Intrahousehold and Interhousehold Child Nutrition Inequality in Malawi

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ABSTRACT

The allocation of resources within households may not be equal, and this may lead to different outcomes including health outcomes for household members. This paper investigates whether child nutrition inequalities are attributable to differences between households or differences within households in Malawi. Using a linear model with random effects, we derive a method to estimate the between and within contributions of both the explained and unexplained variances of child nutrition. Child nutrition is measured using height-for-age z-scores, and weight-for-height z-scores. The empirical analysis uses the 2006 multiple indicator cluster survey (MICS) data. We find evidence of within household nutritional bias along gender, age, and birth order lines in Malawi. The results for rural and urban areas, as well as ethnic and religious groups show that nutrition inequalities largely stem from differences within households. Intrahousehold nutrition inequalities are however less explained by observables, while interhousehold inequalities are more explained by observables.

KEY WORDS: Inequality; nutrition; Malawi.

1. INTRODUCTION

The empirical literature on intrahousehold allocation of resources on children's nutrition suggests the existence of within-household inequality with some children having better nutritional outcomes than others. The gender of a child is found to be a determinant of nutrition within a family. The empirical evidence of this gender bias is rather conflicting as it depends on where the study was conducted. Most studies conducted in South Asia (e.g. Berhman, 1988a; Dancer et al., 2008) find that a girl child is more likely to be malnourished than a boy child

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while most Sub-Saharan African studies find the reverse (e.g. Garret and Ruel, 1999; Linnemayr et al., 2008).

This gender bias in nutrition can arise from three concerns by parents (see for example Berhman (1988a) and Park (2004) for more details) namely; equity, efficiency, and preferences. The equity concern reflects the desire of parents to ensure that children are equally well-off. If nutritional needs differ by gender then observed gender bias may be due to equity bias. The efficiency concern relates to differences in returns to investment in child health. If these returns differ for boys and girls, gender bias can arise from efficiency bias. Gender bias can also be due to preference bias with parents preferring one sex over another.

The household allocation of resources towards child nutrition may also vary with where the child falls in the family birth order. The most common finding is that children with higher birth orders have less favourable health outcomes. For instance, Horton (1988) while focusing on Philippines finds strong negative effects of birth order on long run nutrition as measured by height-for age but only modest effects on short run nutrition as captured by weight-for-height. Nutritional related birth order effects are also found by Behrman (1988b) in rural India, by Dancer et al. (2008) in Bangladesh, by Hatton and Martin (2009) in Britain.

The literature (see for example Berhman (1988b), Horton (1988), Hatton and Martin (2009) for more details) provides a number of possible reasons for birth order effects. Explanations which predict a negative birth order effect include: children of higher birth order are less healthy as they are born to older mothers and are usually of lower birth weight, so parents may prefer to invest more in children of lower birth orders; a higher proportion of children may lead to an increase exposure of an individual child to infection, which may in turn affect nutritional status; dilution of household resources for investing in children, as the number of children in the family increases; dilution of mother's attention as the number of children rises; unanticipated births tighten household resource constraints, so later-born children do worse; the present discounted value of children's earnings to parents is larger for older children. The birth order effect may be positive although this is not a common finding. Explanations for this possibility include: parents' earnings may increase over their life cycle and this may favor later-borns; parents may acquire more effective childrearing skills.

Regardless of the form in which this intrahousehold nutrition inequality takes- gender bias and/or birth order effects, or the interaction of the two- it can lead to significant within-household differences in vulnerability to infection and disease, and survival of individual children in the short run. Besides, in the long run and to the extent that poor nutrition status in infancy may lead to permanent effects and diminished health and education outcomes later in life as adults (Alderman et al., 2006; Case and Paxson, 2006), this inequality may generate further inequality later on in adulthood.

While there are many studies which show the existence of bias in the allocation of health resources within households, we are not aware of any study which quantifies the contribution of this intrahousehold inequality to total nutrition inequality, and what drives it. As Haddad and Kanbur (1990) show, our understanding of intrahousehold welfare is important to our understanding of inequality in general. They show that errors of the order of 30% or more are made in the measurement of the levels of inequality if intrahousehold inequality is ignored.

In order to measure the contribution to total nutrition inequality of intrahousehold and interhousehold nutrition inequality, the paper develops a variance decomposition method for the linear random effects model. Using this method on Malawian data, the paper makes three contributions to the empirical literature on intrahousehold health distribution. First, we show how much of the total long term and short term child nutrition inequality in Malawi arises from inequality within the family (intrahousehold inequality) and how much is attributable to inequality between families (interhousehold inequality). Second, for both the intrahousehold and interhousehold nutrition inequalities, we estimate how much is explained by observable characteristics and how much is unexplained by observable characteristics. Third, in order to have a deeper understanding of the profile of nutrition inequalities, the paper shows how the inequalities differ by area (rural versus urban), religion and ethnicity.

From a policy perspective, knowing the relative importance of intrahousehold and interhousehold differences in nutrition for the different groups is important. When intrahousehold inequalities are large they may alter the effectiveness of redistributive policies such as transfer programmes directed at particular types of household members (e.g. infants and young children). Additionally, the magnitude of intrahousehold inequalities may indicate the extent to which the measurement of health inequality which is done at the household level rather than at the level of each household member may underestimate overall health inequality.

The plan of the paper is as follows. In Section 2 the econometric strategy and the variables used are discussed. The data used and descriptives are the focus of Section 3. This is followed by empirical results in Section 4. Finally, Section 5 concludes.

2. ECONOMETRIC ANALYSIS

In order to measure intrahousehold and interhousehold nutrition inequality, we extend the framework developed by Picard and Wolff (2010) for the random effects probit to the linear random effects model. Assume that child nutrition status is represented by the following linear random effects regression

$$y_{ij} = x'_{ij}\beta + \upsilon_{ij} \qquad j = 1......k;\ i = 1......n_j \tag{1}$$

Where; y_{ij} is a nutritional status indicator of child i in household j, β is a vector of parameters and x_{ij} is a vector of independent variables which influence child nutrition. The error term υ_{ij} which constitutes the unexplained part of the model has two components: u_i, which is common to all children in the household (the random effect) and captures heterogeneity in households' preferences for health, and ε_{ij} which is child-specific, and is assumed to be independent of u_i as well as uncorrelated across members of the household. Both error terms are assumed to be normally distributed. The variance of the within unexplained component, ε_{ij}, is normalized to one, while the variance of the between unexplained component, u_i, is unnormalized and is denoted as σ_u^2. Thus, we have $\varepsilon_{ij} \sim N(0,1)$ and $u_i \sim N(0,\sigma_u^2)$. A sample equivalent of equation (1) is denoted as

$$y_{ij} = \hat{y}_{ij} + \hat{\upsilon}_{ij} \tag{2}$$

After squaring and summing equation (2), we get the following

$$\sum_{j=1}^{k}\sum_{i=1}^{n_j}\left(y_{ij}-\bar{y}\right)^2=\sum_{j=1}^{k}\sum_{i=1}^{n_j}\left(\hat{y}_{ij}-\bar{\hat{y}}\right)^2+\sum_{j=1}^{k}\sum_{i=1}^{n_j}\hat{\upsilon}_{ij}^2$$
$$=\left[\sum_{j=1}^{k}n_j\left(\bar{\hat{y}}_j-\bar{\hat{y}}\right)^2+\sum_{j=1}^{k}\sum_{i=1}^{n_j}\left(\hat{y}_{ij}-\bar{\hat{y}}_j\right)^2\right]+\left[n_j\sum_{j=1}^{k}\hat{u}_j^2+\sum_{j=1}^{k}\sum_{i=1}^{n_j}\hat{\varepsilon}_{ij}^2\right] \quad (3)$$

Where; $\bar{\hat{y}}_j$ is the mean of the estimated health indicator for the j^{th} household, $\bar{\hat{y}}$ is the overall mean of the estimated health indicator. The decomposition of the total variation in equation (3) above makes use of the following; $\sum_{j=1}^{k}\sum_{i=1}^{n_j}\left(\hat{y}_{ij}-\bar{y}\right)\left(\hat{\upsilon}_{ij}\right)=0$, and $\sum_{j=1}^{k}\sum_{i=1}^{n_j}\hat{\upsilon}_{ij}=\sum_{j=1}^{k}\sum_{i=1}^{n_j}\hat{\varepsilon}_{ij}\hat{u}_j=0.$

Equation (3) shows that the total variation can be decomposed into two major parts namely; the explained variation, which is the first term in square brackets, and the unexplained variation, which is the second term in square brackets. The explained variation can further be decomposed into a between explained variation, $\sum_{j=1}^{k}n_j\left(\bar{\hat{y}}_j-\bar{\hat{y}}\right)^2$ and a within explained variation, $\sum_{j=1}^{k}\sum_{i=1}^{n_j}\left(\hat{y}_{ij}-\bar{\hat{y}}_j\right)^2$. Similarly, the unexplained variation can be decomposed into a between unexplained variation, $n_j\sum_{j=1}^{k}\hat{u}_j^2$, and a within unexplained variation, $\sum_{j=1}^{k}\sum_{i=1}^{n_j}\hat{\varepsilon}_{ij}^2$. Using these components of the total variation, both explained and unexplained intrahousehold (within household) and interhousehold (between household) health inequality are then measured by using variances defined as follows;

Explained interhousehold inequality in health

$$\frac{\sum_{j=1}^{k}n_j\left(\bar{\hat{y}}_j-\bar{\hat{y}}\right)^2}{k-1} \quad (4)$$

Explained intrahousehold inequality in health

$$\frac{\sum_{j=1}^{k}\sum_{i=1}^{n_j}\left(\hat{y}_{ij}-\bar{\hat{y}}_j\right)^2}{n_j-1} \quad (5)$$

Unexplained interhousehold inequality in health

$$\frac{n_j \sum_{j=1}^{k} \hat{u}_j^2}{k-1} \tag{6}$$

Unexplained intrahousehold inequality in nutrition

$$\frac{\sum_{j=1}^{k} \sum_{i=1}^{n_j} \hat{\varepsilon}_{ij}^2}{n_j - 1} \tag{7}$$

The proportion of explained interhousehold inequality is then expressed as

$$\frac{\frac{\sum_{j=1}^{k} n_j \left(\bar{\hat{y}}_j - \bar{\hat{y}}\right)^2}{k-1}}{\frac{\sum_{j=1}^{k} n_j \left(\bar{\hat{y}}_j - \bar{\hat{y}}\right)^2}{k-1} + \frac{\sum_{j=1}^{k} \sum_{i=1}^{n_j} \left(\hat{y}_{ij} - \bar{\hat{y}}_j\right)^2}{n_j - 1} + \frac{n_j \sum_{j=1}^{k} \hat{u}_j^2}{k-1} + \frac{\sum_{j=1}^{k} \sum_{i=1}^{n_j} \hat{\varepsilon}_{ij}^2}{n_j - 1}} \tag{8}$$

The proportion of inequality attributable to unexplained interhousehold, unexplained intrahousehold, and unexplained intrahousehold nutrition inequalities can be calculated in a similar manner.

2.1. Variables Used

Child nutrition, the dependent variable, is measured using two anthropometrics, the child's height-for-age-z-score and the weight-for-height z-score. Both anthropometrics are expressed in standard deviations from the median of a reference population. Following a common empirical practice, we use the U.S National Center for Health Statistics (NCHS) as recommended by the World Health Organization (WHO) as a reference population. The height-for-age-z-score measures stunting, and is considered a long term indicator of child nutritional wellbeing or health. It is unaffected by acute episodes of stress occurring at or around the time of measurement (Sahn and Stifel, 2002). The weight-for-height z-score on the other hand captures wasting, and is regarded as a short term or current indicator of child nutritional wellbeing or health. The most commonly used cut-off to define abnormal anthropometry is a value of -2, that is, two standard deviations below the reference median, irrespective of the indicator used

(O'Donnell et al., 2008).

In terms of independent variables, we have a child's age in months and its square to capture possible non linearities, sex of the child, and the status of being a twin, as twins frequently show lower birth weight (Hatkar and Bhide, 1999). We also control for the child's birth order by using the absolute birth order. Thus, higher values correspond to younger children. The effect of birth on nutrition may be non-linear (Horton, 1988); we therefore include the square of birth order to capture this nonlinearity. An interaction variable between the sex of a child and birth order is included to capture the possibility that the effect of birth order on child nutrition may vary with the sex of a child. At the household level, we include the age difference between mother and father to capture the bargaining position of the mother. According to the bargaining literature on household decisions, bargaining status could influence those resources that the mother may receive for herself as well as for her child, possibly leading to adverse nutrition consequences (Smith et al., 2003; Linnemayr et al., 2008). The mother's age in years and its quadratic are also included.

The economic status of a child's household is known to be a strong determinant of her or his nutritional status (see for example Dancer et al., 2008). Poor households and individuals often have low access to food, a necessary condition for food security. They also may have inadequate resources for care, and may not be able to utilize (or contribute to the creation of) resources for health on a sustainable basis (Smith et al., 2005). We measure household economic status by using a wealth index, and the households are categorized into five groups; poor, middle, richer, and richest. The poorest group is the base category. Parental education is included as a three class dummy variable indicating whether the mother/father has primary schooling, or has secondary or more education, no education for mothers and fathers represent the control group. We also include ethnicity of the household as follows; Chewa, Lomwe, Yao, Ngoni, Tumbuka. Other tribes represent the excluded category. The religion of the family is also included classified as follows; protestant, muslim, catholic, with other religions representing the excluded category. Finally, we include a rural-urban dummy as well as regional dummies north and centre, with south as the base.

3. DATA AND DESCRIPTIVE STATISTICS

This paper uses data from the 2006 Multiple Indicator Cluster Survey (MICS) which was conducted by Malawi's National Statistical Office. The main objective of the MICS was to obtain estimates at district level on the key indicators related to the well being of children and women. The survey covers 26 districts, and from each district a total of 1200 households were sampled. Two-stage sampling was used to select the 1200 households. In the first stage, 40 census enumeration areas (clusters) were selected in each district. In the second stage, a household listing was performed within the cluster and a systematic sample of 30 households was drawn to obtain 1,200 households per district. A total of 31200 households were selected in 1,040 clusters. This makes the MICS one of the largest nationally representative household surveys in Malawi. The survey collected information on; children under-five, all women aged 15-49 years, and men aged 15-49 in every third household selected. Information on among other things child anthropometrics was collected. We have a total of 53879 under-five children in the sample.

Before looking at the descriptive statistics for our sample, we first focus on the prevalence rates of malnutrition. Table I reports percentages of mildly, moderately, and severely malnourished under-five children. Generally, the results show that long term malnutrition (stunting) is more prevalent than short term malnutrition (wasting). Slightly more boys, 19%, than girls, 18%, are severely stunted. There is no gender difference in the proportion of boys and girls who are severely wasted; the percentage is 1% for both. The results show that the proportion of stunted children in rural areas is higher than that in urban areas. Severe stunting is higher in rural areas with about 19% severely stunted, compared to 13% in urban areas. The results also indicate that there is no discernible rural-urban difference with respect to wasting. Looking at religion, the results show that children belonging to Protestant families have the lowest prevalence rates of stunting. Specifically, 72%, 44%, and 18% of children in Protestant households are mildly, moderately, and severely stunted respectively. The results for wasting are quite mixed, with prevalence rates across the four religions varying with the extent of wasting. Turning to ethnicity, we observe that Tumbuka families have the lowest proportion of stunted children.

Table II presents descriptive statistics of variables used in the analysis. The means of the height-for-age-z-score are all negative while those for the weight-for-height z-score are all positive; supporting our earlier finding that stunting is a more serious problem than wasting. As a matter of fact, the positive means for the weight-for-height z-score suggest that under-five children are marginally fat for their height. There are slightly more girls than boys in the sample, and boys are more stunted (height-for-age-z-score of -1.78) than girls (height-for-age-z-score of -1.75). Girls are on average marginally fatter (weight-for-height z-score of 0.11) than boys (weight-for-height z-score of 0.08). The average age for both boys and girls is about 27 months. The average birth order is 4, and 17% of fathers have secondary education or more as compared to 9% of mothers. About 23% of the children belong to the poorest families with 16% belonging to the richest households.

In Table III we explore the relationship between birth order and nutritional status of under-five children. The table reports the average nutritional status for each birth order. The mean of the height-for-age-z-score for the first borns is -1.62 and it is -1.96 for the eighth or later borns, the corresponding figures for the weight-for-height z-score are 0.10 and 0.04 respectively. These results suggest that the long run nutritional status and current nutritional status worsens with increasing birth order. That is, first born children are better off nutritionally than later borns. Looking at the first borns versus the eighth or later borns, the results seem to suggest that the birth order effect is more pronounced for short term nutritional status than for long term nutritional status. Besides, for current nutritional status, there is a clear pattern that boys are worse off than girls.

The preceding results seem to indicate the existence of within household nutritional bias along gender and birth order lines. In order to explore this bias further, we look at econometric results in the next section.

4. RESULTS

4.1. National, Rural and Urban

Regression results of height-for-age and weight-for-height that are presented in Tables IV and V respectively. For both measures of nutritional status, we estimate national, rural, and urban regressions. The chi-square statistics for overall significance show that the independent variables included in the different regressions are jointly significant at 1% significance level. There are some differences in the results for long-run nutritional status and current nutritional status.

Looking at the height-for-age z-score results for the three regressions we observe that there is no statistically significant gender effect. There are however significant gender effects for weight-for-height z-score. Boys are significantly (at 1% significance level) smaller than girls in rural areas but the opposite holds (at 5% significance level) in urban areas. Specifically, a male child in rural areas has on average a weight-for-height z-score that is 0.04 standard deviations worse than that of a female child. A male child in urban areas on the other hand, has on average a weight-for-height z-score that is 0.12 standard deviations better than that of a female child. These results seem to indicate that there is intrahousehold gender bias in favour of boys in urban areas and against boys in rural areas, however this evidence of bias holds for current nutritional status only. Looking at twin status, the results show that being part of a twin leads to a statistically significant negative impact on long term nutritional status in both rural and urban areas, perhaps reflecting both biological as well as cultural factors (Linnemayr et al., 2008). However, being a twin has no significant impact on current nutritional status.

We find that a child's age and the two child anthropometrics are nonlinearly related, and this relationship is statistically significant at 1% significance level. It is however insignificant for weight-for-height z-score in the urban regression. The implication of this finding is that older children are more likely to be malnourished, but this effect increases at a decreasing rate, and we have a turning point after which age and nutrition are positively related. For instance, using the national regression, the turning point for the height-for-age z-score is about 15 months (we use the unrounded coefficient of the quadratic term which is 0.00011). The results suggest evidence of intrahousehold age bias.

Another possible source of intrahousehold bias as indicated earlier is birth order. We find statistically significant negative birth-order effects in the weight-for-height rural and national models only, with later-borns having poorer weight-for-height relative to earlier-borns. These results suggest that at a single point in time parents especially in rural areas allocate resources relatively less equitably among children of different birth orders. However, the long run outcome is relatively more equitable. We also find that there is no nonlinear birth order effect as the square of birth order is statistically insignificant. The magnitude of the birth-order effect in current nutrition status is nontrivial. For instance, the last-born child in a rural family of eight has on average a weight-for-height z-score which is 0.3 standard deviations below that of the firstborn. The interaction term between birth order and sex of the child is insignificant in all models, suggesting that the birth order effect is no worse for boys than it is for girls. This is lack of significant interaction effect between birth order and sex of the child is consistent with results from previous studies (for example, Horton (1988)).

Relative to a child whose parents have no education, a child who has parents with secondary education or more has on average a significantly better long term nutrition status. In contrast, the long term nutrition status of a child belonging to parents with primary education does not benefit from this schooling. Parental education does not seem to affect current nutrition status of children. Household wealth is mostly significant in improving both height-for-age z-scores and weight-for-height z-scores. For example, a child born into the wealthiest quintile in rural areas has a height-for-age z-score and weight-for-height z-score that is 0.225 and 0.107 standard deviations better respectively than that of a child from the poorest wealth quintile. We find that the religious group to which a child's parents belong does not influence his or her nutritional status, however ethnic group matters but only in rural areas. For example, relative to other tribes, a rural child whose parents are Chewa has a height-for-age z-score which is 0.27 standard deviations worse.

The above discussion points to evidence of within household nutritional bias along gender, age, and birth order lines in Malawi. In order to shed more light on this intrahousehold inequality, we present variance decomposition results in the bottom panel of Tables IV and V. We draw a number of conclusions from the results. First, for the two anthropometrics, most of the nutrition inequality is attributable to intrahousehold inequalities. Specifically, in both rural and urban areas, intrahousehold inequalities account for about 56% to 86% of total nutrition inequality, and the remainder is attributable to interhousehold inequalities. We also observe that the magnitude of within family nutrition inequalities is larger for current nutrition than for long term nutrition, implying that nutrition inequalities are more pronounced in the short term than the long term. Further to that, intrahousehold inequalities are larger in rural areas than in urban areas, suggesting that rural families are less equal nutritionally than urban ones. Second, most of the overall nutrition inequality is not explained by observable characteristics. The part of total nutrition inequalities which is explained by observable characteristics ranges from 23% to 43% in the height-for-age z-score models, and 13% to 43% in the weight-for-height models.

Third, most of the within family inequalities are unexplained by observable characteristics: unexplained within household inequalities contribute about 56% to 72% to overall long run nutrition inequality, and 56% to 86% to overall short run nutrition inequality. In contrast, most of the between family nutrition inequalities are explained by observables: explained interhousehold inequalities account for about 23% to 42% of overall long run nutrition inequality, and 13% to 42% of overall short run nutrition inequality. Finally, unexplained intrahousehold nutrition inequalities are larger in rural areas than in urban areas; in the height-for-age z-score model it is 76% for rural areas versus 56% for urban areas, and it is 83% for rural areas versus 56% for urban areas in the weight-for-height model. Contrastingly, explained interhousehold nutrition inequality is larger in urban settings than in rural ones. Specifically, it accounts for 23% in rural areas as compared to 42% in urban areas in the height-for-age z-score model, while it accounts for 16% in rural areas as compared to 42% in urban areas in the weight-for-height model.

4.2. Religion and Ethnicity

The preceding results indicate that ethnicity unlike religion plays a significant role in determining a child's nutrition status in Malawi. In order to shed more light on the pattern of nutrition inequalities across ethnic and religious groups, we estimated regressions for each tribe and religion using the same variables as in Tables IV and V. Although, religion does not significantly influence child nutrition, it may still be interesting to investigate the nature of nutrition inequalities within each religion as well. For brevity, we leave out the regression results and only report variance decomposition results in Table VI. The results are based on the national sample only, restricting the estimations to rural or urban children did not qualitatively alter the conclusions.

Across all the religious and ethnic groups, the results are similar to the previous ones; with the exception of other religions, intrahousehold inequalities are a major driver of overall nutrition inequalities. The contribution of intrahousehold inequalities among the religions varies with the nutrition indicator employed. Protestant and Muslim families have the largest percentage of within family long run inequalities, while Protestant and Catholic families have the largest percentage of within family short run inequalities. This suggests that of the four religious groups, protestant families are the least equitable with respect to child nutrition. Similar to the previous results, most of the intrahousehold inequalities are unexplained by observable characteristics, while most of the interhousehold nutrition inequalities are explained by observables. Turning to ethnicity, we find that Chewa and Lomwe families have the largest intrahousehold short run nutrition inequalities. Across all the ethnic groups, within family inequalities are less explained by observables while the reverse holds for between family inequalities.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This paper has investigated whether child nutrition inequalities are attributable to differences between households or differences within households in Malawi. Using a linear model with random effects, we have derived a method to estimate the between and within contributions of both the explained and unexplained variances of child nutrition. Child nutrition is measured using height-for-age z-scores, and weight-for-height z-scores. The empirical analysis uses the 2006 multiple indicator cluster survey (MICS) data. The results for rural and urban areas, as well as ethnic and religious groups show that nutrition inequalities largely stem from differences within households. Intrahousehold nutrition inequalities are however less explained by observables, while interhousehold inequalities are more explained by observables.

These findings have useful policy implications. First, the predominance of intrahousehold inequalities rather than interhousehold inequalities means that redistributive policies such as transfer programmes directed at particular types of household members (e.g. infants and young children) may be more effective and efficient than those that treat a household as one single equitable unit. Second, in the light of these large intrahousehold inequalities, the measurement of health inequality at family level rather than at the child level would underestimate overall health inequality.

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Table I. Percentages of under-fives who are malnourished

Variable	height-for-age z-score			weight-for-height z-score		
	Mild Stunting	Moderate Stunting	Severe Stunting	Mild Wasting	Moderate Wasting	Severe Wasting
Female	73	46	18	17	4	1
Male	74	45	19	18	4	1
Rural	74	46	19	17	4	1
Urban	66	36	13	16	4	1
North	68	37	14	18	5	1
Centre	76	49	21	16	3	1
South	74	46	19	17	4	1
Catholic	74	47	19	15	3	1
Protestant	72	44	18	18	4	1
Muslim	77	49	20	16	3	0
Other religion	73	50	20	22	5	0
Chewa	76	49	22	15	3	1
Lomwe	72	45	20	16	4	1
Yao	77	50	20	16	3	0
Ngoni	77	49	20	17	4	1
Tumbuka	68	38	14	16	5	1
Other tribe	69	40	15	22	5	1

Note: own computations from MICS data. Malnutrition is classified as follows; mild (z-score ≤-1), moderate (z-score ≤-2), and severe malnutrition (z-score ≤-3).

Table II. Means and standard deviations of variables

	All		Male		Female	
	Mean	SD	Mean	SD	Mean	SD
height-for-age z-score	-1.766	1.443	-1.783	1.434	-1.749	1.453
weight-for-height z-score	0.092	1.244	0.077	1.221	0.107	1.267
Male	0.498	0.500				
Twins	0.029	0.168	0.027	0.163	0.031	0.173
Child's age	27.123	19.185	26.981	19.154	27.265	19.214
Square of child's age	1103.726	1164.202	1094.826	1163.573	1112.572	1164.780
Birth order	4.453	2.508	4.444	2.509	4.463	2.507
Square of birth order	26.119	26.717	26.037	26.849	26.200	26.585
Parental age difference	7.173	10.067	7.327	10.387	7.021	9.736
Mother's age	30.998	7.400	30.924	7.341	31.070	7.458
Square of mother's age	1015.613	479.496	1010.197	475.881	1020.996	483.010
Mother primary education	0.685	0.465	0.680	0.467	0.690	0.462
Mother secondary education +	0.093	0.290	0.095	0.294	0.090	0.287
Father primary education	0.666	0.472	0.672	0.470	0.660	0.474
Father secondary education +	0.170	0.376	0.169	0.375	0.171	0.377
Household size	5.994	2.054	5.966	2.009	6.022	2.098
Square of household size	40.148	28.643	39.634	27.497	40.659	29.730
Poor	0.213	0.409	0.216	0.412	0.209	0.406
Middle	0.211	0.408	0.207	0.405	0.214	0.410
Richer	0.188	0.391	0.187	0.390	0.190	0.392
Richest	0.160	0.366	0.158	0.365	0.161	0.368
Protestant	0.639	0.480	0.635	0.481	0.642	0.480
Catholic	0.198	0.398	0.206	0.404	0.190	0.392
Muslim	0.125	0.331	0.120	0.325	0.129	0.336
Other religion	0.038	0.191	0.038	0.191	0.037	0.190
Urban	0.101	0.301	0.105	0.306	0.097	0.296
North	0.209	0.407	0.216	0.411	0.202	0.402
Centre	0.374	0.484	0.371	0.483	0.377	0.485
South	0.417	0.493	0.413	0.492	0.421	0.494
Observations	53879		26856		27023	

Table III. Birth order and average nutritional status

Birth Order	height-for-age z-score			weight-for-height z-score		
	All	Male	Female	All	Male	Female
1	-1.617	-1.620	-1.615	0.101	0.056	0.145
2	-1.746	-1.766	-1.727	0.150	0.160	0.140
3	-1.744	-1.755	-1.732	0.159	0.142	0.177
4	-1.753	-1.792	-1.713	0.047	0.028	0.066
5	-1.788	-1.812	-1.764	0.096	0.170	0.027
6	-1.780	-1.866	-1.691	0.037	-0.029	0.104
7	-1.722	-1.733	-1.711	0.091	0.038	0.141
8+	-1.957	-1.906	-2.007	0.044	0.014	0.072
Observations	53879	26856	27023	53879	26856	27023

Table IV. Results for height-for-age-z-score and nutrition inequality across areas

		National	SE	Rural	SE	Urban	SE
Male		0.020	(0.018)	0.028	(0.019)	-0.040	(0.060)
Twins		-0.113***	(0.031)	-0.106***	(0.032)	-0.221*	(0.121)
Child's age		-0.003***	(0.001)	-0.003***	(0.001)	-0.011***	(0.002)
Square of child's age		0.000***	(0.000)	0.000**	(0.000)	0.000***	(0.000)
Birth order		0.007	(0.014)	0.012	(0.015)	-0.008	(0.047)
Square of birth order		-0.004***	(0.001)	-0.003***	(0.001)	-0.009**	(0.005)
Male x birth order		-0.005	(0.004)	-0.006	(0.004)	-0.002	(0.016)
Parental age difference		-0.000	(0.001)	0.000	(0.001)	-0.004	(0.004)
Mother's age		-0.013	(0.013)	-0.020	(0.014)	0.041	(0.042)
Square of mother's age		0.000	(0.000)	0.000	(0.000)	-0.000	(0.001)
Mother primary education		-0.012	(0.033)	-0.001	(0.034)	-0.138	(0.128)
Mother secondary education +		0.168***	(0.052)	0.123**	(0.058)	0.173	(0.145)
Father primary education		0.004	(0.038)	0.005	(0.039)	0.011	(0.150)
Father secondary education +		0.215***	(0.047)	0.198***	(0.050)	0.275*	(0.160)
Household size		0.018	(0.029)	0.010	(0.031)	0.075	(0.094)
Square of household size		0.000	(0.002)	0.001	(0.002)	-0.003	(0.007)
Poor		0.145***	(0.034)	0.128***	(0.035)	0.508***	(0.184)
Middle		0.155***	(0.035)	0.140***	(0.036)	0.426**	(0.171)
Richer		0.129***	(0.037)	0.143***	(0.039)	0.122	(0.159)
Richest		0.177***	(0.041)	0.225***	(0.046)	0.199	(0.142)
Protestant		-0.015	(0.056)	-0.001	(0.058)	-0.194	(0.203)
Catholic		-0.050	(0.060)	-0.050	(0.063)	-0.080	(0.210)
Muslim		-0.034	(0.079)	-0.007	(0.084)	-0.286	(0.246)
Chewa		-0.230***	(0.043)	-0.260***	(0.046)	0.007	(0.126)
Lomwe		-0.112**	(0.045)	-0.095*	(0.048)	-0.169	(0.132)
Yao		-0.248***	(0.067)	-0.246***	(0.072)	-0.186	(0.177)
Ngoni		-0.229***	(0.050)	-0.242***	(0.053)	-0.130	(0.144)
Tumbuka		-0.096**	(0.048)	-0.155***	(0.053)	0.153	(0.126)
Urban		0.196***	(0.044)				
North		0.171***	(0.034)	0.210***	(0.038)	0.089	(0.088)
Centre		0.048	(0.033)	0.077**	(0.036)	-0.017	(0.089)
Constant		-1.686***	(0.199)	-1.577***	(0.209)	-2.334***	(0.664)
Within	Explained	0.0003	[0.15]	0.0003	[0.14]	0.0020	[0.67]
	Unexplained	0.1588	[71.98]	0.1578	[75.74]	0.1662	[56.13]
Between	Explained	0.0586	[26.59]	0.0475	[22.81]	0.1241	[41.91]
	Unexplained	0.0028	[1.28]	0.0027	[1.31]	0.0038	[1.28]
Chi2		463.070***		301.404***		123.351***	
Observations		46664		41991		4673	

Note: Standard errors in parentheses. In square brackets is the percentage contribution of each component to total inequality. Significance asterisks are defined as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table V. Results for weight-for-height-z-score and nutrition inequality across areas

		National	SE	Rural	SE	Urban	SE
Male		-0.027*	(0.015)	-0.044***	(0.015)	0.119**	(0.047)
Twins		-0.018	(0.026)	-0.030	(0.027)	0.139	(0.096)
Child's age		-0.002***	(0.001)	-0.002***	(0.001)	-0.001	(0.002)
Square of child's age		0.000**	(0.000)	0.000**	(0.000)	0.000	(0.000)
Birth order		-0.040***	(0.012)	-0.042***	(0.012)	-0.035	(0.037)
Square of birth order		0.000	(0.001)	0.000	(0.001)	0.005	(0.004)
Male x birth order		0.001	(0.003)	0.004	(0.003)	-0.028	(0.112)
Parental age difference		0.000	(0.001)	-0.000	(0.001)	0.004	(0.003)
Mother's age		-0.006	(0.011)	0.005	(0.012)	-0.097***	(0.035)
Square of mother's age		0.000	(0.000)	0.000	(0.000)	0.001**	(0.001)
Mother primary education		0.029	(0.029)	0.038	(0.030)	-0.091	(0.112)
Mother secondary education +		0.025	(0.046)	0.064	(0.051)	-0.156	(0.126)
Father primary education		0.037	(0.033)	0.032	(0.035)	0.126	(0.131)
Father secondary education +		0.062	(0.042)	0.064	(0.044)	0.152	(0.140)
Household size		0.028	(0.026)	0.017	(0.027)	0.118	(0.082)
Square of household size		-0.002	(0.002)	-0.001	(0.002)	-0.008	(0.006)
Poor		0.063**	(0.030)	0.055*	(0.031)	0.286*	(0.152)
Middle		0.003	(0.031)	0.021	(0.032)	-0.370***	(0.142)
Richer		0.126***	(0.032)	0.127***	(0.034)	-0.053	(0.132)
Richest		0.098***	(0.036)	0.107***	(0.041)	-0.043	(0.117)
Protestant		-0.059	(0.050)	-0.053	(0.052)	-0.129	(0.177)
Catholic		-0.050	(0.053)	-0.050	(0.056)	-0.106	(0.184)
Muslim		-0.098	(0.070)	-0.119	(0.074)	-0.050	(0.215)
Chewa		0.272***	(0.038)	0.292***	(0.040)	0.058	(0.109)
Lomwe		0.262***	(0.040)	0.277***	(0.043)	0.140	(0.115)
Yao		0.198***	(0.059)	0.224***	(0.064)	0.075	(0.154)
Ngoni		0.153***	(0.044)	0.167***	(0.047)	0.028	(0.125)
Tumbuka		0.128***	(0.043)	0.156***	(0.047)	-0.054	(0.110)
Urban		-0.055	(0.039)				
North		-0.036	(0.029)	-0.067**	(0.032)	0.148**	(0.074)
Centre		-0.092***	(0.029)	-0.087***	(0.032)	-0.154**	(0.076)
Constant		-0.017	(0.172)	-0.175	(0.182)	1.396**	(0.561)
Within	Explained	0.0001	[0.09]	0.0001	[0.11]	0.0011	[0.63]
	Unexplained	0.1051	[85.50]	0.1053	[83.15]	0.1010	[56.11]
Between	Explained	0.0160	[13.08]	0.0196	[15.48]	0.0760	[42.24]
	Unexplained	0.0016	[1.32]	0.0016	[1.26]	0.0018	[1.02]
Chi2		166.850***		179.858***		74.362***	
Observations		46664		41991		4673	

Note: Standard errors in parentheses. In square brackets is the percentage contribution of each component to total inequality. Significance asterisks are defined as follows: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table VI. Results of nutrition inequality by religion and ethnicity

Group	Within				Between			
	Explained		Unexplained		Explained		Unexplained	
	height-for-age z-score							
Protestant	0.0003	[0.15]	0.1644	[72.61]	0.0586	[25.90]	0.0030	[1.33]
Catholic	0.0011	[0.47]	0.1386	[60.09]	0.0888	[38.48]	0.0022	[0.95]
Muslim	0.0013	[0.52]	0.1730	[67.76]	0.0773	[30.28]	0.0037	[1.43]
Other religion	0.0019	[0.78]	0.1160	[46.97]	0.1281	[51.87]	0.0009	[0.37]
Chewa	0.0002	[0.10]	0.1583	[69.23]	0.0676	[29.55]	0.0025	[1.12]
Lomwe	0.0005	[0.24]	0.1674	[76.29]	0.0481	[21.93]	0.0034	[1.54]
Yao	0.0029	[0.88]	0.1776	[54.58]	0.1407	[43.22]	0.0043	[1.32]
Ngoni	0.0007	[0.28]	0.1501	[60.40]	0.0946	[38.06]	0.0031	[1.25]
Tumbuka	0.0014	[0.61]	0.1232	[53.48]	0.1041	[45.17]	0.0017	[0.73]
Other tribe	0.0012	[0.51]	0.1765	[77.32]	0.0480	[21.04]	0.0026	[1.13]
	weight-for-height z-score							
Protestant	0.0001	[0.13]	0.1099	[84.99]	0.0175	[13.55]	0.0017	[1.32]
Catholic	0.0002	[0.18]	0.0881	[73.32]	0.0305	[25.38]	0.0013	[1.12]
Muslim	0.0012	[0.52]	0.1239	[55.69]	0.0949	[42.63]	0.0026	[1.15]
Other religion	0.0034	[1.17]	0.0704	[24.38]	0.2147	[74.31]	0.0004	[0.14]
Chewa	0.0001	[0.11]	0.1077	[89.01]	0.0115	[9.55]	0.0016	[1.33]
Lomwe	0.0005	[0.39]	0.1092	[80.89]	0.0234	[17.34]	0.0019	[1.37]
Yao	0.0011	[0.50]	0.1177	[52.51]	0.1029	[45.93]	0.0024	[1.06]
Ngoni	0.0007	[0.44]	0.0926	[58.57]	0.0634	[40.10]	0.0014	[0.88]
Tumbuka	0.0004	[0.36]	0.0867	[70.21]	0.0353	[28.56]	0.0011	[0.87]
Other tribe	0.0008	[0.41]	0.1155	[61.24]	0.0707	[37.51]	0.0016	[0.83]

Note: In square brackets is the percentage contribution of each component to total inequality.