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Unequal Households or Communities? Explaining Nutritional Inequality in South Asia

Caitlin Brown, Eeshani Kandpal, Jean Lee, and Anaise Williams

Abstract

Using DHS data for South Asia, we find that most undernourished individuals are not found in wealth-poor households. They are also not typically found in the same households: 40 percent of households have differing nutritional status among members, and 66 percent of undernourished individuals reside in households with members who are not undernourished. However, household-level factors such as wealth and infrastructure are also at play. Between-household and within-community inequality represents a relatively larger portion of total inequality in undernutrition; however, average community-level undernourishment is generally low. Given these heterogeneities, accurately reaching undernourished individuals through targeted policy is likely to be difficult. While simple categorical targeting metrics such as age or access to sanitation infrastructure does as well as household wealth-based targeting, all targeting methods considered yield large inclusion and exclusion errors, raising questions as to whether nutrition interventions should be targeted.

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KEYWORDS
Undernutrition, stunting, wasting, household wealth, intra-household inequality, targeting, Demographic and Health Surveys, South Asia

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Explaining Nutritional Inequality in South Asia

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1 Introduction

Poor people often have poor health and nutritional outcomes: most of the world's undernourished live in countries with high global poverty rates (FAO, 2021). Put simply, the lower the household income, the fewer the resources a household has available to them to achieve adequate nourishment, such as food and healthcare. Indeed, evidence of a positive relationship between household welfare and individual nutritional status has been well-documented (Behrman and Deolalikar, 1987; Ravallion, 1990, 1992; Pritchett and Summers, 1996; Headey, 2013). However, undernutrition is complex, and has been shown to arise for reasons additional to household wealth; for example, individual-level biological needs and disease exposure (Habicht and Pelletier, 1990) to geographic factors (Deaton, 2008) and even population history (Luke et al., 2023). At the same time, the existence of within-household inequalities in consumption and health suggests that there may be a weak relationship between household-level welfare and individual nutritional outcomes (Dercon and Krishnan, 2000; Sahn and Younger, 2009; Lise and Seitz, 2011; Dunbar et al., 2013; Roemling and Qaim, 2013; Bargain et al., 2014; Calvi, 2020; Penglase, 2021; De Vreyer and Lambert, 2021). An open question is then the extent to which we see intra-household inequality in nutritional outcomes, and what household- or community-level factors are associated with undernutrition in both adults and children. Understanding whether undernourished individuals live in the same or different households is key for the accurate targeting of nutrition policy, which often relies on proxies related to household or community welfare.

Our focus in this paper is South Asia[1], the most densely populated region in the world and home to almost two billion people, one-fourth of the world's population. The region has experienced rapid economic change over the past three decades, and poverty has fallen from a rate of 40% at the turn of the century to less than 15% in 2016.[2] Despite this, rates of undernourishment, particularly among children, remain stubbornly high (Jayachandran and Pande, 2012). South Asia has the second highest rates of stunting (31.7%) and the highest levels of child wasting (14.3%) (UNICEF/WHO/World Bank, 2020).[3] Two out of five of stunted children and more than half of all wasted children globally live in South Asia.

South Asia is a very heterogeneous region, as Table 1 demonstrates for the countries included in our study. India dominates in terms of population size and has a substantially higher average poverty rate relative to

[1]Our data span the region with the exception of Afghanistan and Bhutan

[2]Indicators are drawn from the World Bank's PovcalNet database, available here.

[3]South Asia is preceded by East Africa at 34.5% and followed by Sub-Saharan Africa at 31.5% for stunting. Child wasting is 6.7% in Sub-Saharan Africa.

the other countries. In contrast, the Maldives has almost zero poverty at the $1.90 per day international poverty line; Sri Lanka and Pakistan also have relatively low poverty rates at 0.9% and 4.0%, respectively. Nevertheless, even among these wealthier countries, around 10% of women are underweight, and child stunting ranges from 13% in the Maldives and Sri Lanka to 32% in Pakistan.

Table 1: National Indicators

	Year	Population (m)	GDP per capita	Gini index	Poverty ($1.90)	Poverty ($3.10)
Bangladesh	2016	158.0	1401.6	32.4	14.5	50.0
India	2012	1266.0	1729.3	35.7	22.5	59.5
Maldives	2016	0.5	9209.3	31.3	0.0	0.2
Nepal	2010	27.0	592.4	32.8	15.0	48.4
Pakistan	2016	203.6	1368.5	33.5	4.0	32.4
Sri Lanka	2016	21.2	3886.3	39.8	0.9	9.7

Note: Data come from the World Bank's Povcalnet database and the World Development Indicators.

Using nationally representative Demographic and Health Survey (DHS) data, we uncover several novel findings about the relationship between nutritional outcomes and welfare. For instance, consistent with previous literature, we find that most undernourished individuals do not reside in wealth poor households, and the relationship between wealth and undernutrition is weakest among the relatively richer countries in our sample. We then explore which community- and household-level factors predict poor nutritional status. While differences within households appear to stem from age and gender, which could be explained by biological factors, we also find evidence of first born and son preferences, particularly among the poorer countries. Female education and household-level infrastructure emerge as additionally important to wealth, lending further weight to the finding that wealth is not a sufficient indicator of nutritional status on its own. Between-household inequality is important and represents more than half of total inequality in nutritional outcomes for all adults. At the same time, most variation in nutritional status occurs within-communities, rather than between them.

Given a binding budget constraint that precludes universal coverage and missing information on individual-level outcomes, the question is whether targeting poor households will still reach a greater proportion of undernourished individuals than alternative targeting methods such as categorical or geographic targeting.[4] Looking at a range of targeting metrics, such as wealth and infrastructure, as well as different targeting levels (individual, household, and community), we compare targeting error rates. Simple cate-

[4]Here, geographical targeting refers to selecting geographic areas to receive a policy, where all residents within that area have access to the policy benefits. Coady et al. (2004) provide a general overview of targeting methods and their implementation.

gorical targeting based on age has lower error rates than household wealth. All other targeting methods considered, based on household or community infrastructure, perform no better than household wealth. However, all methods show large error rates: most undernourished individuals are excluded, and most of those included are not undernourised. This raises the question as to whether nutrition policies should be targeted in the first place.

This paper makes three main contributions. First,while the literature generally ascribes intra-household inequality in health or nutrition to inequality in resource allocations within the household, we show that variation in nutritional outcomes for adults and children between households and within communities is also important. Undernourished individuals are not concentrated in the same households, nor in the same communities. Substantially reducing undernutrition in the region may thus require broader community-level interventions in addition to more finely targeted household-level ones.

Second, an open question in the literature pertains to the identification of undernourished individuals for nutrition policy. The importance of reaching undernourished individuals is a significant policy concern: combating undernutrition in developing countries has been a key component of the Millennium Development Goals and features prominently in the Sustainable Development Goals (World Bank, 2008).[5] To reach the right individuals, policymakers must first understand whether undernourished individuals reside in the same households or whether they are spread across households (i.e., only some people in the household are undernourished). Household wealth-based targeting through a proxy means test has often been considered to be the gold standard (Ravallion, 2016; Del Ninno and Mills, 2015). However, the literature also points to errors of both inclusion and exclusion, with the latter particularly salient in the presence of the sort of inequality in outcomes that we show here (Cowell, 2000, 2011). Typically the alternatives to wealth-based targeting also use household-level measures of well-being, including consumption (Brown et al., 2021) or econometric targeting methods (Brown et al., 2018).

Third, we show that undernourished individuals— importantly, including a significant proportion of men— are found in households across the wealth distribution in South Asia: around 70% of undernourished adults and children *not* found in poorest 20% of households. While Brown et al. (2019) report a similar finding for Sub-Saharan Africa, they focus on women and children.[6] Further, we show that obe-

[5]Of children under age five globally, 21.3% were stunted and 6.9% were wasted in 2019 (UNICEF/WHO/World Bank, 2020).

[6]Brown et al. (2021) perform a similar exercise for Bangladesh using household consumption per-capita and find comparable results. Here, we use the DHS's wealth index as a proxy for household wealth; see Section 2 for further details.

sity, including among children, is more likely to be found in wealthier households than in poorer ones. These findings contrast with existing literature that suggests wealth accumulation drives reductions in undernutrition (e.g., Headey et al., 2015; Headey, 2013; Hong et al., 2006; Behrman and Deolalikar, 1987) and suggests that the dual burden of malnutrition is likely to be a serious problem for the region.

The rest of the paper proceeds as follows. Section 2 seeks to understand the relationships between household wealth and undernutrition, while Section 3 shows that undernourished individuals are not concentrated in a certain type of household and explores salient correlates of undernourishment. 4 shows that simple community-level targeting metrics can be as effective as household-level ones, at greater ease of implementation. Section 5 concludes.

2 Nutritional Outcomes and Household Wealth

The existing evidence regarding the relationship between household income on nutritional outcomes is mixed, and particularly so for South Asia. Well known is the *Asian enigma*: children in South Asia are shorter, on average, relative to children elsewhere, including those who are poorer, on average (Ramalingaswami et al., 1997; Nubé, 2009). Deaton and Drèze (2009), for example, find that per-capita caloric intake is declining in India despite rising incomes across the country. Globally, the income effects on nutritional outcomes have been found to be modest (and often close to zero), particularly in the short run (Behrman and Deolalikar, 1987; Haddad et al., 2003; Smith and Haddad, 2015). On the other hand, there is also a large literature that demonstrates evidence of a "wealth effect"; that is, the positive relationship between nutritional status and household welfare.[7] Here, we focus specifically on quantifying the relationship between undernutrition and household wealth.

2.1 Data

For nutritional indicators, we use anthropometric outcomes available in the DHS for children 5 years and under, women between 15 and 49 years of age, and for some countries, men between 15 and 49 years of age. We drop women who report being pregnant as well as those with missing values for height or

[7] See, e.g., Behrman and Deolalikar, 1987; Ravallion, 1990, 1992; Pritchett and Summers, 1996; Headey, 2013. For South Asia, Hong et al. (2006) find that children in the poorest 20% of households in Bangladesh are more than three times as likely to suffer from stunting as children from the top 20% of households. This echoes similar findings from Headey et al. (2015); Headey and Hoddinott (2015); Headey et al. (2016) that wealth accumulation, in addition to maternal education and sanitation, is one of the biggest drivers behind the reduction in undernutrition in South Asian countries.

weight.[8] For adults, we use body mass index (BMI) and construct an indicator variable equal to one if an adult is underweight, defined as someone with a BMI value of 18.5 or less. For children, we use two different measures which are standard in the literature; namely, height-for-age and weight-for-height z-scores, which reflect stunting and wasting respectively (defined as having a z-score of less than –2). Both measures are important in child development, and generally stem from different causes: stunting is often an indicator of longer-term chronic undernutrition and is associated with poor economic conditions, while wasting tends to reflect shorter-term deprivations, such as lack of food or illness that prevents nutritional absorption. While wasting responds more rapidly to change, stunting is often irreversible: children tend to gain weight quicker than they can grow tall, and age is continually increasing while height may not be (Reinhard and Wijeratne, 2000). As such, the prevalence of stunting increases with age, while wasting most often occurs between 12 and 24 months of age, when dietary deficiencies and diarrheal diseases are more common (WHO, 1986). Table A1 in the Appendix lists the number of women, men and children that we include in our sample, along with the survey year for each country.

Table 2 reports average values for the aforementioned nutritional outcomes. Across the region, 22% of women and 20% of men are underweight, 32% of children are stunted, and 19% are wasted. Boys and girls have generally similar rates stunting and wasting. Perhaps unsurprisingly, India has the highest rates of undernutrition among women, men, and children, with one-quarter of adults underweight and one-third of children stunted. However, even countries that have low extreme poverty rates (as measured by the $1.90 per day poverty line) experience non-negligible rates of undernutrition. For example, in the Maldives, where almost no one lives in extreme poverty, 15% of children are stunted and 9% are wasted. In Sri Lanka, which has a 1% extreme poverty rate, 13% and 14% of children are stunted and wasted, respectively.

While the DHS does not include any questions that can be used to directly measure household income, consumption, or a monetary measure of wealth (such as the value of the household's assets), it does provide a country-specific household wealth index that we use as a proxy. This wealth index is created by aggregating information on household assets (e.g., furniture, appliances) and living conditions (e.g., the type of construction material used in the dwelling, access to water and sanitation facilities) using principal components analysis (see Filmer and Pritchett, 2001; Shea, 2015 for further details). The index

[8]Around 5% of our sample is currently pregnant at the time of being surveyed. There is a question of whether to include lactating women; previous studies such as Brown et al. (2019) exclude them in their calculations. When we exclude lactating women, we find our results to be quantitatively similar. Given that 17% of our adult female sample is lactating, we chose to keep these women in our sample.

Table 2: Summary Statistics for Nutritional Indicators

	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.183	.	0.310	0.279	0.294	0.138	0.125	0.131
India	0.228	0.202	0.335	0.326	0.330	0.189	0.197	0.193
Maldives	0.106	0.141	0.107	0.127	0.117	0.073	0.093	0.083
Nepal	0.172	0.170	0.300	0.279	0.289	0.093	0.093	0.093
Pakistan	0.087	.	0.321	0.316	0.318	0.054	0.063	0.058
Sri Lanka	0.090	.	0.130	0.134	0.132	0.142	0.139	0.140
Total	0.221	0.198	0.325	0.316	0.320	0.182	0.189	0.186

Note: Data are drawn from the DHS. The table gives the average values of underweight in women and men between 15 and 49 years and stunting and wasting in children between 0 and 5 years. Underweight is defined as a BMI value of 18.5 or lower; stunting is a height-for-age z-score of –2 or lower; and wasting is a weight-for-height z-score of –2 or lower. Pregnant women and individuals without height or weight data have been dropped. Statistics are population weighted.

can then be used for ranking households, where higher values of the index indicate "richer" households within countries.

2.2 Undernutrition and Household Wealth

We begin by asking how undernourished individuals are distributed across the wealth distribution in South Asia; that is, do most undernourished individuals live in poor(er) households? We start by constructing concentration curves, which plot the cumulative share of household undernourishment indicators by cumulative household wealth percentile (Wagstaff, 2000; Wagstaff et al., 2014; Bredenkamp et al., 2014). The more concave the concentration curve, the higher the proportion of undernourished individuals who are found in wealth-poor households.

Figure 1 provides the curves plots for women, men, and children across the three nutritional outcomes that we consider. As expected, given that stunting is the result of longer term deprivations, there is more curvature for stunting relative to the incidence of underweight and wasting. However, it is clear that a substantial proportion of undernourished individuals are not in the lower end of the wealth distribution. There are also differences in curvature across countries. The Maldives, Nepal, and to a lesser extent, Sri Lanka, have much less curvature relative to the remaining countries. This suggests that the relationship between wealth and undernutrition may be much weaker in wealthier countries.

Table 3 looks at two specific points in the wealth distribution, the bottom 20% and 40%. We find that

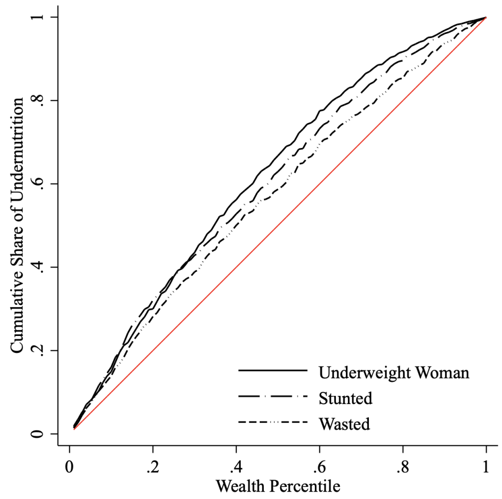
27% of undernourished women and 23% of undernourished men fall in the bottom 20% of the wealth distribution along with 34% of stunted children and 28% of wasted children. The poorest 40% of households have 53% of underweight women, 49% of underweight men, 60% of stunted children, and 51% of wasted children. In other words: most undernourished individuals in South Asia do not live in the poorest 40% of the household wealth distribution, and around 70% are not found in the poorest 20%. In line with the concentration curves, fewer underweight adults and stunted or wasted children are in the poorest households among the wealthier countries that we consider, such as the Maldives and Sri Lanka.

Looking instead at the probability of undernourishment among the poorest (being underweight conditional on being poor), 35% of women and 31% of men are underweight and 45% (22%) of children are stunted (wasted) across countires (see Table A2 in the Appendix for a break-down by country and by gender). Only a slightly lower proportion of individuals are undernourished in the bottom 40% of household wealth: 31%, 28%, 41% and 20% for underweight women, men, stunting and wasting respectively.

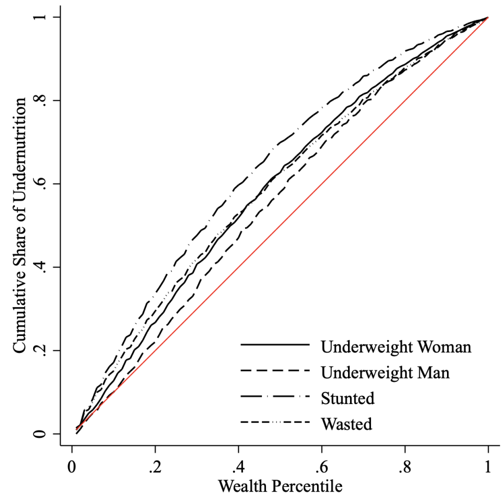
Even among the richest households, there are still a sizable proportion of undernourished individual. For example, around 10% of adults and 15% of children in the richest 10% of households are undernourished on average, and 11% of adults and 17% of children in the richest 20% (Table A3). As a direct comparison to the conditional probabilities in Table 3, Table A4 shows that around 4% of undernourished adults and children are in the wealthiest 10% of households. Child stunting is least common among the wealthy, though 4% of stunted children are found in the top 10% and 9% in the top 20%. Wealthier countries are no less likely to have undernourished individuals in households in the top wealth percentiles as poorer countries; in the Maldives, for example, almost 10% of underweight women are in hosueholds the top 10% of household wealth, and 6% (8%) of stunted (wasted) children.

Wealth of course is still a significant predictor of nutritional outcomes: regressing our nutritional outcomes on household wealth yields significant (negative) coefficients, at –0.330, –0.314, –0.035, and –0.131, for underweight women, underweight men, stunted children and wasted children, respectively.[9] As expected, we find the size of the wealth effect to be larger for poorer countries (Bangladesh, India, Nepal), relative to wealthier ones (Maldives, Pakistan, Sri Lanka), consistent with the curvature of the concentration curves for these countries. However, given the conditional probabilities in Table 3, household wealth on its own

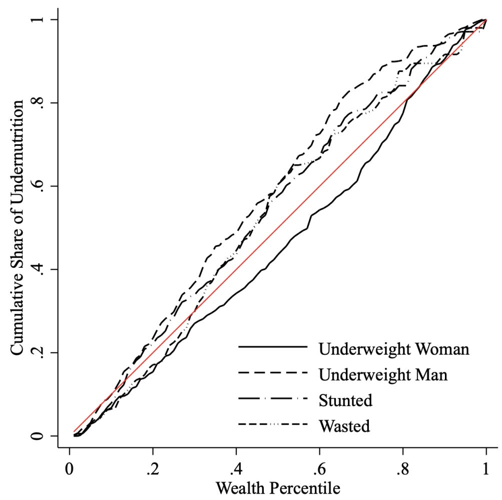
[9]More specifically, the regression is $y = \alpha + \beta W + \epsilon$ where W is the wealth index and y is the standardized continuous value of the nutritional outcome; i.e. BMI, height-for-age, and weight-for-height z-scores. We convert BMI to a z-score for comparability and include all countries in the regression. Table A5 in the Appendix has full results.



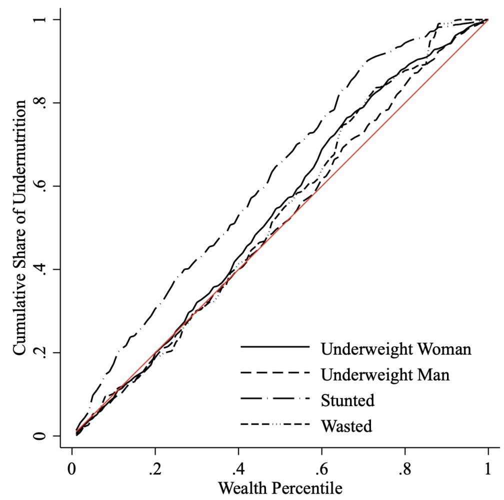
(a) Bangladesh



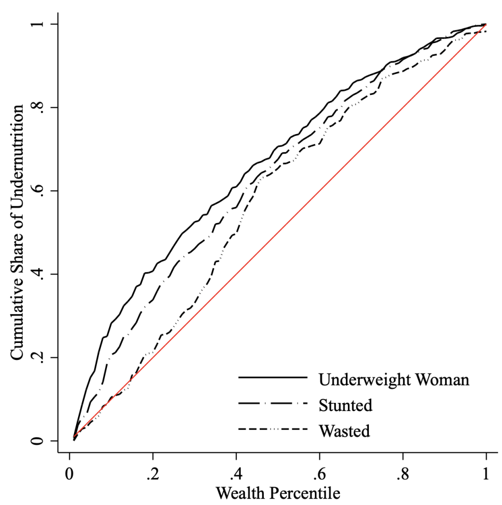
(b) India



(c) Maldives



(d) Nepal



(e) Pakistan

(f) Sri Lanka

Note: DHS data. The graphs show concentration curves for the cumulative proportion of women who are underweight and children ages 0–5 who are stunted and wasted at each household wealth percentile. Observations with missing values and pregnant or lactating women have been dropped. The Stata command `glcurve` is used to construct the curves. 45-degree line in red.

Figure 1: Undernutrition Concentration Curves

appears insufficient as a means of identifying those who are undernourished. We return to this point in Section 3.

Table 3: Proportion of Undernourished Individuals in Poorest 20% and 40% of Household Wealth

	Poorest 20% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.321	.	0.303	0.343	0.323	0.296	0.246	0.271
India	0.273	0.233	0.353	0.340	0.346	0.291	0.280	0.285
Maldives	0.154	0.230	0.226	0.243	0.235	0.189	0.151	0.167
Nepal	0.194	0.196	0.311	0.291	0.301	0.219	0.176	0.197
Pakistan	0.444	.	0.355	0.311	0.333	0.252	0.233	0.242
Sri Lanka	0.299	.	0.267	0.257	0.262	0.213	0.178	0.195
Total	0.273	0.232	0.350	0.338	0.343	0.288	0.275	0.282
	Poorest 40% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Boys	Girls	Overall
Bangladesh	0.572	.	0.505	0.552	0.528	0.460	0.504	0.482
India	0.530	0.488	0.615	0.592	0.603	0.526	0.508	0.517
Maldives	0.325	0.486	0.458	0.424	0.440	0.432	0.435	0.434
Nepal	0.427	0.413	0.545	0.489	0.517	0.464	0.392	0.426
Pakistan	0.649	.	0.604	0.567	0.585	0.534	0.499	0.515
Sri Lanka	0.560	.	0.505	0.512	0.509	0.460	0.411	0.435
Total	0.529	0.486	0.609	0.588	0.598	0.523	0.505	0.513

Note: Data are drawn from the DHS. The table gives the probability of being in the poorest 20% and 40% of the household wealth distribution conditional on being undernourished. Population weighting and sampling probability is used.

2.3 Robustness

There is of course the possibility that these findings may be driven by other factors; for example, measurement error in nutritional outcomes or age. Measurement error in height or weight will increase standard deviations, and therefore influence the number of individuals who are found to be malnourished in the data. While the DHS has invested substantially in improving the accuracy of anthropometric measurements, some surveys may still have sufficiently large error to warrant concern (see, e.g., (Assaf et al.,

2015) for an overview of the changes made).[10] Brown et al. (2019) and Brown et al. (2021) conduct a number of robustness checks, and we repeat and expand on many of them here; full details can be found in the Appendix. We do not find out results to differ significantly if we consider only severely undernourished individuals; that is, those with a BMI of less than 17, or a height-for-age or weight-for-height z-score of -3 or lower. Using these cut-off points, we find that 70% of women, 75% of men, and 65% of stunted children are outside the poorest 20% of households (Table A6). To address potential biases to miss-reporting in age, particularly problematic among very young children, we exclude those less than 18 months of age. Our estimates are very similar to our main results (Table A7).

Measurement error in the wealth index is another potential factor, which could result in a miss-ranking of households in terms of household wealth. However, similar findings to those in have also been obtained in previous work using household consumption data: Brown et al. (2019) use data from Living Standards and Measurement Surveys (LSMS) where nutritional outcomes are available, and find relatively similar conditional probabilities as compared to those using DHS data.[11] As a direct comparison here for Bangladesh, Brown et al. (2021) use the Bangladesh Integrated Household Survey (BIHS) from 2015 find similar results to ours when household consumption per-capita is used to rank households rather than household wealth, as in the DHS: around 60 percent of undernourished adults and children are found in the bottom half of the consumption distribution.

Lastly, we can verify whether nutrition-related illnesses show similar patterns to what we observe above. We construct concentration curves for whether the child has anemia and whether the child reports having a fever or diarrhea in the past two weeks. Figure A1 provides curves for each country (note, however, that not every country contains information for each variable), which, in line with the nutrition-based curves, are relatively flat. We also find a strong correlation between health outcomes for mothers and their children: Table A8 shows that underweight and anemic mothers are more likely to have stunted, wasted, or anemic children or have children who report having had diarrhea in the past two weeks (on the other hand, fever is not correlated with the child's mother's nutritional status and has a small negative

[10]Relative to, for example, National Nutritional Surveys (NNS), the DHS has a lower percentage of children with valid (i.e., not implausible or missing) data, higher means, and higher standard deviations of nutritional outcomes, particularly for height-for-age scores (Corsi et al., 2017). The proportion of valid data is 92% in DHS, as compared to 97% in National Nutritional Surveys (NNS). Grellety and Golden (2016) simulate the effect of random measurement error in height, weight and age, and found significantly higher standard deviations in the DHS as compared to the NNS. In related work, Ghosh et al. (2020) estimate substantial overdispersion due to measurement error in the DHS, likely yielding overestimates in the prevalence of undernutrition. However, South Asian surveys seems to fare reasonably well in this regard, yielding much lower rates of error than data from other regions (Perumal et al., 2020).

[11]The focus in Brown et al. (2019) is on sub-Saharan Africa and nutritional outcomes for women and children are available in several LSMS-ISA surveys, with comparable survey years to the DHS.

correlation with mothers who are found to be anemic).

2.4 Obesity and Household Wealth

While the general focus of this paper is undernutrition, the rising incidence of obesity among adults in Asia cannot be ignored (Yoon et al., 2006; Ramachandran and Snehalatha, 2010; Helble and Francisco, 2017). In line with WHO standards, we define an adult as obese if they have a BMI of 30 or greater, and a child as obese if his or her weight-for-height value is greater than 3 standard deviations above the WHO Child Growth Standards median.[12] Across South Asia, we find considerable heterogeneity in obesity rates, while less than 5% of adults are obese in Bangladesh, India, and Nepal, we find much higher numbers for the Maldives (19% of women and 8% of men), Pakistan (21% of women), and Sri Lanka (13% of women). On the other hand, child obesity appears to be much less prevalent: less than 1.5% of children in our sample are obese.[13] For the remainder of this section, we therefore concentrate on the relationship between adult obesity and household wealth.

A priori, the effect of household wealth on the incidence of obesity is unclear. On the one hand, the poorer the household, the more constrained they are in the quantity and quality of food they can consume, in addition to affording other necessary inputs (such as clean water and proper sanitation infrastructure) for good health.[14] On the other hand, existing work has found a positive relationship between obesity and household wealth, particularly for South Asia (Bishwajit, 2017; Al Kibria et al., 2019; Ahmad et al., 2020). There is also evidence of a double burden of malnutrition in South Asia (particularly among women), whereby high rates of undernutrition can co-exist with high rates of obesity (Anik et al., 2019; Kaku and Patil, 2020; Nguyen et al., 2021)

In Figure A2, we plot the incidence of obesity at each household wealth percentile by country. In contrast to our findings on undernutrition, we see a much higher incidence of obesity at higher wealth percentiles: in Pakistan, for example, around 5% of women are obese at the lowest household wealth percentiles, while the incidence is more than 30% for the highest percentiles. Countries with a relatively low incidence of obesity overall, such as Bangladesh and Nepal, tend to have even higher concentrations of obesity among

[12] More information on WHO growth standards can be found at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

[13] Indeed, low rates child obesity in South Asia have been documented elsewhere; see, for example Kaur et al. (2008); Jafar et al. (2008); Karki et al. (2019) and Bishwajit and Yaya (2020).

[14] A large literature shows that poorer households tend to consume lower quality calories, driven in part by the higher relative prices of "healthy" foods (Headey and Alderman, 2019). Hirvonen et al. (2020) find the cost of a standard healthy diet is not affordable for most of the world's poor; that is the cost of the reference diet exceeded household per-capita income for at least 1.58 billion people.

the top 40% of households. Table 4 lists the conditional probabilities for both the bottom and top ends of the distribution. Indeed, 45% of obese adults are found in the top 20% of the household wealth distribution (ranging from 26% for the Maldives to 60% for Nepal), while only 4% of obese adults are in the bottom 20% and 12% in the bottom 40%.

Table 4: Proportion of Obese Adults in the Poorest and Richest Ends of the Household Wealth Distribution

	Bottom 20%		Bottom 40%		Top 20%		Top 10%	
	Women	Men	Women	Men	Women	Men	Women	Men
Bangladesh	0.040	.	0.093	.	0.580	.	0.388	.
India	0.027	0.022	0.097	0.081	0.462	0.475	0.251	0.277
Maldives	0.142	0.138	0.328	0.304	0.258	0.154	0.124	0.104
Nepal	0.022	0.040	0.098	0.134	0.599	0.538	0.401	0.404
Pakistan	0.056	.	0.197	.	0.373	.	0.221	.
Sri Lanka	0.103	.	0.264	.	0.304	.	0.160	.
Total	0.036	0.032	0.117	0.101	0.447	0.450	0.245	0.266

Note: Data are drawn from the DHS. The table gives the conditional probabilities of being obese given that the individual lives in a household in the poorest 20% and 40% of the household wealth distribution and the top 20% and 10%. Population weighting and sampling probability is used.

3 Inequality in Nutritional Outcomes: Within versus Between Households

In the previous section, we found that around 70% of undernourished adults and children are not in the poorest 20% of households in the wealth distribution, and around 50% of undernourished individuals are not in the poorest 40%. We next ask: 1) Are undernourished individuals are in the same households, such that everyone in a household is or is not undernourished?, or 2) Are undernourished individuals in households where other members are not undernourished? Stated differently, do we see low or high levels of intra-household inequality with regard to nutritional outcomes? The answer to this question has direct implications for policy: with low intra-household inequality, the task is identifying what types of households have poor nutritional outcomes, given that household wealth or consumption appears not to be a sufficient indicator on its own. If intra-household inequality is substantial, targeting that relies on household-level indicators may have difficulty in reaching a majority of the undernourished, especially when coverage is relatively low.

3.1 Intra-household Inequality in Nutritional Status

There are good reasons to expect intra-household inequality in nutritional outcomes given the available evidence of consumption inequalities (Lise and Seitz, 2011; Dunbar et al., 2013; Bargain et al., 2014; Calvi, 2020; Penglase, 2021; De Vreyer and Lambert, 2021), and health inequalities (Dercon and Krishnan, 2000; Sahn and Younger, 2009; Roemling and Qaim, 2013) within households. Indeed, Table **??** shows that households with at least one undernourished man, woman, or child are significantly more likely to have other undernourished household members; however, the correlation coefficients are quite low.

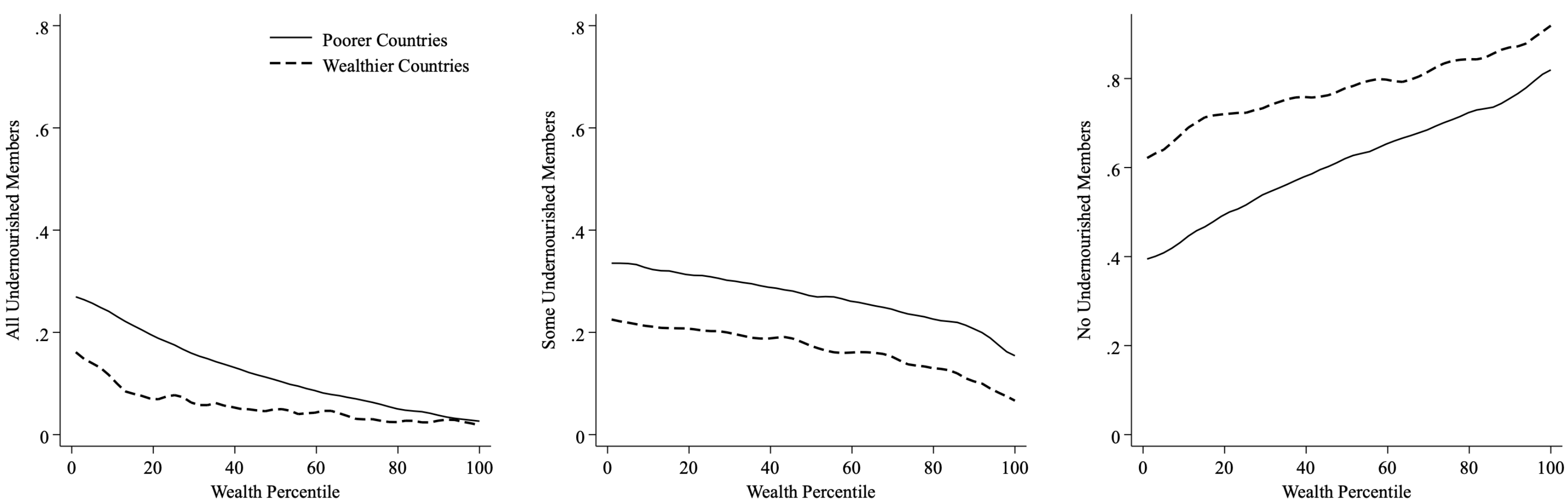
Using DHS data to examine the extent of intra-household inequality is complicated by the fact that we are limited in which household members we observe in our data, and as such, only members with anthropometric information are included in the definition of the households. In most cases, this is likely to be different to the actual number of household members. On average, we have 2 members per household with anthropometric information, compared to an average *de jure* household size of 5 people. A majority of the households surveyed have anthropometrics for 2 or more members (58%), and 54% of households have this information for 2 or more adults. However, only 20% of households have 2 or more children under 5 with anthropometric outcomes.

A second, and more broader, issue is that nutritional outcomes for adults and children are different, complicating within-household comparisons across all members. To address this, we create an indicator variable equal to one if an adult is underweight or if a child is either stunted or wasted and then calculate the average value of this variable for each household; that is, the proportion of household members who are undernourished. If everyone in the household is (or is not) undernourished, the mean undernourishment will equal one (or zero) and take a value between zero and one if there is any variation in nutritional status within the household.

Using this indicator, we find that 61% of households have no undernourished household members, and 12% of households have all members who are undernourished. The remaining 27% of households therefore have some intra-household inequality in nutritional status among the members that we observe. Richer countries see undernourished individuals concentrated in relatively fewer households: 77% of households in these countries have no undernourished members (6% have all undernourished members).

Overall, 34% of undernourished individuals are in households with no intra-household inequality (i.e., everyone is undernourished); the remaining 66% are in households with members who are not undernourished. In other words, two-thirds of undernourished individuals do not live in households with a common nutritional status among members, suggesting that intra-household inequality in nutritional outcomes is substantial. Intra-household inequality is higher in richer countries, with 74% of undernourished residing in households with members who are not undernourished. Relatively more underweight adults (40%) live in households where all members are undernourished than stunted (22%) or wasted (23%) children.

Earlier, we asked where in the wealth distribution undernourished individuals are found; we can ask a similar question here regarding households with and without intra-household inequality in nutritional status. Across countries, 66% of households with all undernourished members are found in the bottom 40% of the household wealth distribution (ranging from 58% in Pakistan to 67% in the Maldives), and 49% of households with some, but not all, undernourished members (44% in Bangladesh to 53% in the Maldives). Figure 2 plots the incidence of i) households where all members are undernourished, ii) households with intra-household inequality in undernourishment, and iii) households with no undernourished members by household wealth percentile. Given the heterogeneities we observed in Section 2, we consider wealthier and poorer countries separately (where Maldives, Pakistan, and Sri Lanka make up the set of wealthier countries).



(a) All members undernourished **(b)** Intra-household inequality **(c)** No members undernourished

Note: DHS data. The first figure shows the relationship between household wealth and households with all members undernourished, undernourishment is an indicator variable equal to one if an adult is underweight or a child is stunted or wasted and zero otherwise. The second figure is the relationship between household wealth and households with some, but not all, members who are undernourished. The third is household wealth and households with no members undernourished. Wealthier countries are the Maldives, Pakistan and Sri Lanka; poorer countries are Bangladesh, India, and Nepal. Lowess has been used to construct the plots.

Figure 2: Household Nutritional Status by Wealth Percentile

The wealth effect on nutrition is evident in all three graphs, with greater household wealth negatively associated with household undernourishment. Nonetheless, around 10% of households at the 60th wealth percentile have all undernourished members (graph (a)), and more than 40% of households in the poorer set of countries and at the bottom end of the distribution have no undernourished members (more than 60% in the wealthier countries, see graph (c)). Households with some, but not all, members undernourished are fairly evenly distributed by wealth, with somewhat of a decline at higher wealth percentiles (graph (b)). At the median, around 30% (20%) of household have some undernourished members among the poorer (richer) countries. For the poorest 40% of households, 19% have all undernourished members, 31% have intra-household inequality in nutritional status, and the remaining 50% have no undernourishd members.[15]

To look further into the extent of intra-household inequality in nutritional status, we decompose an overall measure of inequality into within and between household components. Here, we focus on mean log deviation (MLD), given that it is perfectly decomposable into subcompnents, unlike the Gini index.[16] Letting y in this setting represent nutritional outcomes for an individual i and taking the group j to be the household the MLD formula can be decomposed into between and within group inequality components equal to the following:[17]

$$\begin{aligned} MLD &= \ln \bar{y} - \frac{1}{n}\sum_{j=1}^{J}\sum_{i=1}^{n_j} \ln y_{ij} \\ &= \underbrace{\frac{1}{n}\sum_{j=1}^{J}\sum_{i=1}^{n_j} \ln\left(\frac{\bar{y}_j}{y_{ij}}\right)}_{\text{Within}} + \underbrace{\frac{1}{n}\sum_{j=1}^{J} n_j \ln\left(\frac{\bar{y}}{\bar{y}_j}\right)}_{\text{Between}} \end{aligned}$$

where J and n are the total number of groups and individuals, respectively, and each group j has a total of n_j members, and an average nutritional outcome of $\bar{y}_j$.

Given that MLD is undefined for zero values, we return our focus to the continuous nutritional outcomes. We decompose inequality in both adult BMI and child height-for-age and weight-for-height z-scores, which will allow us to infer the relative contribution of within (between) household inequality to overall in-

[15]For households with intra-household inequality in undernourishment, Figure A3 in the Appendix provides concentration curves by country with the distribution of these households. Figure A4 plots the equivalent for household with no undernourished members. In line with the wealth effect, the curves in Figure A3 fall above the 45-degree line (in red); the curves in Figure A4 fall below. However, what is evident is that in many countries, these households are distributed fairly evenly across the wealth distribution.

[16]MLD is from the class of generalized entropy measures, which take the form $GE(\theta) = \frac{1}{\theta(\theta-1)}\frac{1}{n}\sum_{i=1}^{n}\left[\left(\frac{y_i}{\bar{y}}\right)^{\theta} - 1\right]$ for $\theta \notin (0,1)$, where y_i is equal to the outcome for individual i who is part of a population with size n and $\bar{y}$ is the average outcome in the population considered. MLD is given by $\theta = 0$.

[17]See the Appendix in Brown et al., 2021 for the derivation.

equality among adults and children separately. For nutrition-related measures that are available for all individuals, we use height-for-age and weight-for-height z-scores. While these measures are not standard indicators for adults and not easily interpretable, they are useful to get a sense of the extent of inequality in nutrition-related outcomes. Similar to children, the z-scores for adults are calculated using a age- and country-specific reference population (see Nestel and Rutstein (2002) for details). Given that MLD is scale independent, we rescale all outcomes to be non-negative.

Table 5: Nutritional Inequality Decomposition

		Households		Communities	
	MLD	Between (%)	Within (%)	Between (%)	Within (%)
All height-for-age	0.011	56	44	10	90
All weight-for-height	0.008	60	40	13	87
Adult BMI	0.017	78	22	20	80
Child height-for-age z-scores	0.019	80	20	22	78
Child weight-for-height z-scores	0.012	81	19	24	76

Note: Data are drawn from the DHS. Between and within refer to decompositions of mean log deviation (MLD). BMI is measured for adults between 15 and 49 years. Men's BMI is only available for India, Maldives, and Nepal. Height-for-age and weight-for-height z-scores are for children five years and younger.

Table 5 lists the overall value for MLD as well as the relative contributions of the between and within household and community inequality to overall inequality. The decompositions reveal an interesting and consistent pattern: between-household inequality constitutes a relatively larger portion of overall inequality than within household inequality, while the converse is true for between and within community inequality. This holds for all outcomes that we consider here. Across all individuals we observe, intra-household inequality represents 44% of total inequality in height-for-age and 40% of total inequality in weight-for-height z-scores. Once we consider inequality among children or adults, the majority of variation occurs between households: within-household inequality accounts for just 20% of adult BMI and child height-for-age and weight-for-height z-scores.[18] Inequality within communities is roughly four times as large as inequality between communities.

3.2 Correlates of Nutritional Status Within Households and Communities

The above discussion suggests that elements within communities are likely important for nutritional outcomes, in addition to household-level factors. In this section, we aim to understand what variables are

[18]These findings are generally in line with Sahn and Younger (2009), who also find that intra-household inequality accounts for a large share of overall inequality in BMI, though they find between-household inequality to be relatively larger.

correlated with nutritional status within communities and within households? Household wealth is clearly important, yet only accounts for around 4% of total variation in undernutrition among adults and children. Other factors are clearly at play, given our findings from Section 2.

Starting with individual-level outcomes, available biological evidence shows that both age and gender likely play a role: Wells (2000), for example, show that female infants naturally have stronger vitality related to nutrition, growth, and resilience to environmental stress.[19] Given that height changes more slowly over time than weight, older children are less likely to be wasted but more likely to be stunted. Related to this is a firstborn height advantage due to, among other things, parental behavior (Price, 2008; Lehmann et al., 2018) and early maternal investments (Buckles and Kolka, 2014). While we exclude pregnant women from our sample, post-partum women will carry additional weight for some time, and so it may be less likely that they are underweight relative to men (particularly in our sample, which contains exclusively women of child-bearing age).

Household preferences for resource allocations are clearly relevant, and here specifically we consider the role of son preference and birth order, following a large literature demonstrating their importance for child outcomes (Das Gupta, 1987; Behrman, 1988; Behrman and Deolalikar, 1988; Das Gupta and Shuzhuo, 1999; Pande, 2003; Pande and Yazbeck, 2003; Oster, 2009; Willis et al., 2009; Jayachandran and Kuziemko, 2011; Jayachandran and Pande, 2017). These preferences may also be captured in part by the gender and education-level of the household head, as well as the education level of women within the household (Sahn and Alderman, 1997; Sahn and Stifel, 2002; Webb and Block, 2004; Milazzo and Van de Walle, 2017).

Water, sanitation and hygiene (WASH) facilities have been long emphasized as being critical for health outcomes (e.g., Luby et al. (2005); Rah et al. (2015); Torlesse et al. (2016) and Cameron et al. (2021).) We therefore include whether the household does anything to make the water safe and if the dwelling has an improved toilet.[20] Other covariates potentially related to health we consider are whether the dwelling has electricity, if there is a separate kitchen room (as a proxy for indoor air pollution), and number of

[19] This essentially yields higher rates of male infant mortality than female mortality, which is also called the Trivers-Willard theory. This theory states that natural selection necessarily means that females in poorer conditions produce lower ratios of males to females (Trivers and Willard, 1973). Excess male infant mortality has also been documented in Naeye et al. (1971); McMillen (1979); Garenne (2003), and Drevenstedt et al. (2008), among many others. In adulthood, the retention of postpartum weight may create gender differences in outcomes (Johnston, 1991; Olson et al., 2003).

[20] Following DHS standards, we define an improved toilet as (1) flush latrines (flushed to piped sewer systems or septic tanks), (2) ventilated pit latrines or those with a slab, or (3) compostable toilets. This definition is consistent with the recommendations for safe and sanitary toilets in World Health Organization's most recent Guidelines on Sanitation and Health. We choose not to include the household's water source (e.g. whether the water is from a piped source or well) as it is less clear if one water source is better than another.

household members per sleeping room (as a proxy for overcrowding).[21] For community-level covariates, we use community wealth, proportion of improved toilets, and prevalence of water treatment at the community-level, which we calculate by taking the leave-out mean of the household-level variables. We also include an indicator for whether the community is an in urban area.

To explore how these variables covary with undernutrition both within communities and within households, we apply community and household fixed effects respectively. Table 6 reports the results for adult undernutrition and child stunting; results for wasting can be found in Table A9 in the Appendix. Many of the covariates are highly significant, and continue to be for both within communities and, for the individual-level outcomes, within households. In contrast to our priors, we find women to be more likely to be underweight, and we see no significant association with gender among children. Age, on the other hand, does follow expectations: older adults are less likely to be underweight, while older children are more likely to be stunted. Among children, we do find indications of a first born preference, and in households with a son preference, those children are more likely to be stunted, potentially reflecting broader socio-cultural issues; however this variable becomes statistically insignificant in explaining within-household differences. Similar results are found for child wasting.

Turning next to household-level factors, adults with a female household head are more likely to have underweight adults, while individuals in households with educated heads are more likely to have better nutritional outcomes. Interestingly, in households where at least one woman has primary education or higher, children have better health outcomes (for both stunting and wasting), though the same cannot be said for adults, who (with community fixed effects) have worse outcomes. The household infrastructure variables go largely in the direction that we expect. Having a separate kitchen room for cooking does not appear to matter for adults, but it does for children, while the converse can be said for electricity.

The community-level variables show a less clear relationship here, and this may be due to the household- and individual-level covariates. Dropping these and focusing on solely community-level variables, both community wealth and the share of improved toilets in the community are significantly and positively associated with better nutritional outcomes, while we find the share of households who treat their water to matter far less (Table A13). Urban communities are associated with better outcomes for adults, but worse outcomes for children.

[21] Existing work has documented the role of indoor wood or charcoal cooking stoves in worsening outcomes for child health, particularly for respiratory health; see, e.g., Duflo et al. (2008); Pope et al. (2010); Kurata et al. (2020); Zhu et al. (2023), among many others.

Table 6: Predictors of Undernourishment Status Within Countries, Communities, and Households

	Underweight Adults			Stunted Children		
	(1)	(2)	(3)	(4)	(5)	(6)
Individual covariates						
Female	0.02***	0.02***	0.01***	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Age	-0.01***	-0.01***	-0.01***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
No education	0.03***	0.02***	0.02***			
	(0.00)	(0.00)	(0.00)			
First born				-0.03***	-0.03***	-0.06***
				(0.00)	(0.00)	(0.00)
Son preference				0.02***	0.01***	-0.01
				(0.00)	(0.00)	(0.01)
Household covariates						
Female head	0.01***	0.01***		-0.01*	-0.00	
	(0.00)	(0.00)		(0.00)	(0.00)	
Head has no education	0.01***	0.01***		0.03***	0.02***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Women with primary edu.	0.00	0.00***		-0.04***	-0.03***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Wealth index	-0.06***	-0.06***		-0.07***	-0.07***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Persons per room	0.00***	0.00***		0.01***	0.00***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Treats water	-0.00**	-0.00***		-0.01***	-0.01***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Improved toilet	-0.01***	-0.01***		-0.01***	-0.01***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Electricity	-0.01***	-0.01***		-0.00	-0.00	
	(0.00)	(0.00)		(0.00)	(0.00)	
Kitchen room	-0.00	-0.00		-0.01***	-0.01***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Community covariates						
Wealth	0.00**			-0.01**		
	(0.00)			(0.00)		
Treats water	0.01***			0.01		
	(0.00)			(0.01)		
Improved toilets	-0.02***			-0.00		
	(0.00)			(0.01)		
Urban area	-0.01***			0.02***		
	(0.00)			(0.00)		
Constant	0.47***	0.47***	0.48***	0.23***	0.24***	0.23***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)
Community FE	No	Yes	Yes	No	Yes	Yes
Household FE	No	No	Yes	No	No	Yes
R^2	0.096	0.161	0.710	0.073	0.227	0.791
N	768169	768176	790123	231416	231416	240721

Note: Data are drawn from the DHS. Regressions estimated using OLS. Age is measured in years for adults and months for children. Son preference is an indicator equal to one if the child's mother reports wanted more boys than girls. Women with primary education is an indicator equal to one if there is at least one woman in the household with primary education or higher. Person per room refer to the number of household members per sleeping room. Kitchen room is an indicator equal to one if the household cooks inside and has a separate room for cooking. Community-level variables are formed by taking the leave out-mean of the household-level term. Country-region fixed effects included in all regressions. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We can also compare how much variation in outcomes is explained by communities and households. For adults, 11% of the variation in the underweight indicator is explained by community-level fixed effects; for child outcomes, community-level factors account for 20%. Unsurprisingly, household-level fixed effects account for a much greater share of total variation, at 70% for adults and 80% for children. However, this is likely in part due to the fact that we observe in our data fewer members than the true household size.

Looking separately at wealthier and poorer countries reveals some interesting differences in what factors are associated with undernutrition. Women and adults in female-headed households have significantly worse nutritional outcomes in Bangladesh, India, and Nepal; however, for the Maldives, Pakistan and Sri Lanka, women are *less* likely to be underweight. The relationship between son preference and child nutritional outcomes is significant for the poorer countries but not for the richer ones. Here, son preference is associated with a higher likelihood of stunting and wasting within countries and communities, but a *lower* likelihood once household fixed effects are included.

Among the household-level covariates, as expected, the "wealth effect" on undernutrition is greater for poorer countries than for wealthier ones and whether or not the head has any education is more important for poorer countries. More surprisingly, the role household-level infrastructure seen in Table 6 on both adult and child outcomes is driven by the poorer countries: among richer countries, we find no significant relationship between these variables and nutritional outcomes. These results indicate that undernourished individuals have different individual- and household-level characteristics across countries, and these differences are likely to be a function of country-level welfare.

3.3 Undernutrition and the Community

While household- and individual-level factors are clearly important in explaining nutritional outcomes for both adults and children, the results from the previous section suggest that community-level outcomes are also relevant. Existing work has demonstrated the importance of community-level sanitation in determining health outcomes, particularly among children (Hammer and Spears, 2013, 2016; Augsburg and Rodríguez-Lesmes, 2018; Geruso and Spears, 2018). Using available geographic information on districts for India which can be merged with the data on nutritional outcomes, we can plot the geographic distribution of undernutrition (A5). We do see evidence of geographic concentration of undernutrition, where districts with a relatively high proportion of undernourished found more in the center and in the northeastern part of the country. Child stunting in particular is geographically concentrated around Uttar Pradesh and Bihar—33 out of the 50 districts we observe with stunting rates greater than 50% are found in these two states. Underweight women and child wasting are somewhat less concentrated (no district has more than 50% prevalence); nevertheless, three states (Gujarat, Jharkhand, and Rajasthan) contain more than half of all districts with more than 35% wasted, while these same states in addition to Madhya Pradesh host more than 65% of states with more than 35% of underweight women.

Other countries also exhibit concentrations of undernourished in certain communities. Across countries, only 8% of communities have no undernourished individuals, as we observe in our data (the highest is Sri Lanka at 13%, the lowest is the Maldives at 4%). At the other end, 29% of communities in Bangladesh and 40% of communities in India have a rate of undernutrition greater than 40%.

4 Targeting Undernourished Individuals: Community or Household?

In the previous section, we found that both household infrastructure in addition to household wealth is significantly associated with individual nutritional status. Individual-level characteristics such as age and gender are also found to play a role. Here, we ask how our findings above can inform the targeting of nutrition policy, which has known concerns with targeting (Ruel and Alderman, 2013).

Broadly, there are two related components to targeting. The first is the unit at which programs should be targeted, for example, whether a program should include individual-, household-, or community-level targeting (or some combination of these). Often this decision is driven by the type of program to be implemented; that is, whether it is a household- or community-level intervention. For example, conditional cash transfer schemes are targeted at the household level, while larger infrastructure programs such as clean water and sanitation initiatives tend to be at the community level.[22] Many nutrition policies are targeted using a hybrid of household and geographic targeting, where all individuals in a household or community are exposed to at least some components of the program.[23] Other nutrition interventions rely on categorical targeting, where every person fitting some criteria is eligible for a program.

[22] Such geographic targeting can be sensible in the presence of spatial poverty traps: as noted by Kraay and McKenzie (2014), in many low- and middle-income countries, a few regions or areas explain a disproportionate share of national poverty.

[23] Note that our use of the term community-level targeting is aligned with geographic targeting, where policymakers target based on geographic location. This differs from community-based targeting, where leaders in a community are tasked with allocating a program to households or individuals within the community.

The second component is the information available for targeting purposes. Since data on individual nutritional status are almost never available in large populations, correlated proxy variables are used; for example, household (or community) welfare, age, or gender. For example, programs like the Indian *Janani Suraksha Yojana* cash transfer that targets all pregnant women or school-feeding programs such as India's midday meal scheme. Conditional cash transfer schemes, such as Mexico's PROGRESA, are typically based on community and/or household income or consumption (Gertler, 2004).

In this section, we consider several different levels of targeting; specifically, individual-, household-, and community-level targeting. We look at a range of different variables for targeting at these levels. Starting with the household and community, we focus on (1) wealth, (2) an infrastructure index, comprised of the housing and sanitation variables in Table 6,[24] and (3) the share of households with an improved toilet in the village. Note that for the improved toilet indicator, we exclude both the Maldives and Sri Lanka, as these countries have almost universal usage of improved toilets; on the other hand, less than 60% of our sample for India live in a household with an improved toilet. Given it is a binary variable, we cannot create household-level percentiles, so for comparison purposes we include this variable as a targeting metric in itself at the household level (i.e., whether or not the household *does not* have an improved toilet). At the individual-level, we look at simple categorical targeting based on age (here, we choose adults 15 to 19 and children 3-5 years).[25] We also consider education, where for adults we use own education and for children we use mother education.

Our aim is to compare both the level of targeting as well as the variables used for targeting. We treat the wealth index variable as our benchmark (under the assumption that it "best" represents household welfare) and the remaining variables as a comparison. While wealth, in practice, will not be observable in large populations, our infrastructure variables serve a more practical purpose with potential policy-relevance; for example, whether or not a household has an improved toilet is straightforward to measure.

To measure targeting performance, we calculate inclusion and exclusion errors. In this context, inclusion errors refer to the proportion of those targeted who are not undernourished, and exclusions errors quantify the proportion of undernourished who are not targeted (Grosh, 1994; Del Ninno and Mills, 2015;

[24]More specifically, we include persons per room, whether or not the household treats its water source, whether or not the household has a toilet that is considered "improved", if the household has electricity, if the household cooks indoors and has a separate room for cooking. We aggregate these variables within countries at the household-level using principal components analysis. Given that Sri Lanka is missing both persons per room and kitchen room, we exclude it from our analysis.

[25]Our goal in this exercise is to best identify currently undernourished individuals, and these ages were chosen based on the results from Table 7 and to achieve a coverage rate around 20%. However, many nutrition programs are targeted towards younger children, with the goal of preventing undernourishment at older ages. As such, this exercise likely deviates from standard practices.

Brown et al., 2018) Generally, the broader the coverage (where coverage refers to the proportion targeted), the higher the inclusion errors and the lower the exclusion errors. We focus on the bottom 20% of households and communities (average undernourishment is 27%), and assume universal coverage within these groups; that is, if a household (community) is in the poorest 20%, then individuals within that household (community) are covered by the program.

Table 7 lists inclusion and exclusion errors for the two targeting levels and three metrics that we consider, as well as coverage rates and the proportion of the sample that we ideally would like to reach (i.e., the proportion undernourished). Coverage across the different targeting levels of course varies: the number of individuals in the bottom 20% of households is unlikely to be the same as the number in the bottom 20% of communities. Nevertheless, coverage across targeting levels and metrics generally hovers around our aim of 20%, with the exception of the household-level improved toilet indicator (which is simply the share of households without and improved toilet). Given the rates of undernourishment, with perfect targeting reaching 20% of the sample, we should only expect inclusion errors for the Maldives (which has an undernourishment rate of only 13%) and Sri Lanka (14%). For the remaining countries, our exclusion error rates will be greater than zero, as coverage should be lower than the proportion of undernourished.

Overall, we find high error rates across all metrics and both levels. Echoing our conditional probabilities in Section 2, 59% of those who are in the bottom 20% of household wealth are not undernourished, and 70% of those who are undernourished are not in the bottom 20% of household wealth. Looking instead at the poorest 20% of communities, we find slightly higher inclusion error rates, on average, but very similar exclusion errors. We do see heterogeneity across countries, though no country stands out as having noticeably lower inclusion and exclusion error rates.

Using household-level wealth as a comparison, household infrastructure, both at the household and community level, performs almost as well and in some cases better in terms of both inclusion and exclusion errors. At the household level, inclusion error rates slightly higher, at 0.61 on average, while exclusion error rates are lower (on average), at 0.68. We find very similar rates when comparing targeting based on community-level wealth to community-level sanitation. The share of improved toilets in a community, an arguably straightforward targeting metric, has commensurate error rates with the other targeting metrics, at 0.62 and 0.68 for the inclusion and exclusion errors respectively. Even more straightforward is the simple indicator as to whether the household has an improved toilet or not, and this too appears

Table 7: Inclusion and Exclusion Errors for Household- and Community-Level Targeting of Bottom 20%

		Targeting on Wealth					
		Household-level			Community-level		
	% Undernour	Coverage	Incl. Errors	Excl. Errors	Coverage	Incl. Errors	Excl. Errors
Bangladesh	0.247	0.200	0.614	0.687	0.199	0.651	0.719
India	0.278	0.197	0.580	0.702	0.210	0.605	0.701
Maldives	0.127	0.180	0.844	0.780	0.207	0.863	0.777
Nepal	0.210	0.186	0.728	0.759	0.194	0.747	0.766
Pakistan	0.220	0.199	0.618	0.655	0.229	0.620	0.539
Sri Lanka	0.144	0.205	0.782	0.690	0.207	0.797	0.709
Total	0.271	0.197	0.592	0.703	0.210	0.616	0.702
		Targeting on Household Infrastructure					
		Household-level			Community-level		
	% Undernour	Coverage	Incl. Errors	Excl. Errors	Coverage	Incl. Errors	Excl. Errors
Bangladesh	0.247	0.224	0.682	0.711	0.198	0.710	0.768
India	0.278	0.214	0.605	0.691	0.217	0.617	0.700
Maldives	0.127	0.159	0.872	0.836	0.219	0.870	0.775
Nepal	0.210	0.213	0.699	0.693	0.218	0.699	0.688
Pakistan	0.220	0.208	0.644	0.659	0.231	0.614	0.531
Total	0.271	0.213	0.612	0.677	0.217	0.623	0.685
		Targeting on Improved Toilets					
		Household-level			Community-level		
	% Undernour	Coverage	Incl. Errors	Excl. Errors	Coverage	Incl. Errors	Excl. Errors
Bangladesh	0.247	0.277	0.661	0.619	0.205	0.660	0.718
India	0.278	0.428	0.635	0.437	0.210	0.613	0.707
Nepal	0.210	0.133	0.649	0.778	0.223	0.694	0.675
Pakistan	0.220	0.138	0.622	0.762	0.223	0.660	0.657
Total	0.271	0.404	0.641	0.467	0.211	0.616	0.681

Note: Data are drawn from the DHS. % Undernour refers to the proportion of the sample that is undernourished. Incl. Errors refers to inclusion errors, defined as the proportion of those who are covered who are not undernourished. Excl. Errors refers to exclusion errors, defined as the proportion of those who are undernourished who are not covered. Undernourishment is an indicator variable equal to one if a man or woman is underweight or a child is stunted or wasted. Sanitation is the sanitation index as described in Section **??**. Improved toilets is an indicator variable equal to one if the household has an improved toilet and zero otherwise. At the household-level, we target households without an improved toilet. Community-level variables are calculated by taking the within-community household averages. For community-level improved toilets specifically, we take the proportion of households in the community with an improved toilet.

to perform well relative to more comprehensive metrics. Though coverage is higher for Bangladesh, for example, inclusion and exclusion error rates are lower than those for the household infrastructure index.

Table A14 provides targeting error rates for our categorical outcomes based on age and gender of the household head. Here, our error rates are surprisingly not too dissimilar from those using more comprehensive information. Overall, both inclusion and exclusion error rates are *lower* than when household wealth is used. Focusing specifically on Sri Lanka, whose coverage using age categories is 19%, inclusion (exclusion) error is 0.73 (0.65), both lower than those using household wealth. Education also performs reasonably well, though results in higher targeting errors than the other metrics.

Of course, it is difficult to compare the efficacy of different targeting metrics given differing rates of both country-level undernourishment and coverage. Using targeting errors as an outcome and regressing targeting type, we do not find error rates to differ significantly over the 8 different targeting methods considered. However, once we control for the coverage rate and incidence of undernourishment, we find that age-based targeting performs significantly *better* than household wealth-based targeting in terms of both inclusion and exclusion error rates (Table 8 provides the full regression results). Only targeting based on education performs significantly worse than household wealth (with high exclusion errors); all other targeting methods are not significantly different in their error rates from household wealth.

5 Conclusion

Wealth poverty is often assumed to underlie deficits in women's and children's nutritional status. Here, we show that most undernourished adults and children in South Asia do not live in wealth-poor households, building on findings by Brown et al. (2018). We next ask, if undernourished individuals are then not in poor households, in what households do they live? We find that they do not tend to live in households where all other members are undernourished; indeed, 40% of households in our sample have some intra-household inequality in nutritional status among the household members that we observe. Two-thirds of undernourished individuals do not live in households with a common nutritional status. At the same time, decomposing nutritional inequalities reveals more between-household variation than within-household variation. We also see substantially more variation in nutritional outcomes within communities relative to between communities.

Table 8: Targeting Error Rate Comparisons Across Targeting Methods

	(1) Inclusion Errors	(2) Exclusion Errors
Community wealth	0.01	0.01
	(0.01)	(0.02)
Household infrastructure	0.02	0.03
	(0.01)	(0.02)
Community infrastructure	0.02	0.02
	(0.01)	(0.02)
Improved toilet	-0.01	0.01
	(0.02)	(0.03)
Community share improved toilet	0.01	0.01
	(0.02)	(0.03)
Age	-0.04**	-0.07**
	(0.02)	(0.03)
Education	0.05**	0.05
	(0.02)	(0.03)
Coverage	0.12***	-1.16***
	(0.04)	(0.07)
Rate of undernourishment	-1.47***	-0.30*
	(0.09)	(0.15)
Constant	0.98***	1.00***
	(0.02)	(0.04)
R^2	0.859	0.840
Observations	62	62

Note: Inclusion and exclusion error rates are the outcome variables. Coefficients are relative to targeting based on household wealth. Data from Tables 7 and A14. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

There are of course many factors correlated with nutritional status, and here we consider several that have been highlighted in the literature. We focus on the role that these covariates play in explaining under-nutrition, using fixed effects to examine these relationships within communities and within households. Many of the variables go in the direction that we expect, and most individual-level covariates remain statistically significant even after including household fixed effects, further revealing that nutritional status within households varies depending on person-type. Quite interestingly, many of the key relationships are driven by the poorer countries, Bangladesh, India and Nepal. For example, the role of son preference and household-level infrastructure disappears for wealthier countries. Our findings thus highlight the importance of within-community inequality as an important, overlooked dimension of inequality in nutritional status, as well as important heterogeneities in the types of households and individuals that are undernourished across countries.

We conclude with a comparison of the effectiveness of targeting using household wealth versus community-level infrastructure. We find that targeting based on age does better in terms of both inclusion and exclusion errors than household-level wealth, and other targeting outcomes such as household or community sanitation or whether or not the household has an improved toilet do no worse. In other words, simple categorical variables like age or the proportion of improved toilets in the village provide inexpensive and effective alternatives to household wealth-based targeting. This is particularly true for the larger, more unequal South Asian countries of India, Pakistan, and Bangladesh.While a full cost-effectiveness analysis of targeting approaches is beyond the scope of this paper, data on a single, clearly defined proxy for sanitation infrastructure—the proportion of improved toilets—are likely less expensive to collect than the full set of household characteristics required for consumption- or wealth-based targeting or indeed the data needs of a proxy means test (Brown et al., 2018, 2021). In turn, updating such a measure is also likely less expensive than updating a household-level PMT database. Finally, because this measure relies on a single outcome, it is less likely to suffer from measurement error (Grosh and Baker, 1995). However, all targeting metrics lead to large errors of inclusion and exclusion, raising first-order questions about whether nutrition interventions should be targeted or more broadly provided.

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A Appendix: Additional Tables and Figures

A.1 Additional Figures and Tables for Section 2

Table A1: Sample Sizes and Survey Years

	Survey Year	Women	Children 0-5	Men
Bangladesh	2014	15,624	6,958	
India	2015/16	655,807	224,495	98,570
Maldives	2016/17	6,776	2,336	3,767
Nepal	2016	5,893	2,356	3,767
Pakistan	2017/18	4,554	4,077	
Sri Lanka	2016	16,840	7,663	
Total		685,512	247,885	106,104

Note: Data are drawn from the DHS. Pregnant women and individuals without height or weight data have been dropped.

Table A2: Proportion of Individuals in Bottom 20% and 40% of Household Wealth who are Undernourished

	Poorest 20% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.320		0.421	0.422	0.421	0.183	0.135	0.158
India	0.358	0.322	0.468	0.454	0.461	0.218	0.226	0.222
Maldives	0.114	0.182	0.144	0.171	0.159	0.082	0.078	0.080
Nepal	0.195	0.221	0.437	0.423	0.430	0.096	0.086	0.091
Pakistan	0.218		0.551	0.469	0.509	0.066	0.070	0.068
Sri Lanka	0.165		0.195	0.200	0.198	0.171	0.143	0.156
Total	0.348	0.313	0.460	0.446	0.453	0.212	0.218	0.215
	Poorest 40% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.283		0.380	0.376	0.378	0.154	0.154	0.154
India	0.324	0.290	0.428	0.415	0.422	0.206	0.215	0.211
Maldives	0.106	0.168	0.133	0.135	0.134	0.085	0.102	0.094
Nepal	0.203	0.217	0.369	0.346	0.358	0.098	0.093	0.095
Pakistan	0.152		0.457	0.440	0.448	0.068	0.077	0.072
Sri Lanka	0.140		0.172	0.183	0.178	0.172	0.152	0.162
Total	0.314	0.283	0.418	0.406	0.412	0.200	0.208	0.204

Note: Data are drawn from the DHS. The table gives the probability of being undernourished given that the individual is in the bottom 20% and 40% of households. Population weighting and sampling probability is used.

Table A3: Proportion of Individuals in Top 10% and 20% of Household Wealth Who Are Undernourished

	Richest 10% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.050		0.129	0.124	0.127	0.091	0.104	0.098
India	0.098	0.093	0.164	0.167	0.165	0.147	0.164	0.156
Maldives	0.089	0.122	0.075	0.091	0.083	0.084	0.088	0.086
Nepal	0.079	0.059	0.087	0.108	0.098	0.032	0.015	0.023
Pakistan	0.014		0.146	0.134	0.139	0.027	0.046	0.037
Sri Lanka	0.036		0.057	0.082	0.070	0.075	0.081	0.078
Total	0.095	0.092	0.156	0.160	0.158	0.138	0.154	0.147
	Richest 20% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.067		0.163	0.149	0.156	0.103	0.106	0.104
India	0.116	0.105	0.177	0.187	0.183	0.160	0.168	0.164
Maldives	0.091	0.123	0.078	0.136	0.106	0.059	0.064	0.062
Nepal	0.090	0.098	0.097	0.124	0.112	0.077	0.088	0.083
Pakistan	0.023		0.196	0.172	0.183	0.037	0.033	0.035
Sri Lanka	0.043		0.067	0.100	0.084	0.103	0.099	0.101
Total	0.112	0.105	0.171	0.181	0.176	0.151	0.159	0.155

Note: Data are drawn from the DHS. The table gives the probability of being in the richest 10% and 20% of the household wealth distribution conditional on being undernourished. Population weighting and sampling probability is used.

Table A4: Proportion of Undernourished Individuals in Top 10% and 20% of Household Wealth

	Richest 10% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.032		0.043	0.043	0.043	0.069	0.080	0.074
India	0.048	0.056	0.035	0.039	0.037	0.056	0.064	0.060
Maldives	0.092	0.052	0.058	0.058	0.058	0.096	0.075	0.084
Nepal	0.057	0.049	0.017	0.023	0.020	0.019	0.010	0.014
Pakistan	0.020		0.039	0.043	0.041	0.042	0.075	0.060
Sri Lanka	0.045		0.044	0.060	0.053	0.053	0.058	0.055
Total	0.048	0.056	0.035	0.040	0.037	0.056	0.064	0.060
	Richest 20% of Households							
	Underweight		Stunting			Wasting		
	Women	Men	Girls	Boys	Overall	Girls	Boys	Overall
Bangladesh	0.082		0.104	0.108	0.106	0.148	0.169	0.158
India	0.111	0.123	0.078	0.091	0.085	0.125	0.135	0.131
Maldives	0.204	0.101	0.130	0.175	0.155	0.146	0.113	0.127
Nepal	0.112	0.146	0.041	0.067	0.054	0.103	0.141	0.123
Pakistan	0.062		0.106	0.113	0.110	0.120	0.109	0.114
Sri Lanka	0.104		0.102	0.154	0.129	0.143	0.147	0.145
Total	0.111	0.123	0.080	0.093	0.086	0.126	0.136	0.131

Note: Data are drawn from the DHS. The table gives the probability of being in the richest 10% and 20% of the household wealth distribution conditional on being undernourished. Population weighting and sampling probability is used.

Table A5: Wealth Effect for Nutritional Outcomes

	Body Mass Index			
	Women	Men	Height-for-age	Weight-for-height
	(1)	(2)	(3)	(4)
All countries				
Wealth Index	0.329***	0.314***	0.350***	0.131***
	(280.89)	(103.03)	(110.04)	(54.12)
Poorer countries				
Wealth Index	0.334***	0.318***	0.349***	0.131***
	(280.25)	(103.33)	(105.81)	(52.46)
Wealthier countries				
Wealth Index	0.207***	0.146***	0.333***	0.097***
	(31.33)	(7.13)	(27.89)	(9.10)

Note: Data are drawn from the DHS. Poorer countries are Bangladesh, India, and Nepal. Wealthier countries are Maldives, Pakistan, and Sti Lanka. Standard errors are clustered at the community-level. *t*-statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A.2 Robustness Checks for Section 2: Measurement Error

In this section, we conduct several tests to check how robust our results are to measurement error. The first issue we address is in regard to the appropriateness of the cut-off point for undernourishment for South Asia. For children, the two generally accepted international measurements of undernourishment are based on height-for-age and weight-for-height z-scores, where the reference population is based on children from a wide variety of ethnic and socioeconomic backgrounds internationally (Waterlow, 1972; Waterlow et al., 1977; WHO, 1986).[26] For adults, generally no reference scales (such as z-scores) are used, and the BMI cut-off point of 18.5 is based on the level at which adults begin suffering from chronic energy deficiency (see, e.g., James et al., 1988; James and Francois, 1994; Kurpad et al., 2005). Nevertheless, for both children and adults, the cut-off points for being classified as undernourished (i.e., underweight, stunted, or wasted) are essentially arbitrary. In other words, a child or adult just above or below the cut-off point are likely to be similar in terms of both short and long-term health outcomes.[27] Furthermore, if measurement error is generating overdispersion for child z-scores, then the incidence of stunting and wasting will be higher than it should be; that is, children will have lower observed z-scores than their true value.

As such, we first consider conditional probabilities for severely undernourished individuals, where severe stunting is defined as three standard deviations below the median for height-for-age, and severe wasting is a z-score of –3 or lower for weight-for-height. For adults we use a BMI of 17 or lower. This should help address concerns that either individuals have lower (or higher) values of the health indices than they should due to miss-measurement in height or weight. Table A6 lists the conditional probabilities for severe undernourishment. As expected, the wealth effect is stronger, particularly for stunting, but a large proportion of severely undernourished individuals remain outside the bottom end of the wealth distribution: 75% of men, 70% of women and 65% of stunted children around outside the poorest 20% of households.

Misreporting in age is another key source of measurement error that could be biasing our findings. This could be particularly problematic for very young children, whose height is difficult to measure and even slight discrepancies in months of age can yield very different nutritional conclusions (Ulijaszek and Kerr,

[26]Habicht et al. (1974) find that ethnic differences in height and weight for nourished preschool children are relatively small; social background, on the other hand, matters substantially.

[27]More specifically, to our knowledge, there is no scientific literature that indicates that a z-score equal to 90% and 80% of the reference median of height-for-age and weight-for-height distributions physiologically implies undernourishment; rather, it seems to be a target for policy that encourages healthy childhood growth. Waterlow et al. (1977), among others, provide discussion on the topic.

Table A6: Proportion of Severely Undernourished Individuals in Poorest 20% and 40% of Household Wealth

	Poorest 20% of Households							
	Underweight		Stunting			Wasting		
	Men	Women	Boys	Girls	Overall	Boys	Girls	Overall
Bangladesh	.	0.34	0.39	0.34	0.37	0.27	0.29	0.28
India	0.25	0.29	0.40	0.42	0.41	0.30	0.31	0.30
Maldives	0.26	0.19	0.38	0.25	0.32	0.13	0.32	0.21
Nepal	0.19	0.20	0.37	0.35	0.36	0.31	0.28	0.30
Pakistan	.	0.45	0.39	0.48	0.43	0.25	0.24	0.25
Sri Lanka	.	0.39	0.30	0.36	0.33	0.23	0.35	0.28
Total	0.23	0.31	0.37	0.37	0.37	0.25	0.30	0.27
	Poorest 40% of Households							
	Underweight		Stunting			Wasting		
	Men	Women	Boys	Girl	Overall	Boys	Girls	Overall
Bangladesh	.	0.60	0.60	0.56	0.58	0.54	0.41	0.49
India	0.50	0.54	0.63	0.67	0.65	0.52	0.54	0.53
Maldives	0.47	0.36	0.65	0.45	0.56	0.49	0.39	0.44
Nepal	0.47	0.45	0.55	0.58	0.56	0.48	0.49	0.49
Pakistan	.	0.69	0.62	0.68	0.65	0.64	0.62	0.63
Sri Lanka	.	0.63	0.54	0.62	0.57	0.52	0.57	0.54
Total	0.48	0.54	0.60	0.59	0.60	0.53	0.50	0.52

Note: All data are drawn from the DHS. The table gives the conditional probabilities of being severely undernourished given that the individual lives in a household in the poorest 20% and 40% of the household wealth distribution. Severe undernourishment is defined as 3 standard deviations below median for height-for-age or weight-for-height scores for children or with a BMI less than 17 for adults. Population weighting and sampling probability is used.

1999; Larsen et al., 2019; Agarwal et al., 2017; Bilukha et al., 2020). Relatedly, teenagers are still experiencing growth and may have more varied outcomes relative to older adults. Given the difficulties associated with accurate measurement of these groups, we redo our conditional probabilities excluding children less than 18 months of age and adults less than 18 years of age (Table A7). We do not find this to substantially alter our main findings (70% of men, 70% of women and 65% of stunted children around outside the poorest 20% of households.

Table A7: Proportion of Undernourished Individuals in Poorest 20% and 40% of Household Wealth Excluding Women Less than 18 Years and Children Less than 18 Months of Age

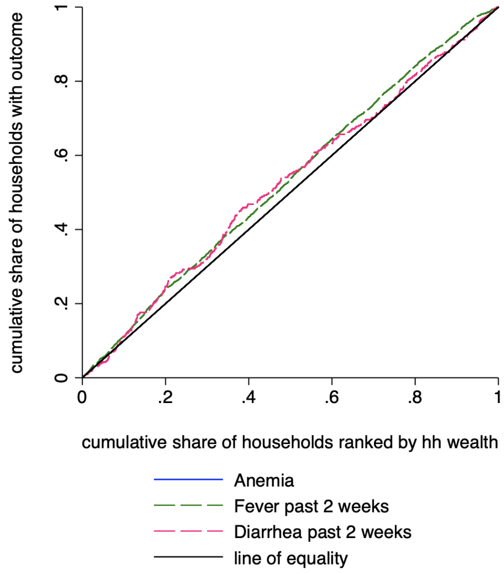
	Poorest 20% of Households							
	Underweight		Stunting			Wasting		
	Men	Women	Boys	Girls	Overall	Boys	Girls	Overall
Bangladesh		0.33	0.34	0.30	0.32	0.23	0.27	0.25
India		0.30	0.35	0.36	0.35	0.29	0.30	0.30
Maldives		0.17	0.24	0.25	0.24	0.21	0.13	0.20
Nepal		0.19	0.26	0.30	0.28	0.19	0.31	0.21
Pakistan		0.44	0.30	0.38	0.34	0.24	0.25	0.26
Sri Lanka		0.35	0.33	0.33	0.33	0.24	0.23	0.26
Total		0.30	0.30	0.32	0.31	0.24	0.25	0.25
	Poorest 40% of Households							
	Underweight		Stunting			Wasting		
	Men	Women	Boys	Girls	Overall	Boys	Girls	Overall
Bangladesh		0.59	0.56	0.54	0.55	0.50	0.45	0.48
India		0.55	0.59	0.61	0.60	0.52	0.54	0.53
Maldives		0.34	0.45	0.49	0.47	0.54	0.37	0.47
Nepal		0.45	0.50	0.55	0.52	0.52	0.43	0.48
Pakistan		0.64	0.54	0.60	0.57	0.52	0.56	0.54
Sri Lanka		0.60	0.55	0.58	0.57	0.49	0.52	0.51
Total		0.53	0.53	0.56	0.55	0.52	0.48	0.50

Note: Data are drawn from the DHS. The table gives the conditional probabilities of being undernourished given that the individual lives in a household in the poorest 20% and 40% of the household wealth distribution, excluding children younger than 18 months of age and adults younger than 18 years of age. Population weighting and sampling probability is used.

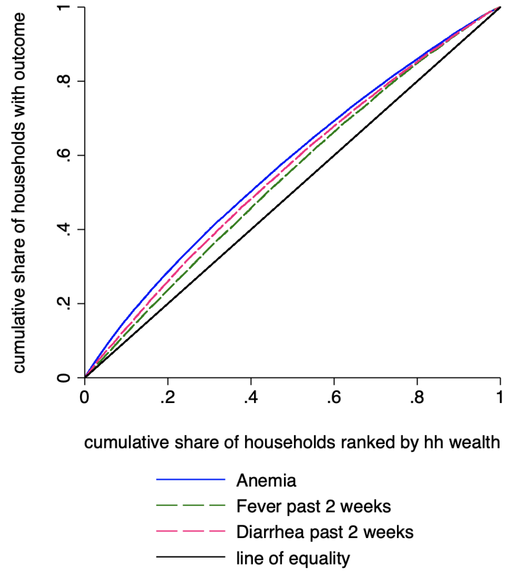
Table A8: Correlation Matrix: Mother and Child Nutrition

	Stunted	Wasted	Diarrhea	Anemia	Fever
Mother underweight	0.0949***	0.0897***	0.0113***	0.0574***	0.0013
Mother anemia	0.0407***	0.0197***	0.0056***	0.1356***	-0.0075***

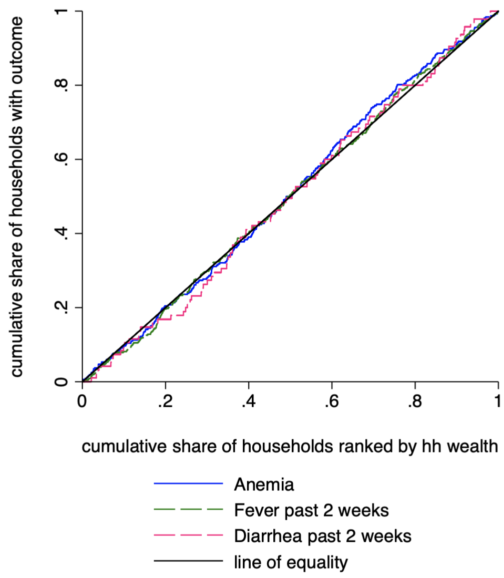
Note: Data are drawn from the DHS.



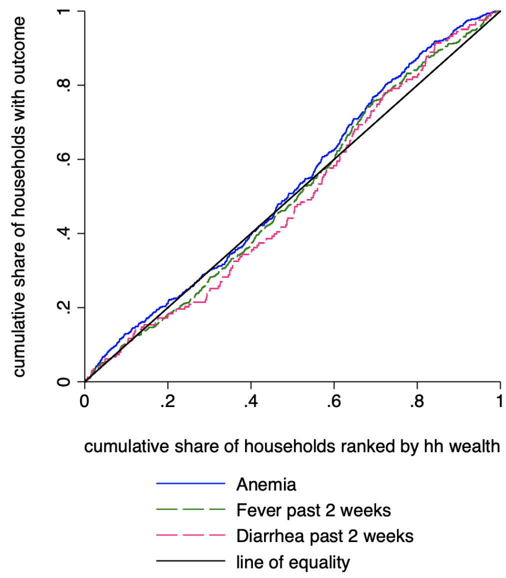
(a) Bangladesh



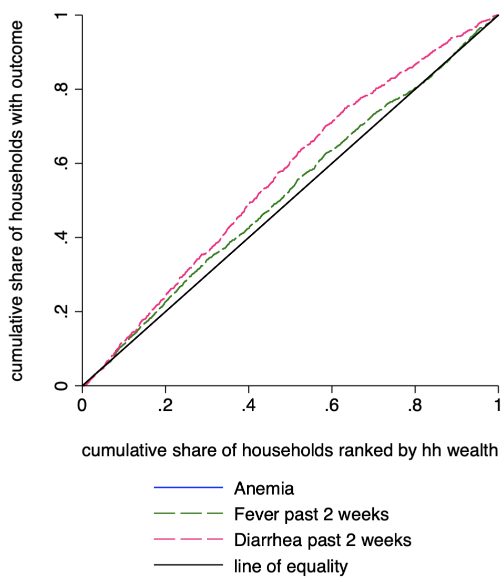
(b) India



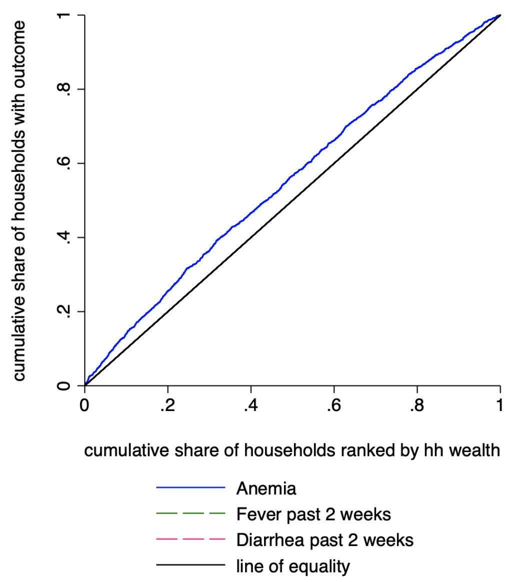
(c) Maldives



(d) Nepal



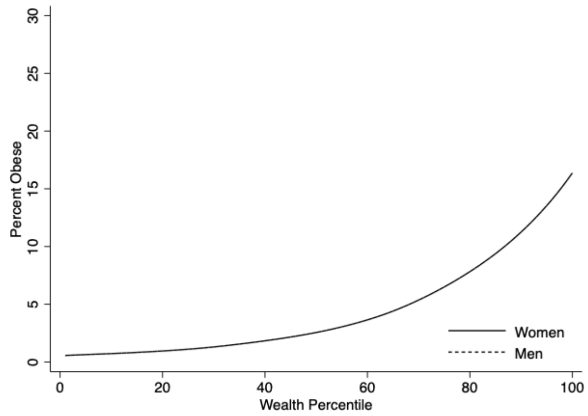
(e) Pakistan



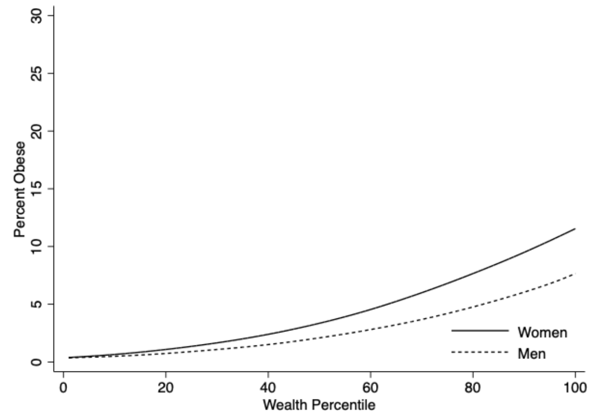
(f) Sri Lanka

Note: DHS data. The graphs show concentration curves for the cumulative proportion of children who report suffering from various illnesses. The Stata command `glcurve` is used to construct the curves.

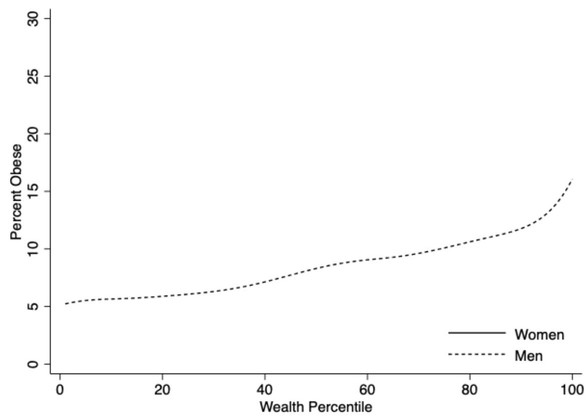
Figure A1: Concentration Curves for Child Anemia, Fever, and Diarrhea



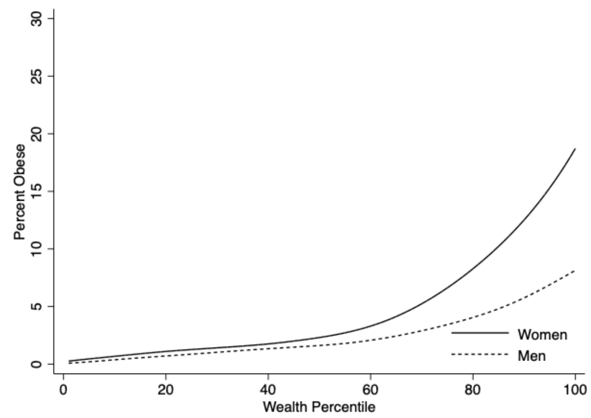
(a) Bangladesh



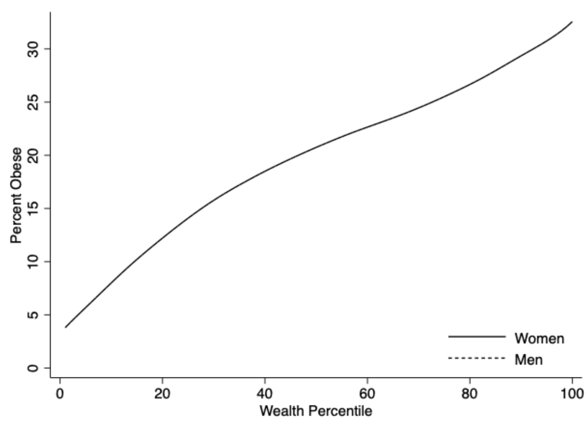
(b) India



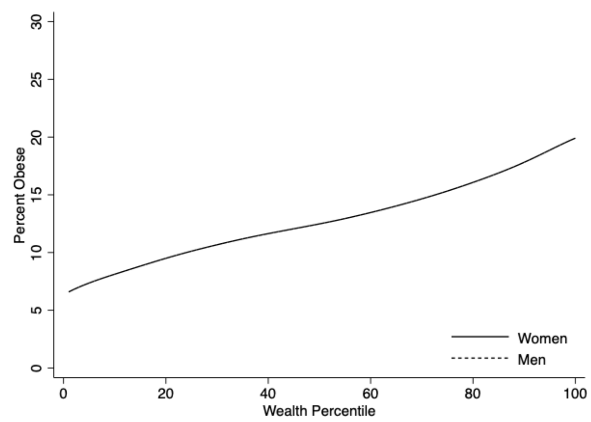
(c) Maldives



(d) Nepal



(e) Pakistan

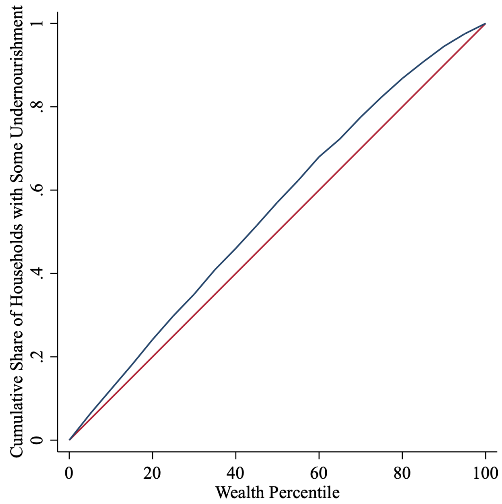


(f) Sri Lanka

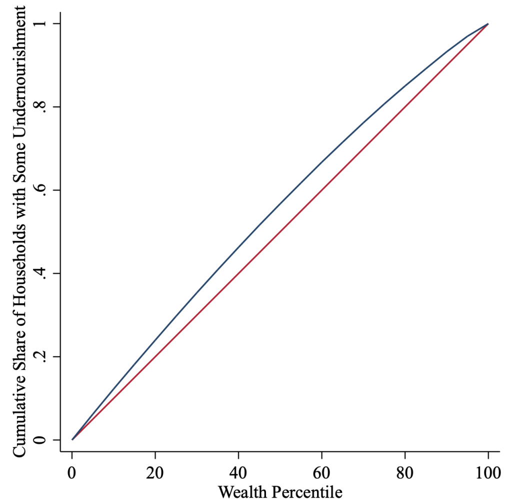
Note: DHS data. The graphs show lowess curves for the proportion of women and men who are obese in each household wealth percentile. Observations with missing values and pregnant or lactating women have been dropped.

Figure A2: Incidence of Obesity by Household Wealth

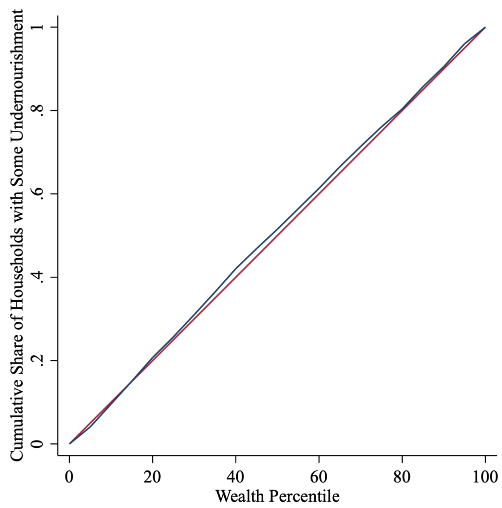
A.3 Additional Figures and Tables for Section 3



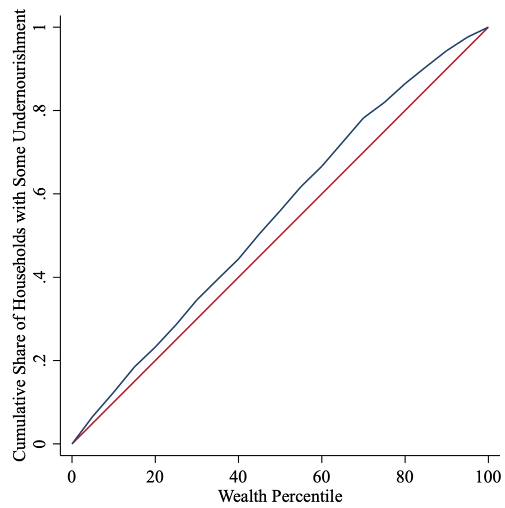
(a) Bangladesh



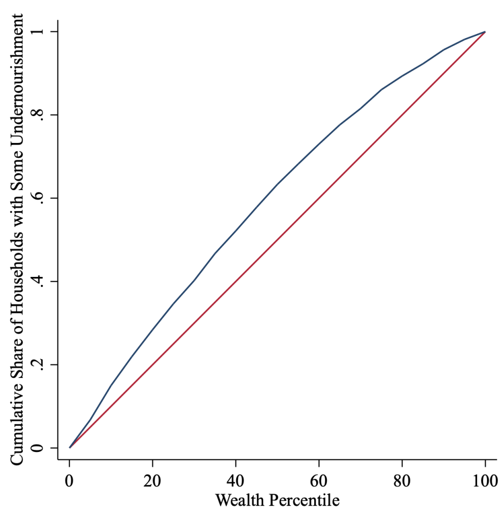
(b) India



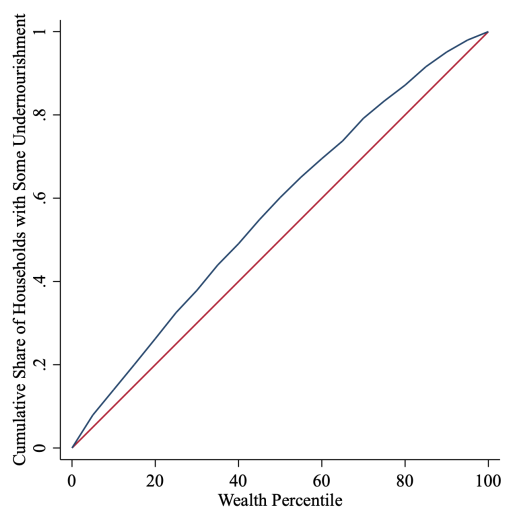
(c) Maldives



(d) Nepal



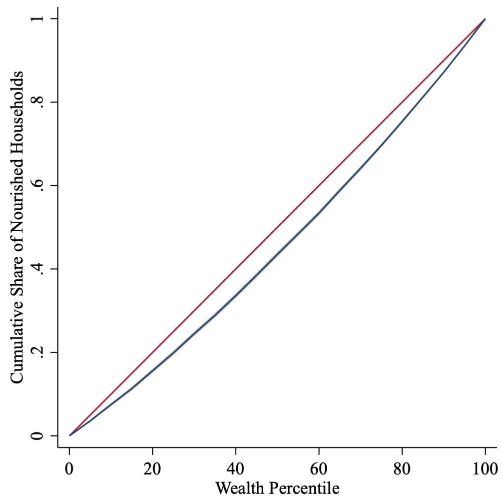
(e) Pakistan



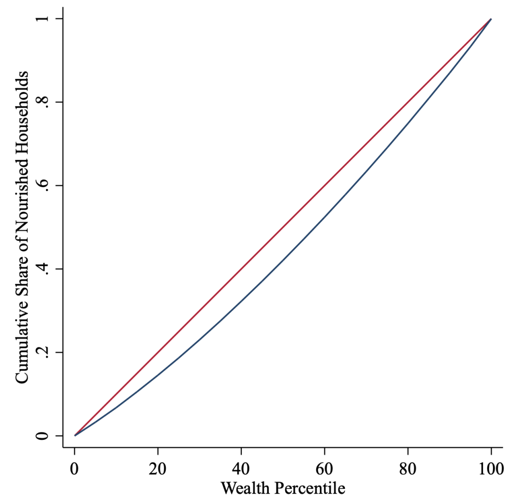
(f) Sri Lanka

Note: DHS data. The graphs show concentration curves for the cumulative proportion of households with intra-household inequality in household members (i.e. at least one household member but not all household members are undernourished) at each household wealth percentile. Undernourished is defined as an underweight man or woman, or a stunted or wasted child. The Stata command `glcurve` is used to construct the curves. 45-degree line in red.

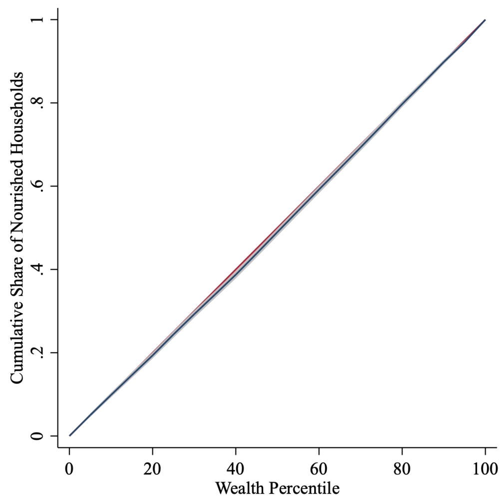
Figure A3: Concentration Curves for Households with Intra-household Inequality in Undernourishment



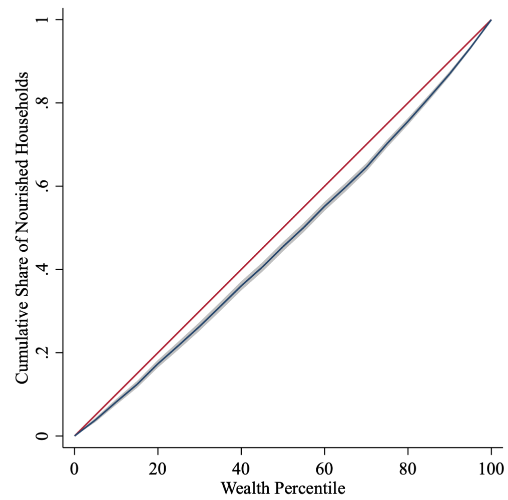
(a) Bangladesh



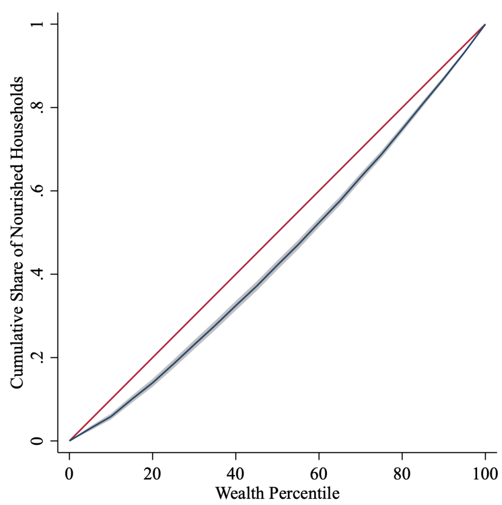
(b) India



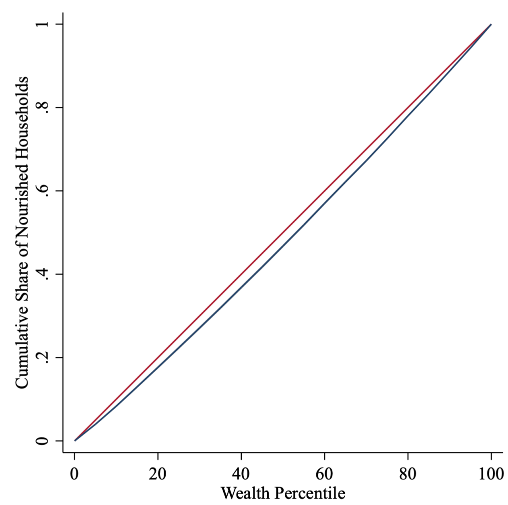
(c) Maldives



(d) Nepal



(e) Pakistan



(f) Sri Lanka

Note: DHS data. The graphs show concentration curves for the cumulative proportion of households with no undernourished household members at each household wealth percentile. Undernourished is defined as an underweight man or woman, or a stunted or wasted child. The Stata command `glcurve` is used to construct the curves. 45-degree line in red.

Figure A4: Concentration Curves for Households with No Undernourished Members

Table A9: Predictors of Child Wasting Within Countries, Communities, and Households

	(1)	(2)	(3)
Individual covariates			
Female	-0.01***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)
Age (months)	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)
First born	-0.00***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)
Son preference	-0.00	0.00	0.01
	(0.00)	(0.00)	(0.01)
Household covariates			
Female head	-0.01***	-0.00	
	(0.00)	(0.00)	
Head has no education	0.00	0.00	
	(0.00)	(0.00)	
Women with primary edu.	-0.01***	-0.01***	
	(0.00)	(0.00)	
Wealth index	-0.02***	-0.02***	
	(0.00)	(0.00)	
Persons per room	-0.00***	-0.00***	
	(0.00)	(0.00)	
Treats water	-0.00*	-0.00	
	(0.00)	(0.00)	
Improved toilet	-0.00**	-0.01	
	(0.00)	(0.00)	
Electricity	-0.00	-0.01	
	(0.00)	(0.00)	
Kitchen room	0.00	0.00	
	(0.00)	(0.00)	
Community covariates			
Wealth	-0.00		
	(0.00)		
Treats water	0.01**		
	(0.00)		
Improved toilets	-0.01		
	(0.01)		
Urban area	0.01***		
	(0.00)		
Constant	0.22***	0.24***	0.24***
	(0.00)	(0.00)	(0.00)
Community FE	No	Yes	Yes
Household FE	No	No	Yes
R^2	0.024	0.202	0.791
N	231416	231416	240721

Note: Data are drawn from the DHS. Regressions estimated using OLS. Son preference is an indicator equal to one if the child's mother reports wanted more boys than girls. Women with primary education is an indicator equal to one if there is at least one woman in the household with primary education or higher. Kitchen room is an indicator equal to one if the household cooks inside and has a separate room for cooking. Community-level variables are formed by taking the leave out-mean of the household-level term. Country-region fixed effects included in all regressions. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A10: Predictors of Underweight Adults By Wealthier versus Poorer Countries

	Wealthier Countries			Poorer Countries		
	(1)	(2)	(3)	(4)	(5)	(6)
Individual covariates						
Female	-0.03***	-0.03***	-0.03***	0.02***	0.02***	0.02***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Age	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
No education	0.03***	0.04***	0.06***	0.03***	0.02***	0.02***
	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)	(0.00)
Household covariates						
Female head	0.00	0.00		0.01***	0.01***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Head has no education	-0.01	-0.01		0.01***	0.01***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Women with primary edu.	-0.02*	-0.01		0.00	0.00**	
	(0.01)	(0.01)		(0.00)	(0.00)	
Wealth index	-0.02***	-0.02***		-0.06***	-0.06***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Persons per room	0.00	0.00		0.00***	0.00***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Treats water	0.01	0.00		-0.00**	-0.00***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Improved toilet	-0.03	-0.02		-0.01***	-0.01***	
	(0.02)	(0.02)		(0.00)	(0.00)	
Electricity	-0.01	0.04		-0.01***	-0.01***	
	(0.02)	(0.03)		(0.00)	(0.00)	
Kitchen room	-0.00	-0.01*		0.00	-0.00	
	(0.01)	(0.01)		(0.00)	(0.00)	
Community covariates						
Wealth	-0.01			0.00**		
	(0.01)			(0.00)		
Treats water	0.02			0.01***		
	(0.02)			(0.00)		
Improved toilets	-0.11***			-0.02***		
	(0.03)			(0.00)		
Urban area	0.01			-0.01***		
	(0.01)			(0.00)		
Constant	0.52***	0.38***	0.43***	0.47***	0.47***	0.48***
	(0.03)	(0.03)	(0.01)	(0.00)	(0.00)	(0.00)
Community FE	No	Yes	Yes	No	Yes	Yes
Household FE	No	No	Yes	No	No	Yes
N	14269	14273	31782	749247	749250	758341
R^2	0.093	0.151	0.772	0.095	0.159	0.708

Note: Data are drawn from the DHS. Regressions estimated using OLS. Age is measured in years. Women with primary education is an indicator equal to one if there is at least one woman in the household with primary education or higher. Person per room refer to the number of household members per sleeping room. Kitchen room is an indicator equal to one if the household cooks inside and has a separate room for cooking. Community-level variables are formed by taking the leave out-mean of the household-level term. Country-region fixed effects included in all regressions. Standard errors in parentheses. Wealthier countries include the Maldives, Pakistan and Sri Lanka. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A11: Predictors of Child Stunting By Wealthier versus Poorer Countries

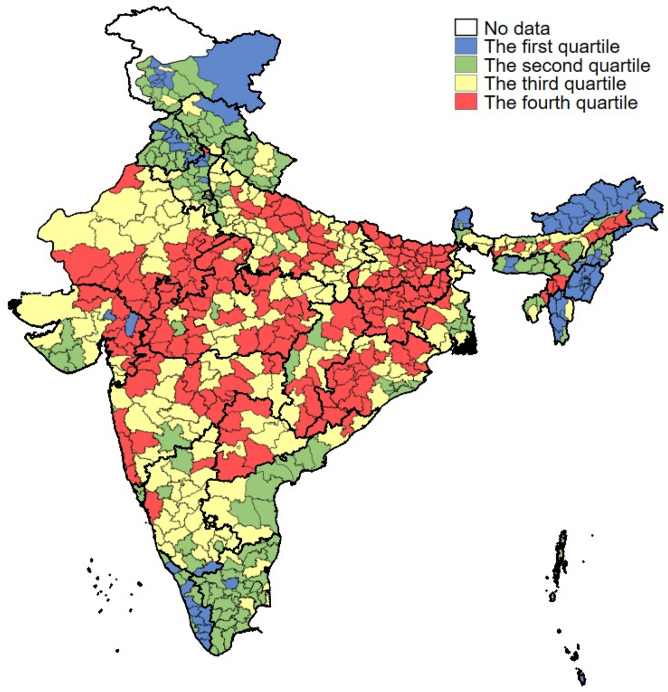
	Wealthier Countries			Poorer Countries		
	(1)	(2)	(3)	(4)	(5)	(6)
Individual covariates						
Female	-0.01	-0.01	-0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Age(months)	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
First born	-0.02*	-0.03**	-0.07***	-0.03***	-0.02***	-0.06***
	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)	(0.00)
Son preference	0.02*	0.01	0.03	0.01***	0.01***	-0.02*
	(0.01)	(0.01)	(0.03)	(0.00)	(0.00)	(0.01)
Household covariates						
Female head	-0.01	-0.00		-0.00	-0.00	
	(0.01)	(0.02)		(0.00)	(0.00)	
Head has no education	0.03**	0.02*		0.03***	0.02***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Women with primary edu.	-0.05***	-0.06***		-0.04***	-0.03***	
	(0.02)	(0.02)		(0.00)	(0.00)	
Wealth index	-0.04***	-0.04***		-0.07***	-0.07***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Persons per room	0.00	-0.00		0.01***	0.00***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Treats water	-0.00	0.00		-0.01***	-0.01**	
	(0.02)	(0.02)		(0.00)	(0.00)	
Improved toilet	-0.03	-0.03		-0.01***	-0.01***	
	(0.02)	(0.03)		(0.00)	(0.00)	
Electricity	-0.01	-0.00		-0.00	-0.00	
	(0.03)	(0.04)		(0.00)	(0.00)	
Kitchen room	0.01	0.01		-0.01***	-0.01***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Community covariates						
Wealth	-0.07***			-0.01***		
	(0.02)			(0.00)		
Treats water	-0.03			0.01		
	(0.04)			(0.01)		
Improved toilets	0.00			-0.01		
	(0.04)			(0.01)		
Urban area	0.03*			0.02***		
	(0.02)			(0.00)		
Constant	0.22***	0.24***	0.13***	0.24***	0.24***	0.23***
	(0.04)	(0.05)	(0.01)	(0.01)	(0.01)	(0.00)
Community FE	No	Yes	Yes	No	Yes	Yes
Household FE	No	No	Yes	No	No	Yes
N	6025	6025	13518	224085	224085	227203
R^2	0.145	0.291	0.804	0.070	0.225	0.790

Note: Data are drawn from the DHS. Regressions estimated using OLS. Age is measured in months. Son preference is an indicator equal to one if the child's mother reports wanted more boys than girls. Women with primary education is an indicator equal to one if there is at least one woman in the household with primary education or higher. Person per room refer to the number of household members per sleeping room. Kitchen room is an indicator equal to one if the household cooks inside and has a separate room for cooking. Community-level variables are formed by taking the leave out-mean of the household-level term. Country-region fixed effects included in all regressions. Standard errors in parentheses. Wealthier countries include the Maldives, Pakistan and Sri Lanka. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

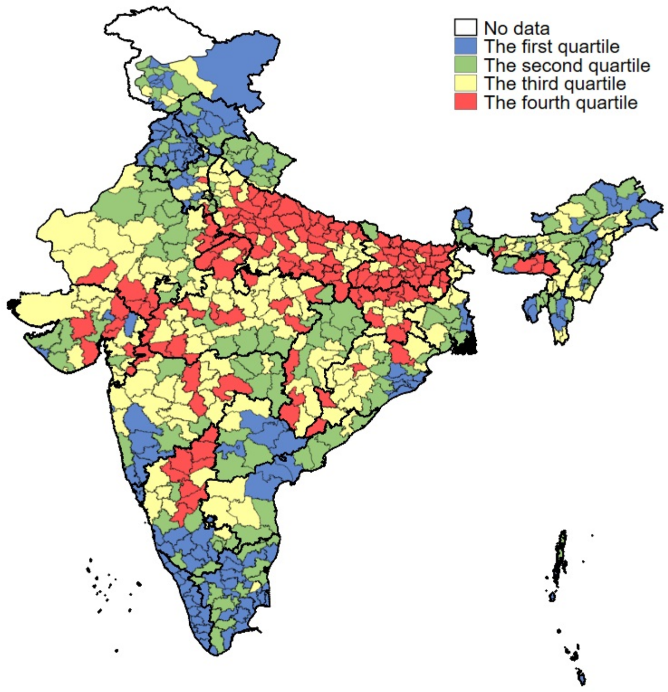
Table A12: Predictors of Child Wasting By Wealthier versus Poorer Countries

	Wealthier Countries			Poorer Countries		
	(1)	(2)	(3)	(4)	(5)	(6)
Individual covariates						
Female	-0.01	-0.01	-0.00	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Age	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
First born	-0.02*	-0.03**	-0.07***	-0.03***	-0.02***	-0.06***
	(0.01)	(0.01)	(0.02)	(0.00)	(0.00)	(0.00)
Son preference	0.02*	0.01	0.03	0.01***	0.01***	-0.02*
	(0.01)	(0.01)	(0.03)	(0.00)	(0.00)	(0.01)
Household covariates						
Female head	-0.01	-0.00		-0.00	-0.00	
	(0.01)	(0.02)		(0.00)	(0.00)	
Head has no education	0.03**	0.02*		0.03***	0.02***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Women with primary education	-0.05***	-0.06***		-0.04***	-0.03***	
	(0.02)	(0.02)		(0.00)	(0.00)	
Wealth index	-0.04***	-0.04***		-0.07***	-0.07***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Persons per room	0.00	-0.00		0.01***	0.00***	
	(0.00)	(0.00)		(0.00)	(0.00)	
Treats water	-0.00	0.00		-0.01***	-0.01**	
	(0.02)	(0.02)		(0.00)	(0.00)	
Improved toilet	-0.03	-0.03		-0.01***	-0.01***	
	(0.02)	(0.03)		(0.00)	(0.00)	
Electricity	-0.01	-0.00		-0.00	-0.00	
	(0.03)	(0.04)		(0.00)	(0.00)	
Kitchen room	0.01	0.01		-0.01***	-0.01***	
	(0.01)	(0.01)		(0.00)	(0.00)	
Community covariates						
Wealth	-0.07***			-0.01***		
	(0.02)			(0.00)		
Treats water	-0.03			0.01		
	(0.04)			(0.01)		
Improved toilets	0.00			-0.01		
	(0.04)			(0.01)		
Urban area	0.03*			0.02***		
	(0.02)			(0.00)		
Constant	0.11***	0.11***	0.11***	0.18***	0.18***	0.18***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Community FE	No	Yes	Yes	No	Yes	Yes
Household FE	No	No	Yes	No	No	Yes
N	14079	14079	14079	233894	233894	233894
R^2	0.019	0.288	0.832	0.016	0.193	0.786

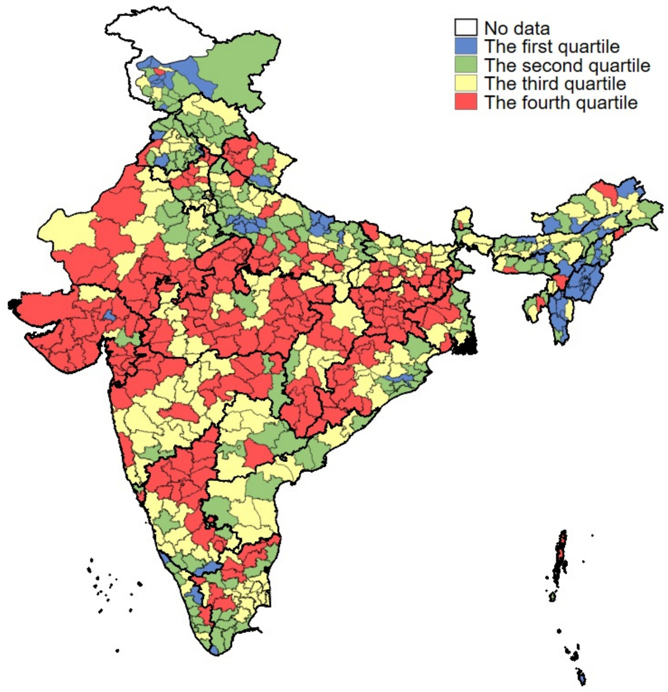
Note: Data are drawn from the DHS. Regressions estimated using OLS. Age is measured in months. Son preference is an indicator equal to one if the child's mother reports wanted more boys than girls. Women with primary education is an indicator equal to one if there is at least one woman in the household with primary education or higher. Person per room refer to the number of household members per sleeping room. Kitchen room is an indicator equal to one if the household cooks inside and has a separate room for cooking. Community-level variables are formed by taking the leave out-mean of the household-level term. Country-region fixed effects included in all regressions. Standard errors in parentheses. Wealthier countries include the Maldives, Pakistan and Sri Lanka. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$



(a) Underweight women



(b) Child stunting



(c) Child wasting

Note: DHS data. The graphs the spatial correlation in nutritional status— the prevalence of underweight women, and stunted and wasted children– in the districts of India.

Figure A5: Spatial Trends in Undernutrition by District in India

Table A13: Community-level Covariates and Undernutrition

	(1) Underweight	(2) Stunted	(3) Wasted
Community wealth	-0.06***	-0.10***	-0.03***
	(0.00)	(0.00)	(0.00)
Share households who treat water	0.00*	-0.00	0.00
	(0.00)	(0.00)	(0.00)
Share of households with an imp. toilet	-0.03***	-0.02***	-0.01***
	(0.00)	(0.01)	(0.00)
Urban area	-0.01***	0.03***	0.01***
	(0.00)	(0.00)	(0.00)
Constant	0.24***	0.32***	0.18***
	(0.00)	(0.00)	(0.00)
R^2	0.047	0.044	0.020
N	791599	247972	247972

Note: Country-region fixed effects included in all regressions. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A14: Inclusion and Exclusion Errors for Categorical Targeting Using Age and Gender of Household Head

	Age (3-5 and 15-19)			No Education		
	Coverage	Incl. Errors	Excl. Errors	Coverage	Incl. Errors	Excl. Errors
Bangladesh	0.250	0.650	0.646	0.221	0.700	0.732
India	0.276	0.571	0.573	0.266	0.667	0.680
Maldives	0.236	0.704	0.704	0.039		
Nepal	0.292	0.662	0.662	0.270	0.750	0.680
Pakistan	0.293	0.677	0.677	0.507	0.717	0.348
Sri Lanka	0.186	0.732	0.732	0.013		
Total	0.273	0.580	0.580	0.260	0.669	0.679

Note: Data are drawn from the DHS. No education refers to the individual adult or the mother of the child. Age group (3-5 years and 15-19 years) and education are both categorical variables were any individual meeting that criteria is covered. Incl. Errors refers to inclusion errors, defined as the proportion of those who are covered who are not undernourished. Excl. Errors refers to exclusion errors, defined as the proportion of those who are undernourished who are not covered.