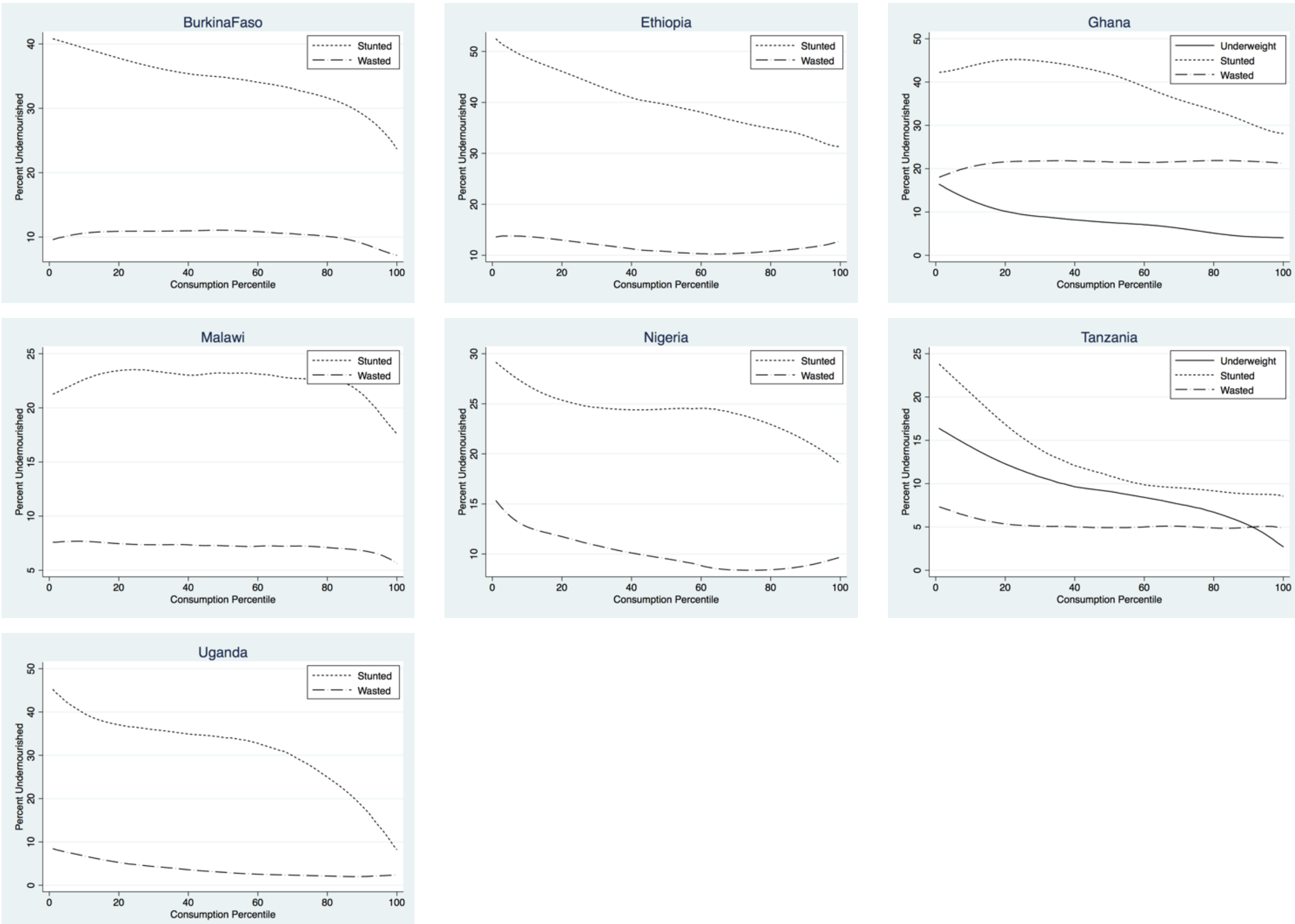
Figure 1: Nutritional outcomes and household wealth





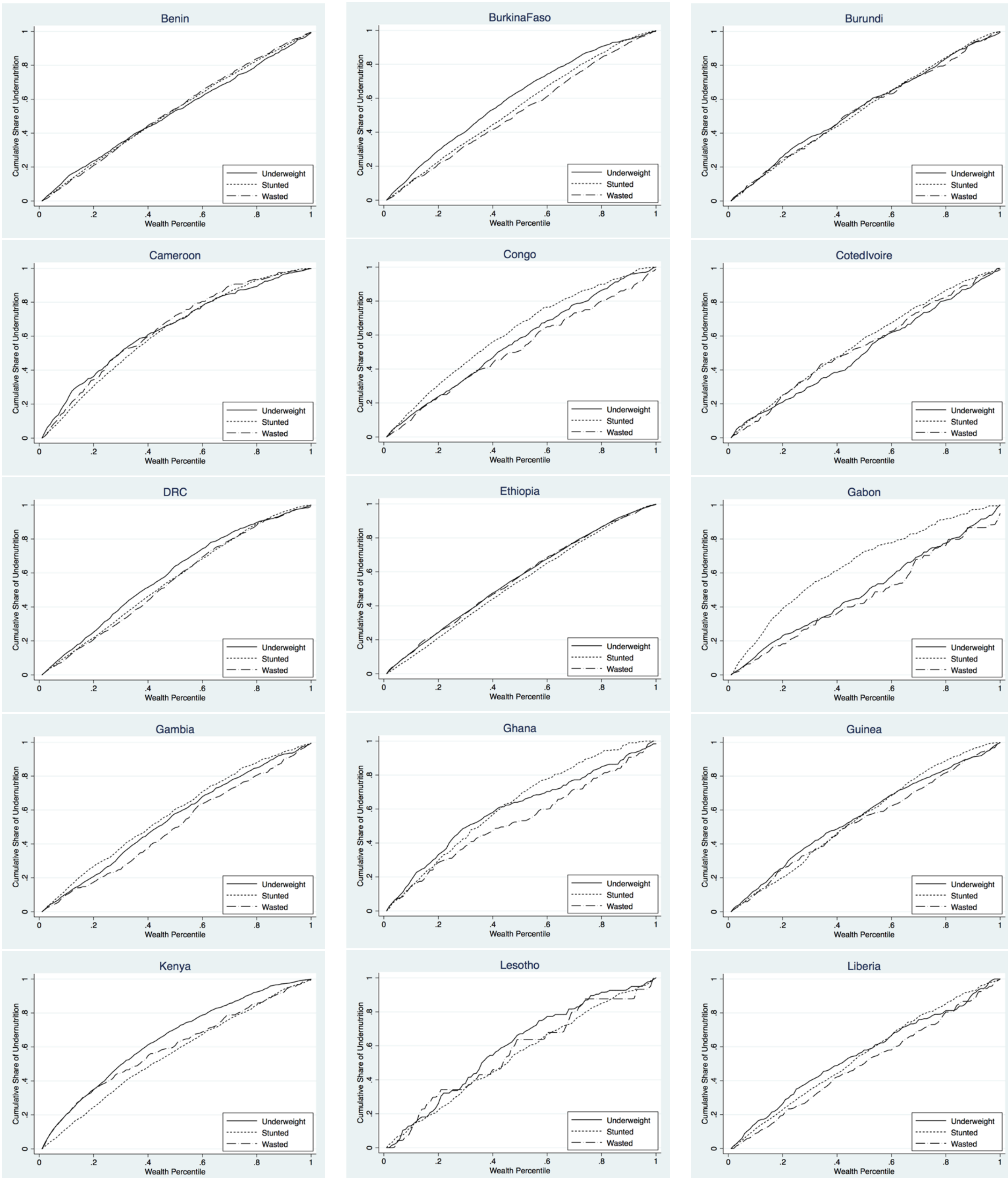
Note: The graphs show the proportion of women who are underweight and the proportion of children who are stunted and wasted at each wealth percentile. Data are drawn from DHS. Observations with missing values and pregnant women have been dropped. Women between 15 and 49 years of age are included in the construction of the solid line. Woman between 20 and 49 years of age are included in the construction of the dashed line. Children aged between 0 and 5 are included in the stunted and wasted lines. The household wealth index is used to construct the wealth percentiles. Wealth percentiles are constructed separately for women and children. A lowess regression is used to fit the lines.

Figure 2: Nutritional outcomes and household consumption



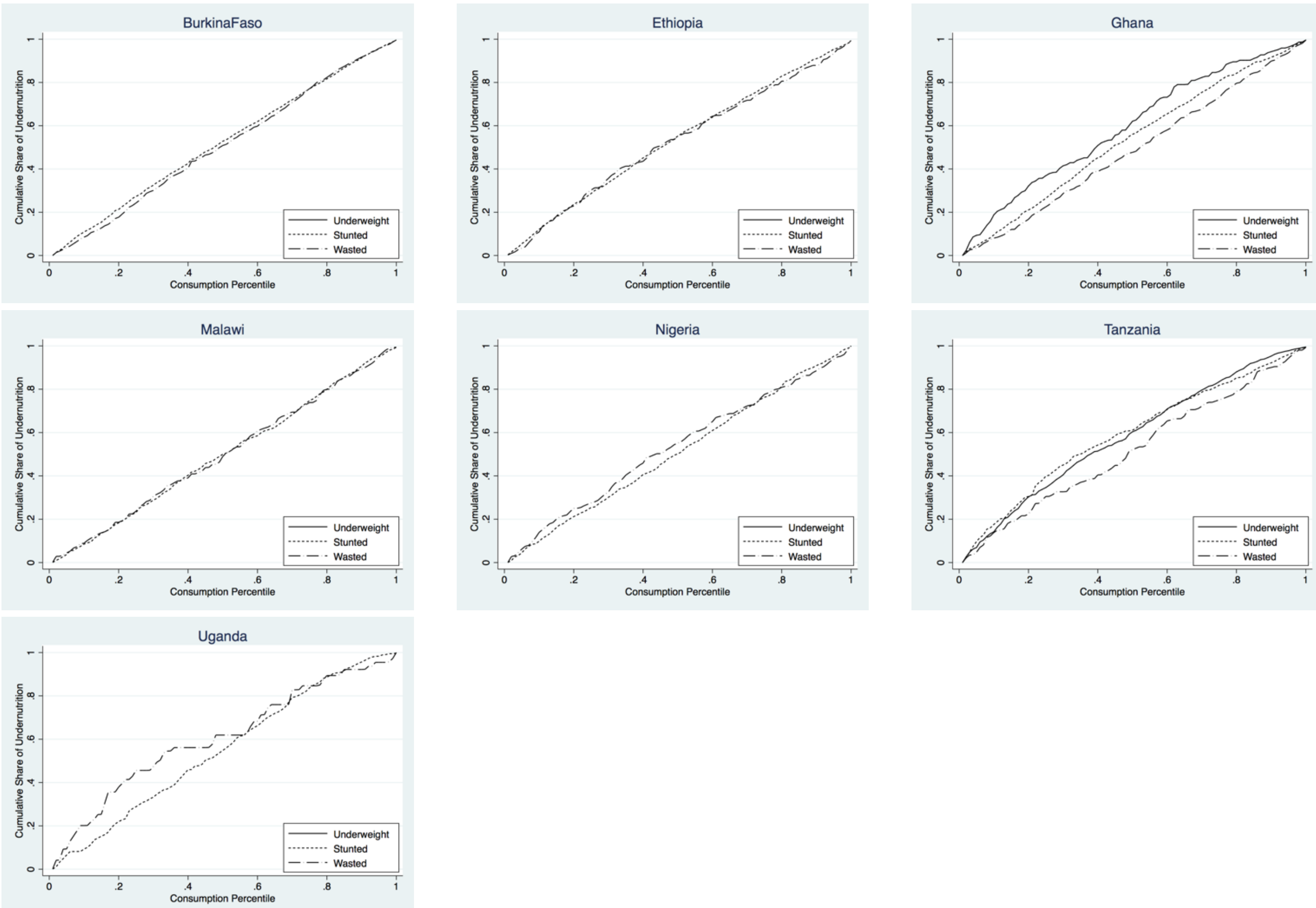
Note: The graphs show the proportion of women who are underweight, and children who are stunted and wasted at each wealth percentile. Data are drawn from LSMS surveys. Observations with missing values and pregnant women in Ghana have been dropped. Women between 15 and 49 years of age and children between 0 and 5 years of age are included in the sample. Household consumption, which is spatially deflated and in per capita terms, is used to construct the consumption percentiles. Consumption percentiles are constructed separately for women and children. A lowess regression is used to fit the lines.

Figure 3: Concentration curves for undernutrition and household wealth



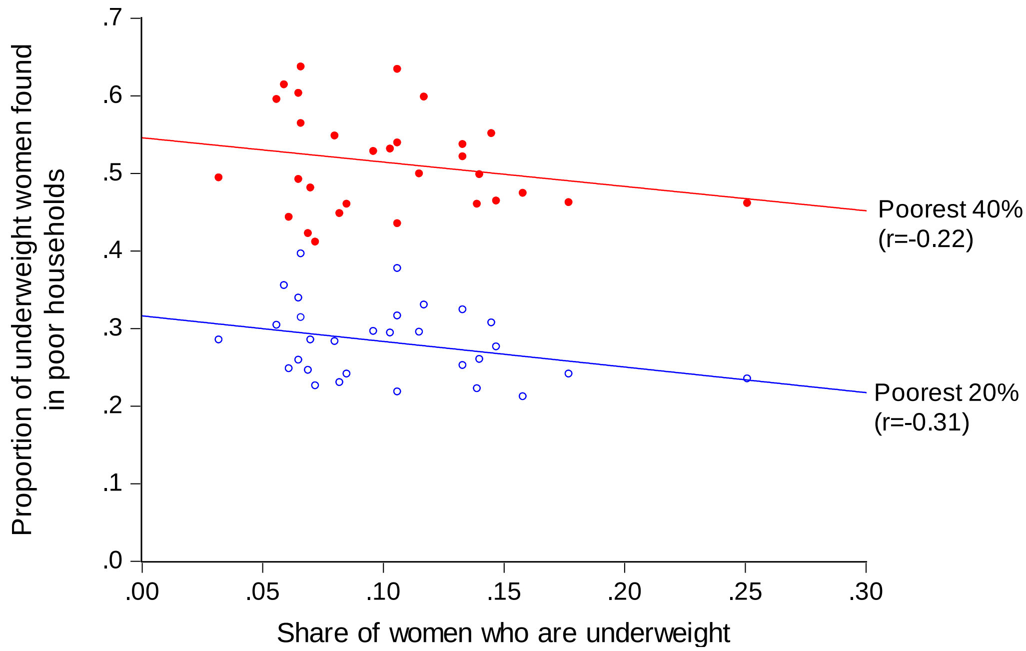
Note: The graphs show the concentration curves for cumulative proportion of women who are underweight, and children who are stunted and wasted at each wealth percentile. Data is drawn from the DHS. Observations with missing values and pregnant women have been dropped. Women between 15 and 49 years of age and children between 0 and 5 years of age are included in the sample. The household wealth index is used to construct the wealth percentiles. Wealth percentiles are constructed separately for women and children. The Stata command glcurve is used to construct the lines.

Figure 4: Concentration curves for undernutrition and household consumption



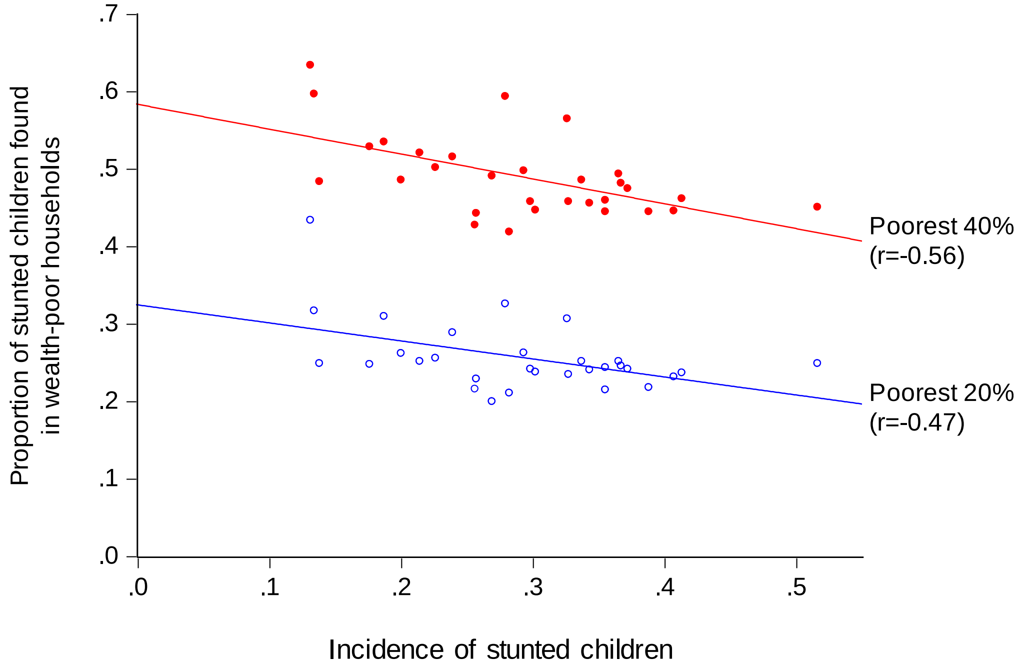
Note: The graphs show the concentration curves for cumulative proportion of women who are underweight, and children who are stunted and wasted at each consumption percentile. Data is drawn from the LSMS surveys. Observations with missing values have been dropped. Women between 15 and 49 years of age and children between 0 and 5 years of age are included in the sample. Household consumption is used to construct the consumption percentiles. Consumption percentiles are constructed separately for women and children. The Stata command glcurve is used to construct the lines.

Figure 5: Countries with fewer underweight women tend to have a higher proportion of those women in wealth-poor households



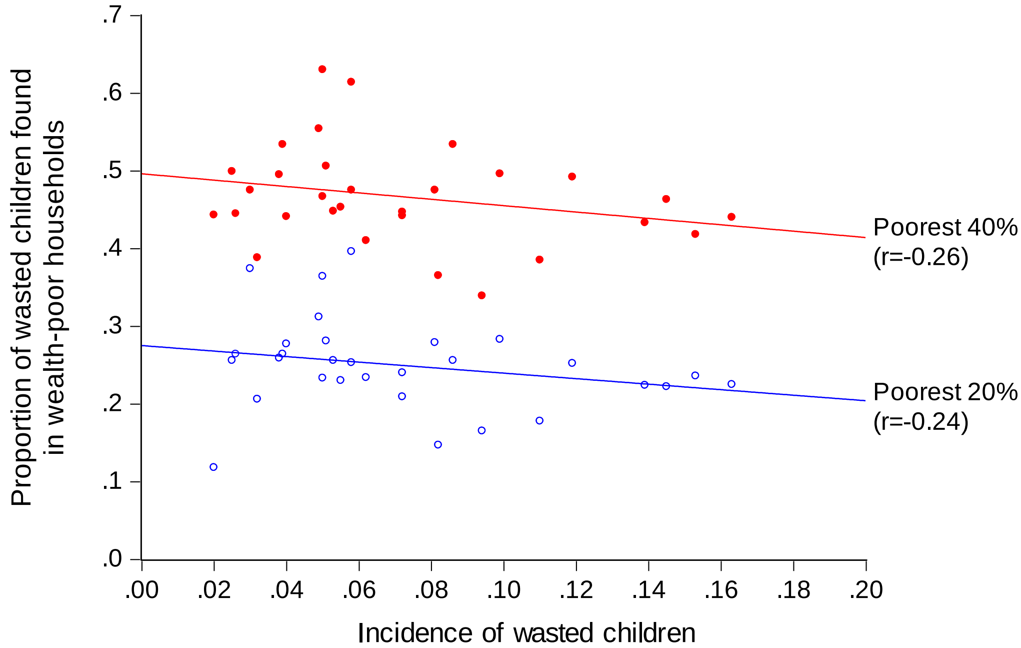
Note: The graph plots the joint probability of a woman being both underweight and in a poor household against the share of women who are underweight for each country. The actual values are given in Tables 2 and 8.

Figure 6: Countries with fewer stunted children tend to have a higher proportion of those children in wealth-poor households



Note: The graph plots the joint probability of a child being both stunted and in a poor household against the share of children who are stunted for each country. The actual values are given in Tables 2 and 8.

Figure 7: Countries with fewer wasted children tend to have a higher proportion of those children in wealth-poor households



Note: The graph plots the joint probability of a child being both wasted and in a poor household against the share of children who are wasted for each country. The actual values are given in Tables 2 and 8.

Table 1: List of countries and survey years

	Demographic and Health Surveys			Consumption surveys with anthropometric data		
		Observations in DHS			Observations in the survey	
Country	Year	Women	Children	Year	Women	Children
Benin	2011	13,626	7,193			
Burkina Faso	2010	7,218	6,223	2014	n.a.	9,134
Burundi	2010	3,751	3,190			
Cameroon	2011	6,431	4,585			
Congo	2011	4,543	4,127			
Cote D'Ivoire	2011	3,950	2,967			
DRC	2013	7,872	7,791			
Ethiopia	2011	13,830	9,144	2013/14	n.a.	2,731
Gabon	2012	4,195	3,043			
Gambia	2013	3,843	2,828			
Ghana	2014	4,153	2,589	2009	2,165	1,968
Guinea	2012	3,996	2,969			
Kenya	2008	7,286	4,852			
Lesotho	2009	1,895	731			
Liberia	2013	4,015	3,075			
Malawi	2010	6,409	4,283	2013/14	n.a.	2,400
Mali	2012	4,402	4,134			
Mozambique	2011	11,186	8,622			
Namibia	2013	3,393	1,649			
Niger	2012	3,896	4,285			
Nigeria	2013	30,900	22,499	2012/13	n.a.	2,742
Rwanda	2010	5,491	3,507			
Senegal	2010	2,188	1,139			
Sierra Leone	2013	7,023	3,938			
Swaziland	2006	4,190	1,883			
Tanzania	2010	8,528	6,402	2012/13	6,170	3,633
Togo	2013	4,153	3,023			
Uganda	2011	2,297	1,987	2011/12	n.a.	1,494
Zambia	2013	13,872	10,769			
Zimbabwe	2010	7,382	4,071			
Total	2011	205,914	147,498		8,335	24,102

Note: Observations with missing values and for pregnant women have been dropped. Women between 15 and 49 years of age and children between 0 and 5 years of age are included. The LSMS surveys used are Burkina Faso's 2014 Multisector Survey; the 2013-14 Ethiopian Rural Socioeconomic Survey; Ghana's 2009 Socioeconomic Panel Survey; Malawi's 2013-14 Third Integrated Household Survey; Nigeria's 2012-13 General Household Survey; Tanzania's 2012-13 National Panel Survey and Uganda's 2011-12 National Panel Survey. It is not possible to determine whether a woman is pregnant at the time of measurement in the Tanzania survey.

Table 2: Summary statistics for nutritional indicators using DHS

	Underweight women	Stunted children	Wasted children
Benin	0.064	0.407	0.144
Burkina Faso	0.154	0.298	0.139
Burundi	0.160	0.516	0.051
Cameroon	0.068	0.279	0.050
Congo	0.144	0.187	0.051
Cote D'Ivoire	0.078	0.238	0.071
DRC	0.144	0.366	0.072
Ethiopia	0.266	0.388	0.086
Gabon	0.074	0.131	0.032
Gambia	0.167	0.200	0.110
Ghana	0.061	0.134	0.053
Guinea	0.122	0.269	0.099
Kenya	0.122	0.293	0.058
Lesotho	0.058	0.302	0.030
Liberia	0.073	0.257	0.058
Malawi	0.087	0.413	0.038
Mali	0.114	0.337	0.119
Mozambique	0.086	0.371	0.049
Namibia	0.140	0.176	0.081
Niger	0.154	0.355	0.153
Nigeria	0.111	0.326	0.163
Rwanda	0.070	0.365	0.025
Senegal	0.222	0.159	0.090
Sierra Leone	0.090	0.327	0.082
Swaziland	0.033	0.226	0.020
Tanzania	0.113	0.355	0.040
Togo	0.070	0.214	0.062
Uganda	0.117	0.281	0.039
Zambia	0.102	0.343	0.055
Zimbabwe	0.070	0.256	0.028
Mean	0.114	0.321	0.086

Note: Observations with missing values and pregnant women are dropped. Means are population weighted. Women between 15 and 49 years of age and children between 0 and 5 years of age are included. A woman is underweight if she has a BMI less than or equal to 18.5. A child is stunted if she is two standard deviations below median height-for-age and wasted if she is two standard deviations below median weight-for-height. GDP and literacy are taken from the World Bank's World Development Indicators. Literacy rate for 2011 or closest available year to 2011 in 2007-15; more recent year for ties.

Table 3: Summary statistics for nutritional indicators using LSMS

	Underweight women	Stunted children	Wasted children
Burkina Faso	n.a.	0.342	0.110
Ethiopia	n.a.	0.406	0.121
Ghana	0.081	0.385	0.202
Malawi	n.a.	0.260	0.079
Nigeria	n.a.	0.234	0.106
Tanzania	0.095	0.120	0.048
Uganda	n.a.	0.280	0.036
Mean	n.a.	0.288	0.093

Note: Data are drawn from LSMS surveys. Observations with missing values have been dropped. Means are population weighted. Women between 15 and 49 years of age and children between 0 and 5 years of age are included in the sample. A woman is underweight if she has a BMI less than or equal to 18.5. A child is stunted if she is two standard deviations below median height-for-age and wasted if she is two standard deviations below median weight-for-height.

Table 4: Summary statistics on selected other indicators

	GDP per capita, 2011, $PPP/year	Poverty		Female literacy rate	Access to improved water (%)	Access to improved sanitation (%)
		Poverty rate (%)	Year for poverty rate			
Benin	1762	53.1	2011	0.184	75.3	17.8
Burkina Faso	1470	55.3	2009	0.216	80.0	18.0
Burundi	713	77.7	2006	0.846	75.0	47.2
Cameroon	2614	29.3	2007	0.648	73.1	44.9
Congo	5632	28.7	2011	0.729	51.1	27.2
Cote D'Ivoire	2547	29.0	2008	0.305	74.8	14.4
DRC	617	773	2012	0.629	80.9	21.3
Ethiopia	1165	33.5	2010	0.289	49.7	23.0
Gabon	17101	8.0	2005	0.799	91.6	41.2
Gambia	1532	45.3	2003	0.446	89.5	58.8
Ghana	3431	25.3	2005	0.653	84.3	14.0
Guinea	1184	35.3	2012	0.122	73.8	18.4
Kenya	2623	33.6	2005	0.669	60.8	29.4
Lesotho	2297	59.7	2010	0.850	81.0	28.9
Liberia	733	68.6	2007	0.270	72.0	15.8
Malawi	1079	70.9	2010	0.513	82.9	39.2
Mali	1863	49.3	2009	0.246	68.9	22.9
Mozambique	952	68.7	2008	0.365	49.3	19.3
Namibia	8626	22.6	2009	0.784	88.0	32.7
Niger	807	50.3	2011	0.089	55.1	9.8
Nigeria	5231	53.5	2009	0.414	64.5	30.2
Rwanda	1397	60.3	2010	0.647	73.7	58.2
Senegal	2159	38.0	2011	0.404	75.6	45.6
Sierra Leone	1415	52.3	2011	0.350	58.5	12.7
Swaziland	7620	42.0	2009	0.824	72.3	57.0
Tanzania	2207	46.6	2011	0.744	55.3	13.6
Togo	1255	54.3	2011	0.480	60.5	11.5
Uganda	1649	33.2	2012	0.620	74.2	18.3
Zambia	3343	64.4	2010	0.518	62.2	43.0
Zimbabwe	1524	n.a.	n.a.	0.801	77.7	37.5
Mean	2806	42.7	2012	0.472	71.1	29.1

Note Poverty rates are for $1.90 per person per day at 2011 PPP; estimates from PovcalNet, accessed 8/18/2016. Mean poverty rate is for Sub-Saharan Africa as a whole. GDP, literacy, access to improved water and sanitation are all taken from the World Bank's World Development Indicators. Literacy rate for 2011 or closest available year to 2011 in 2007-15; more recent year for ties. Water and sanitation for 2011.

Table 5: Correlation matrix for nutritional and other indicators

	Under-weight women	Stunted children	Wasted children	GDP per capita	Poverty rate	Female literacy rate	Access to water	Access to sanitation
Underweight women	1.000	0.126	0.384	-0.208	-0.066	-0.232	-0.214	0.000
Stunted children	0.126	1.000	0.114	-0.540	0.712	-0.167	-0.331	-0.060
Wasted children	0.384	0.114	1.000	-0.215	0.047	-0.729	-0.071	-0.307
GDP per capita	-0.208	-0.540	-0.215	1.000	-0.613	0.462	0.326	0.291
Poverty rate	-0.066	0.712	0.047	-0.613	1.000	-0.147	-0.144	0.007
Female literacy rate	-0.232	-0.167	-0.729	0.462	-0.147	1.000	0.260	0.475
Access to water	-0.214	-0.331	-0.071	0.326	-0.144	0.260	1.000	0.377
Access to sanitation	0.000	-0.060	-0.307	0.291	0.007	0.475	0.377	1.000

Note: The critical value for prob.=0.05 is r=0.306.

Table 6: Incidence of undernutrition for countries with data on male BMI

	Underweight		Male head is underweight			Male head is not underweight		
	Men	Women	Underweight women	Stunted children	Wasted children	Underweight women	Stunted children	Wasted children
Ethiopia	0.371	0.266	0.301	0.392	0.122	0.249	0.355	0.066
			(0.300)	(0.291)	(0.408)	(0.700)	(0.709)	(0.592)
Ghana	0.104	0.061	0.171	0.183	0.083	0.050	0.126	0.056
			(0.146)	(0.069)	(0.070)	(0.854)	(0.931)	(0.930)
Lesotho	0.188	0.062	0.084	0.406	0.041	0.043	0.240	0.029
			(0.154)	(0.185)	(0.156)	(0.846)	(0.815)	(0.844)
Namibia	0.232	0.137	0.270	0.183	0.070	0.097	0.169	0.067
			(0.289)	(0.142)	(0.137)	(0.711)	(0.858)	(0.863)
Rwanda	0.158	0.073	0.116	0.375	0.053	0.057	0.360	0.016
			(0.166)	(0.092)	(0.246)	(0.834)	(0.908)	(0.754)
Senegal	0.275	0.216	0.278	0.184	0.088	0.219	0.181	0.062
			(0.184)	(0.145)	(0.190)	(0.816)	(0.855)	(0.810)
Sierra Leone	0.155	0.091	0.138	0.247	0.102	0.083	0.279	0.062
			(0.118)	(0.060)	(0.106)	(0.882)	(0.940)	(0.894)
Mean	0.240	0.159	0.259	0.358	0.108	0.141	0.296	0.053
			(0.256)	(0.196)	(0.291)	(0.744)	(0.804)	(0.709)

Note: The table shows the proportion of undernourished women and children in male headed households separated by the nutritional status of the household head. The figures in parentheses are the shares of those women or children who are undernourished found in each of the two groups of households according to whether the male head is underweight. Men and women are between 15 and 49 years of age. Male heads of household are also restricted to 15 and 49 years of age. Children are between 0 and 5 years of age.

Table 7: Regression coefficients of individual nutritional outcomes on the DHS household wealth index and household consumption per person

	DHS			LSMS		
	BMI	Height-for-age	Weight-for-height	BMI	Height-for-age	Weight-for-height
Benin	0.194***	0.189***	0.080***			
Burkina Faso	0.279***	0.281***	0.097***	n/a	0.377***	-0.016
Burundi	0.242***	0.505***	0.115***			
Cameroon	0.285***	0.451***	0.257***			
Congo	0.265***	0.292***	0.051**			
Cote D'Ivoire	0.203***	0.279***	0.043			
DRC	0.276***	0.378***	0.073***			
Ethiopia	0.352***	0.374***	0.229***	n/a	0.037	0.025
Gabon	0.182***	0.397***	0.056**			
Gambia	0.208***	0.297***	0.061**			
Ghana	0.385***	0.299***	0.070***	0.120***	0.178**	0.172
Guinea	0.284***	0.285***	0.023			
Kenya	0.331***	0.257***	0.210***			
Lesotho	0.263***	0.182***	0.091*			
Liberia	0.182***	0.183***	-0.024			
Malawi	0.197***	0.224***	0.072***	n/a	0.103**	0.004
Mali	0.025***	0.039***	0.002	n/a	0.044	0.006
Mozambique	0.344***	0.372***	0.156***			
Namibia	0.289***	0.323***	0.217***			
Niger	0.268***	0.254***	0.119***			
Nigeria	0.291***	0.566***	0.042***	n/a	0.450***	0.200***
Rwanda	0.211***	0.395***	0.026			
Senegal	0.157***	0.110***	-0.025			
Sierra Leone	0.189***	0.253***	0.027			
Swaziland	0.174***	0.305***	0.115***			
Tanzania	0.295***	0.303***	-0.022	0.213***	0.111**	0.036
Togo	0.323***	0.319***	0.073**			
Uganda	0.364***	0.278***	0.175***			
Zambia	0.284***	0.255***	0.070***			
Zimbabwe	0.311***	0.147***	0.151***			

Note: The table gives coefficients from a regression of standardized nutritional outcomes on the wealth index or standardized consumption per capita. Robust standard errors are used; * prob.<.10 ** prob.<.05 *** prob.<.01.

Table 8: Proportion of undernourished individuals who fall into the poorest 20% and 40% of the household wealth distribution

	Poorest 20% of households			Poorest 40% of households		
	Underweight women	Stunted children	Wasted children	Underweight women	Stunted children	Wasted children
Benin	0.248	0.233	0.223	0.444	0.446	0.464
Burkina Faso	0.307	0.242	0.224	0.551	0.458	0.433
Burundi	0.276	0.249	0.281	0.464	0.451	0.506
Cameroon	0.396	0.326	0.364	0.637	0.594	0.630
Congo	0.221	0.310	0.232	0.460	0.534	0.465
Cote D'Ivoire	0.226	0.289	0.240	0.414	0.516	0.447
DRC	0.252	0.247	0.209	0.521	0.482	0.442
Ethiopia	0.235	0.218	0.259	0.461	0.445	0.534
Gabon	0.246	0.434	0.206	0.422	0.634	0.388
Gambia	0.212	0.262	0.178	0.474	0.486	0.385
Ghana	0.355	0.317	0.256	0.614	0.597	0.448
Guinea	0.295	0.200	0.283	0.499	0.491	0.496
Kenya	0.329	0.262	0.396	0.599	0.497	0.614
Lesotho	0.304	0.238	0.374	0.595	0.447	0.475
Liberia	0.285	0.229	0.253	0.481	0.443	0.475
Malawi	0.230	0.237	0.259	0.448	0.462	0.495
Mali	0.218	0.252	0.252	0.434	0.486	0.492
Mozambique	0.283	0.242	0.312	0.548	0.476	0.554
Namibia	0.324	0.248	0.279	0.537	0.529	0.475
Niger	0.260	0.215	0.236	0.498	0.445	0.418
Nigeria	0.294	0.307	0.225	0.531	0.565	0.440
Rwanda	0.259	0.252	0.256	0.492	0.494	0.499
Senegal	0.241	0.249	0.165	0.462	0.484	0.339
Sierra Leone	0.241	0.235	0.147	0.460	0.458	0.365
Swaziland	0.285	0.256	0.118	0.494	0.502	0.443
Tanzania	0.316	0.243	0.277	0.539	0.459	0.441
Togo	0.339	0.252	0.234	0.607	0.521	0.410
Uganda	0.377	0.211	0.264	0.634	0.419	0.534
Zambia	0.296	0.241	0.230	0.528	0.456	0.454
Zimbabwe	0.315	0.219	0.260	0.564	0.430	0.433
Mean	0.275	0.255	0.240	0.508	0.487	0.461

Note: Data are drawn from DHSs. Means are population weighted. The table lists the proportion of underweight women, stunted children and wasted children who fall below the bottom 20th and 40th percentiles of the wealth index distribution. For example, 24.8 percent of underweight women fall below the bottom 20th percentile of wealth in Benin.

Table 9: Proportion of undernourished individuals who fall into the poorest 20% and 40% of the household consumption per capita distribution

	Poorest 20% of households			Poorest 40% of households		
	Underweight women	Stunted children	Wasted children	Underweight women	Stunted children	Wasted children
Burkina Faso		0.222	0.184		0.449	0.420
Ethiopia		0.250	0.230		0.463	0.465
Ghana	0.297	0.217	0.184	0.467	0.448	0.378
Malawi		0.184	0.182		0.414	0.419
Nigeria		0.222	0.275		0.424	0.526
Tanzania	0.322	0.319	0.284	0.529	0.565	0.442
Uganda		0.214	0.265		0.466	0.496
Mean	0.318	0.241	0.228	0.519	0.465	0.448

Note: Data are drawn from LSMS surveys. Means are population weighted. The table lists the proportion of underweight women, stunted children and wasted children who fall in the bottom 20th and 40th percentiles of the consumption per capita distribution.

Table 10: Joint probabilities of being undernourished and wealth poor

	Poorest 20% of Households			Poorest 40% of Households		
	Underweight women	Stunted children	Wasted children	Underweight women	Stunted children	Wasted children
Benin	0.016	0.095	0.032	0.028	0.181	0.067
Burkina Faso	0.047	0.072	0.031	0.085	0.136	0.060
Burundi	0.044	0.129	0.014	0.074	0.233	0.026
Cameroon	0.027	0.091	0.018	0.043	0.166	0.031
Congo	0.032	0.058	0.012	0.066	0.100	0.023
Cote D'Ivoire	0.018	0.069	0.017	0.032	0.123	0.032
DRC	0.036	0.090	0.015	0.075	0.177	0.032
Ethiopia	0.063	0.085	0.022	0.123	0.173	0.046
Gabon	0.018	0.057	0.007	0.031	0.083	0.012
Gambia	0.035	0.052	0.020	0.079	0.097	0.042
Ghana	0.022	0.042	0.014	0.038	0.080	0.024
Guinea	0.036	0.054	0.028	0.061	0.132	0.049
Kenya	0.040	0.077	0.023	0.073	0.146	0.035
Lesotho	0.018	0.072	0.011	0.034	0.135	0.014
Liberia	0.021	0.059	0.015	0.035	0.114	0.027
Malawi	0.020	0.098	0.010	0.039	0.191	0.019
Mali	0.025	0.085	0.030	0.049	0.164	0.058
Mozambique	0.024	0.090	0.015	0.047	0.177	0.027
Namibia	0.045	0.044	0.022	0.075	0.093	0.038
Niger	0.040	0.076	0.036	0.077	0.158	0.064
Nigeria	0.033	0.100	0.037	0.059	0.184	0.072
Rwanda	0.018	0.092	0.006	0.034	0.181	0.013
Senegal	0.053	0.040	0.015	0.102	0.077	0.031
Sierra Leone	0.022	0.077	0.012	0.041	0.150	0.030
Swaziland	0.009	0.058	0.002	0.016	0.114	0.009
Tanzania	0.036	0.086	0.011	0.061	0.163	0.018
Togo	0.024	0.054	0.014	0.042	0.111	0.025
Uganda	0.044	0.059	0.010	0.074	0.118	0.021
Zambia	0.030	0.083	0.013	0.054	0.157	0.025
Zimbabwe	0.022	0.056	0.007	0.040	0.110	0.012
Mean	0.031	0.082	0.021	0.058	0.156	0.040
Corre. coeff.	0.914	0.912	0.928	0.965	0.961	0.969
Elasticity of joint to marginal	0.888	0.765	0.953	0.950	0.824	0.947
	(0.057)	(0.096)	(0.109)	(0.045)	(0.045)	(0.033)

Note: Data are drawn from the DHS. Means are population weighted. The correlation coefficient is that between the joint probability and the relevant undernutrition rate from Table 7. Elasticities estimated by double-log regression. Robust standard errors in parentheses.

Table 11: Correlation coefficients for conditional probabilities

	Poorest 20% of Households			Poorest 40% of Households		
	Underweight women	Stunted children	Wasted children	Underweight women	Stunted children	Wasted children
Poorest 20%						
Underweight women	1.000	0.013	0.503	0.911	0.191	0.450
Stunted children	0.013	1.000	-0.039	-0.072	0.884	-0.103
Wasted children	0.503	-0.039	1.000	0.531	0.016	0.790
Poorest 40%						
Underweight women	0.911	-0.072	0.531	1.000	0.102	0.422
Stunted children	0.191	0.884	0.016	0.102	1.000	-0.025
Wasted children	0.450	-0.103	0.790	0.422	-0.025	1.000
Marginal probabilities						
Underweight women	-0.312	-0.236	-0.073	-0.222	-0.241	-0.036
Stunted children	-0.150	-0.467	0.226	-0.133	-0.561	0.367
Wasted children	-0.266	-0.160	-0.236	-0.237	-0.069	-0.255
Other indicators						
Wealth-index effect	0.640	0.390	0.469	0.713	0.439	0.640
GDP per capita	-0.013	0.766	-0.195	-0.165	0.674	-0.213
Poverty rate	-0.173	-0.525	-0.011	-0.049	-0.598	-0.001
Female literacy rate	0.311	0.417	0.199	0.302	0.335	0.145
Access to water	0.029	0.293	-0.106	-0.046	0.282	-0.214
Access to sanitation	-0.149	0.257	-0.143	-0.155	0.200	0.031

Note: The critical value for prob.=0.05 is r=0.306. The wealth-index effect is for BMI in the case of underweight women, while it is height-for-age and weight-for-height in the case of the conditional probabilities for stunting and wasting.

Table 12: Proportion of underweight women who fall into the bottom 20 and 40 percent of predicted values for all women

	Model 2		Model 3	
	Bottom 20%	Bottom 40%	Bottom 20%	Bottom 40%
Benin	0.271	0.482	0.369	0.620
Burkina Faso	0.351	0.597	0.368	0.610
Burundi	0.287	0.562	0.318	0.579
Cameroon	0.494	0.746	0.481	0.749
Congo	0.287	0.537	0.358	0.631
Cote D'Ivoire	0.254	0.459	0.346	0.569
DRC	0.389	0.654	0.416	0.669
Ethiopia	0.283	0.515	0.302	0.511
Gabon	0.228	0.513	0.433	0.755
Gambia	0.293	0.528	0.389	0.618
Ghana	0.374	0.624	0.447	0.673
Guinea	0.314	0.553	0.326	0.575
Kenya	0.363	0.629	0.389	0.654
Lesotho	0.408	0.601	0.484	0.639
Liberia	0.301	0.530	0.350	0.612
Malawi	0.302	0.514	0.378	0.572
Mali	0.274	0.490	0.314	0.541
Mozambique	0.303	0.565	0.365	0.591
Namibia	0.350	0.589	0.397	0.667
Niger	0.320	0.582	0.379	0.630
Nigeria	0.335	0.577	0.418	0.682
Rwanda	0.327	0.584	0.402	0.608
Senegal	0.307	0.537	0.376	0.629
Sierra Leone	0.280	0.510	0.333	0.577
Swaziland	0.354	0.588	0.451	0.759
Tanzania	0.346	0.587	0.360	0.601
Togo	0.399	0.652	0.388	0.645
Uganda	0.406	0.636	0.380	0.629
Zambia	0.325	0.549	0.331	0.573
Zimbabwe	0.343	0.585	0.432	0.635
Mean	0.322	0.562	0.369	0.611

Note: Data are drawn from DHSs. Means are population weighted. The table lists the proportion of underweight women who fall into the bottom 20^{th} and 40^{th} percentiles of predicted values from the regressions with log BMI as the dependent variable. For example, 27.1 percent of underweight women in Benin have predicted BMI values that fall into the bottom 20 percent of all predicted values for women.

Table 13: Proportion of undernourished children who fall into the bottom 20 and 40 percent of predicted values for all children

	Stunting				Wasting			
	Model 2		Model 3		Model 2		Model 3	
	Bottom 20%	Bottom 40%	Bottom 20%	Bottom 40%	Bottom 20%	Bottom 40%	Bottom 20%	Bottom 40%
Benin	0.267	0.496	0.288	0.515	0.278	0.486	0.280	0.512
Burkina Faso	0.268	0.504	0.310	0.583	0.331	0.564	0.402	0.661
Burundi	0.252	0.483	0.289	0.522	0.298	0.497	0.434	0.596
Cameroon	0.352	0.605	0.407	0.663	0.527	0.768	0.561	0.802
Congo	0.355	0.571	0.419	0.633	0.335	0.536	0.352	0.616
Cote D'Ivoire	0.340	0.608	0.401	0.639	0.239	0.460	0.342	0.549
DRC	0.303	0.543	0.346	0.603	0.320	0.563	0.314	0.566
Ethiopia	0.262	0.481	0.283	0.554	0.297	0.547	0.421	0.630
Gabon	0.416	0.713	0.431	0.635	0.294	0.575	0.303	0.504
Gambia	0.311	0.553	0.378	0.598	0.306	0.543	0.354	0.592
Ghana	0.374	0.646	0.453	0.706	0.203	0.484	0.443	0.679
Guinea	0.297	0.544	0.351	0.620	0.352	0.599	0.435	0.638
Kenya	0.274	0.520	0.324	0.588	0.448	0.641	0.419	0.628
Lesotho	0.355	0.586	0.379	0.668	0.645	0.812	0.634	0.655
Liberia	0.287	0.514	0.319	0.581	0.269	0.521	0.441	0.679
Malawi	0.253	0.478	0.283	0.526	0.291	0.541	0.284	0.526
Mali	0.283	0.514	0.313	0.588	0.289	0.495	0.351	0.574
Mozambique	0.286	0.498	0.301	0.537	0.352	0.558	0.442	0.626
Namibia	0.341	0.601	0.388	0.621	0.361	0.656	0.382	0.602
Niger	0.289	0.531	0.328	0.579	0.271	0.469	0.359	0.568
Nigeria	0.346	0.624	0.375	0.649	0.325	0.552	0.370	0.595
Rwanda	0.299	0.529	0.328	0.599	0.353	0.567	0.445	0.589
Senegal	0.392	0.593	0.474	0.689	0.401	0.637	0.273	0.599
Sierra Leone	0.250	0.471	0.264	0.511	0.218	0.492	0.278	0.545
Swaziland	0.337	0.556	0.387	0.646	0.370	0.594	0.362	0.636
Tanzania	0.274	0.517	0.327	0.581	0.383	0.645	0.415	0.566
Togo	0.361	0.607	0.390	0.650	0.338	0.575	0.445	0.641
Uganda	0.325	0.586	0.400	0.625	0.473	0.681	0.455	0.668
Zambia	0.254	0.477	0.291	0.536	0.337	0.555	0.342	0.537
Zimbabwe	0.276	0.486	0.321	0.579	0.355	0.525	0.389	0.546
Mean	0.294	0.533	0.329	0.584	0.320	0.548	0.372	0.595

Note: Data are drawn from DHSs. Means are population weighted. The table lists the proportion of stunted and wasted children who fall into the bottom 20th and 40th percentiles of predicted values from the regressions with height-for-age and weight-for-height respectively as the dependent variable. For example, 26.7 percent of stunted children in Benin have predicted values that fall into the bottom 20 percent of all predicted values for children in the Model (2) regression with height-for-age as the dependent variable.