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2013 No. 84

DEMOGRAPHIC AND HEALTH SURVEYS

February 2013

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ICF International
Calverton, Maryland, USA

February 2013

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ACKNOWLEDGEMENTS

The author gratefully acknowledges the technical support provided by the ICF International team in the course of writing this paper. In particular, technical support from Thomas Pullum, Sunita Kishor, Sarah E.K. Bradley and Shanxiao Wang is acknowledged. Special thanks go to ICF International reviewers Monica Kuthari and Fred Arnold for their useful comments and their input into the study. The author also gratefully acknowledges USAID and ICF International for funding this research through the DHS Fellows Program. Thank you to Bryant Robey for editing and to Yuan Cheng for formatting the document.

The *DHS Working Papers* series is an unreviewed prepublication series of papers reporting on research in progress that is based on Demographic and Health Surveys (DHS) data. This research is carried out with support provided by the United States Agency for International Development (USAID) through the MEASURE DHS project (#GPO-C-00-08-00008-00). The views expressed are those of the authors and do not necessarily reflect the views of USAID or the United States Government.

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ABSTRACT

Child malnutrition remains one of the health challenges that African countries have to deal with to remain on course to achieve the health-related Millennium Development Goals (MDGs). This study analyzes the impact of maternal education on child nutritional status in three African countries, based on data from the Demographic and Health Surveys (DHS), the 2010 Malawi DHS, with a sample of 4,563 children age 0-59 months; the 2009-10 Tanzania DHS, 4,821 children; and the 2005-06 Zimbabwe DHS, 3,473 children. Bivariate analyses and the Pearson Chi-square test of independence were used to test the association of maternal education and three measures of child nutrition—stunting, wasting, and underweight. A survey logistic regression was employed to assess the determinants of the three measures and to examine the relationship between maternal education and child nutrition.

The results show that in all three countries the three measures of child nutritional status significantly decrease with increased levels of mother's education. The analysis also shows that, after controlling for other factors, maternal education reduces the odds of the three measures of child nutrition in all three countries. The threshold level of maternal education above which it significantly improves child stunting and underweight is 9 years of schooling in Malawi and 11 years of schooling in Tanzania and Zimbabwe.

The policy implication is that the free primary education currently offered in the three countries may not be sufficient to address child malnutrition. In all three countries, if maternal education is to play a significant role in reducing child malnutrition, women need to be educated beyond the primary school level. In addition, offering nutritional education programs for women, particularly those with low levels of education, would help them attain better nutritional outcomes for their children.

Keywords: Maternal education, child nutrition, stunting, Malawi, Tanzania, Zimbabwe.

INTRODUCTION AND PROBLEM STATEMENT

Child malnutrition remains one of the many health challenges facing Africa today. The problem of malnutrition has an impact on health, education, and the economy of the affected countries. Malnutrition is a major single and underlying cause of child morbidity and mortality in many southern African countries, including Malawi. In Malawi nearly half of children age 0-59 months are chronically stunted, and the proportion of stunted children is 24 times the level expected in a healthy, well-nourished population (ORC Macro 2006). Further, about one-third of all under-five deaths in Malawi are related to either moderate or severe malnutrition (ORC Macro 2006).

Nutritional status of under-five children is an important outcome measure of children's health (NBS and ICF Macro 2011). Research shows that the level of resistance to infection is lower for malnourished children than other children, causing high levels of morbidity and mortality (UNICEF 2001). Further, poor nutrition also affects the cognitive development of children.

The importance of mother's education for child health and nutrition has been well demonstrated (Caldwell 1979, Kabubo-Mariara et al. 2009, Ruel et al. 1992). According to Mosley and Chen (1984), maternal education affects children's health and nutritional outcomes through its effect on improving women's socioeconomic status. In turn higher socioeconomic status affects a set of "proximate determinants" of health that directly affect the health and nutritional outcomes of children. The proximate determinants include fertility factors, feeding practices, and the utilization of health services. After controlling for household socioeconomic characteristics, studies have concluded that maternal education is an important determinant of child survival. The various pathways through which maternal education promotes child survival, as suggested by the literature, include the acquisition of health knowledge, adherence to recommended feeding practices for children, and increased command over resources.

Since the 1990s there has been a drive to promote free primary education in Africa. For example, free primary education was introduced in Malawi in 1994 to promote literacy. One of the implicit assumptions in the promotion of free primary education is that improved literacy would lead to better health-seeking behavior and improved nutrition for the population. In particular, it has been argued that literate women are more likely to be aware of the importance

of immunizing children against diseases, feeding children at appropriate times and in the right quantities, and taking early actions against infant diarrhea.

Table 1 shows female literacy rates and indicators of child malnutrition in Malawi, Tanzania, and Zimbabwe in 2008. The female adult literacy rate was highest in Zimbabwe, at 89 percent, and lower in Malawi and Tanzania, at 66 percent each. The percentages of children stunted, wasted, and underweight all were lower in Zimbabwe than in Malawi and Tanzania, but there appears to be no consistent pattern of association between literacy levels and the indicators of malnutrition. It is currently not clear whether the introduction of free primary education, leading to increased levels of literacy in sub-Saharan Africa, has significantly contributed to improved child nutrition. Further, the debate remains inconclusive as to whether there is a threshold level of maternal education needed before reductions in child malnutrition begin to accrue.

This is the entry point of this study. The research will analyze the relationship between maternal education and child malnutrition, using stunting as an indicator, and examine the minimum level of maternal education that is sufficient to promote child nutrition in southern Africa. This will provide policy options with regard to the role of free primary education in the promotion of child nutrition in the region.

Table 1. Female literacy rates and child malnutrition in Malawi, Tanzania and Zimbabwe

	Malawi		Tanzania		Zimbabwe	
Indicator	**Statistic (%)**	**Year**	**Statistic (%)**	**Year**	**Statistic (%)**	**Year**
Female adult literacy* rate	65.8	2008	66.3	2008	88.8	2008
% of children (0-59 months) who are stunted	47.1	2010	42.0	2010	28.1	2005/06
% of children (0-59 months) who are wasted	4.0		4.8		15.8	
% of children (0-59 months) who are underweight	12.8		15.8		5.8	

Source: Child nutrition figures (stunting, wasting and underweight) are from DHS Country Reports:
Literacy figures are from the World Bank.

Note: Female adult literacy rate only considers women age 15 and older.

* According to the World Bank, adult female literacy rate is the percentage of females age 15 and older who can, with understanding, read and write a short, simple statement on their everyday life.

REVIEW OF THE LITERATURE

Most of the past studies linking maternal education and child nutrition have focused on identifying different pathways through which the education of a mother affects the nutrition of her children. Using data from Nigeria, Caldwell (1979) argued that the education of the mother plays an important role in determining child survival even after controlling for household socioeconomic characteristics. The pathways highlighted by his paper include improved mother's health knowledge and greater control over the health choices for her children, among others. Since Caldwell's paper, studies have shown mixed results about the effect of maternal education on child nutritional status. Gwatkin et al. (2000) found that prevalence of child malnutrition is lower among children of educated mothers. Desai and Alva (1998), however, found that the effect of maternal education on height-for-age was significant only in 5 of the 22 countries studied. Other earlier studies, including Bairagi (1980) and Solon et al. (1985) found a significant association between maternal education and child nutrition only for the richest households, and the association was not significant for the poorest households.

In the literature, modeling the effects of maternal education on child nutrition outcomes has focused on four factors: socioeconomic status; women's empowerment and autonomy; health knowledge and attitudes; and health and reproductive behavior (Emina et al. 2009). A number of studies that use maternal education as a proxy for socioeconomic status both at the individual and household levels argue that women with more education tend to have better work opportunities, and they are also more likely to marry men with more education (Cleland and Van Ginneken 1988). Further, more educated women tend to live in urban areas, where they have access to better health and sanitation services.

Using data from Cambodia's 2005 DHS survey, Miller and Rodgers (2009) analyzed how nutritional status of under-five children varied with maternal education, using birth size, low height-for-age (stunting), and low weight-for-height (wasting) as measures of children's nutritional status. After controlling for socioeconomic status, the study found that maternal education was strongly inversely associated with stunting, but not with small birth size or wasting. The inverse relationship between maternal education and child malnutrition has also been reported in other studies, such as Mukuria et al. (2005) and Frost et al. (2005).

Models on women's empowerment and autonomy argue that women's education promotes empowerment and influences participation in decisions that affect child nutrition and access to health services (Emina et al. 2009). Hobcraft (1993) argued that education permits women to exert greater control over health choices for their children. A series of studies have argued that maternal education affects child nutrition through health knowledge and attitudes, and in particular that maternal education improves the mother's knowledge about child health, including causes, prevention, and treatment of diseases (Frost et al. 2005). Further, maternal education promotes positive attitudes toward health-seeking behavior for their children, including awareness of the importance of immunization (Ruel et al. 1992). Caldwell (1979) argued that maternal education leads to "a shift from 'fatalistic' acceptance of health outcomes towards implementation of simple health knowledge." Emina et al. (2009) observed that children whose mothers are educated tend to live in more hygienic environments and are more likely to be vaccinated and have better nutritional outcomes.

Another set of studies focuses on health and reproductive behavior as a pathway through which maternal education affects child nutrition. For example, using data from Bolivia, Forste (1998) showed that short birth intervals are associated with higher prevalence of stunting. Other studies have shown that more educated women have longer birth intervals and give birth at low-risk ages (Cleland and van Ginneken 1998, Mukuria et al. 2005), and their children tend to have better nutritional outcomes. Studies by Bairagi (1980) and Solon et al. (1985) found that, while maternal education had a positive effect on child nutritional status, the effect was limited to the richer segments of their study populations. Education had no effect in the poorer segments.

Another set of studies looks at the association between mother's education and child survival, without explicitly looking at nutrition. Using 28 World Fertility Surveys, Hobcraft et al. (1984) reported that the relationship between maternal education and child survival was weaker in sub-Saharan Africa than in Asia and Latin America. The paper further concluded that there was no minimum level of maternal education needed before benefits in child survival began to accrue.

Kabubo-Mariara et al. (2009) analyzed the determinants of children's nutritional status in Kenya using a pooled sample of 1998 and 2003 Kenya DHS data sets. The study analyzed the impact of child, parental, household, and community characteristics on children's height and on

the likelihood of suffering from stunting. The study found that boys were more likely to be malnourished than girls, and children of multiple births were more likely to be malnourished than their counterparts. The study also found maternal education to be a more important determinant of children's nutritional status than the educational attainment of the father.

OBJECTIVES

This analysis uses the most recent DHS data from Malawi, Tanzania, and Zimbabwe to understand how children's nutritional status varies by mother's educational attainment in the three countries. The main objective is to assess how children's nutritional status varies by mother's educational attainment.

Specific Objectives

The study addresses the following specific objectives:

- To estimate the association between maternal education and child nutrition in Malawi, Tanzania, and Zimbabwe;
- To identify the determinants of child nutritional status in the three countries;
- To identify a threshold level of maternal education required to reduce child malnutrition in the three countries.

Research Questions

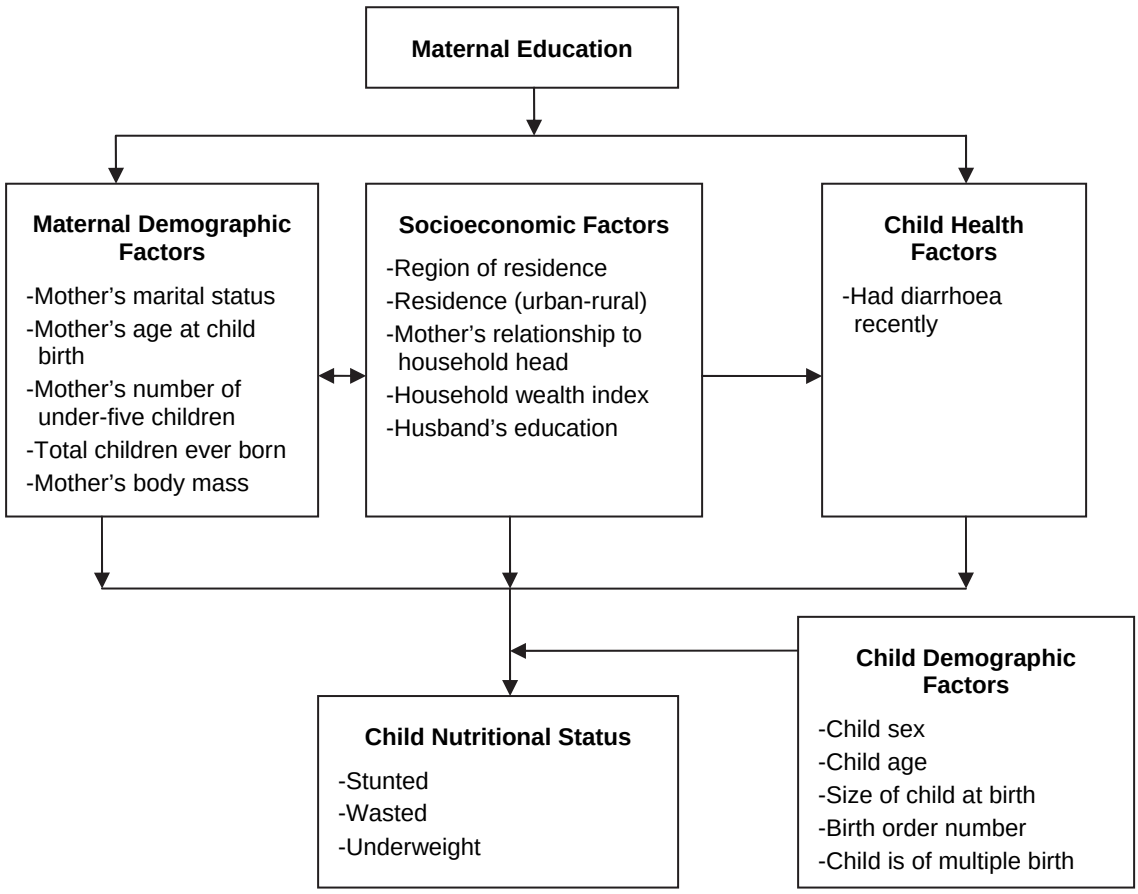
Based on the specific objectives, the study aims to answer the following questions:

- What is the association between education levels of mothers and levels of child malnutrition (stunting, wasting, and underweight)?
- What are the major child, maternal, and socioeconomic characteristics that affect child nutrition in the three countries?
- Is there a threshold level of maternal education required to reduce child malnutrition in the three countries?

CONCEPTUAL FRAMEWORK

The conceptual framework guiding this study is based on the linkage between maternal schooling, childcare, and nutritional outcome. Figure 1 shows the possible linkages between maternal education and child nutrition that this study explores. The possible pathway through which maternal education can affect nutritional outcomes of children is through skill acquisition that leads to improved knowledge about health care and nutritional knowledge. It is therefore expected that women with more education are more aware of the benefits of immunizing children against diseases, the importance of taking children to health clinics, feeding children at the appropriate times and in right quantities, and preventing child illnesses. These practices can improve child nutrition and health.

Figure 1. Linkages between maternal education and child nutrition



Source: Adapted from UNICEF (1998)

METHODOLOGY

The study uses multivariate analysis to assess the relationship between the different measures of child nutritional status. The Pearson $\chi 2$ test of independence is used to test the association between the different measures of children's nutritional status (stunting, wasting, and underweight) and other categorical variables, such as educational level of the mother, place of residence, and age of the child. The Pearson $\chi 2$ statistic is generated by taking into account the survey design that was used in the collection of the data.

In order to control for DHS sample design, a survey logistic regression analysis is used in the analysis of the determinants of child nutritional status, instead of an ordinary least squares (OLS) regression. Unlike OLS regression, sampling weights, clustering, and stratification are all taken into account when calculating standard errors under survey regression analysis (Kabubo-Mariara et al. 2009). Failure to account for the survey design leads to increased variance of the estimator compared with the variance under simple random sampling (Holt and Scott 1981).

DATA

The study uses the most recent DHS survey from each of the three countries (Malawi 2010, Tanzania 2009-10, and Zimbabwe 2005-06).

Table 2. Description of datasets

Country	Sampling frame	Number of clusters	Number of interviewed women
Malawi	2008 Malawi Population and Housing Census	849	23,020
Tanzania	2002 Population and Housing Census	475	10,139
Zimbabwe	2002 Zimbabwe Master Sample*	400	8,907

Source: DHS Country Reports

* The 2002 Zimbabwe Master Sample was developed by the Central Statistical Office after the 2002 Population Census (CSO and Macro International 2007).

The DHS are nationally representative surveys of women age 15-49 and their households. Among other characteristics, the DHS surveys collect data on anthropometric indicators to provide outcome measures of nutritional status of under-five children. The study only considers data on children age 0-59 months belonging to interviewed, de facto women. The study uses a weighted sample of 4,563 children (0-59 months) in Malawi, 4,821 children (0-59 months) in Tanzania, and 3,473 children (0-59 months) in Zimbabwe who had no missing information on height-for-age Z-scores, weight-for-height Z-scores, and weight-for-age Z-scores and with no missing information on mother's body mass index.

Important Variables

Child Nutritional Status

The dependent variable is child nutritional status. Child nutritional status is measured using height and age data. Height-for-age is an anthropometric measure that is determined by both prenatal and postnatal growth, and low height-for-age is associated with effects of inadequate nutrition and health that accumulate over a period of time (Gillespie and Haddad

2001). Three measures of children's nutritional status that are used in the study are stunting, wasting, and underweight. Children (age 0-59 months) whose height-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the WHO reference population are considered stunted, or chronically malnourished (NBS and ICF Macro 2011). This means that a child who is stunted is considered short for age, a measure of chronic nutritional deficiency (Rutstein and Rojas 2006).

Wasting relates to the weight-for-height index which measures body mass in relation to body height or length and describes current nutritional status. Children (0-59 months) with Z-scores below minus two standard deviations (-2SD) are considered wasted, or acutely malnourished. Further, weight-for-age is a composite index of height-for-age and weight-for-height. It takes into account both chronic and acute malnutrition. Children (0-59 months) with weight-for-age below minus two standard deviations are classified as underweight. Height-for-age does not distinguish between chronic malnutrition (stunting) and acute malnutrition (wasting) (NSO and ICF Macro 2011).

Maternal Education

Maternal education is used as a categorical variable in this study based on the total number of years of formal schooling for the mother. Five categories are used in the analysis: (1) No schooling; (2) Junior primary (i.e. 1-4 years); (3) Senior primary (5-7 years for Tanzania and Zimbabwe, 5-8 years for Malawi) (4) Junior secondary (8-10 years for Tanzania and Zimbabwe), (9-10 years for Malawi); and (5) Senior secondary and above (>10 years).

RESULTS

Descriptive Statistics

Table 3 shows that 44 percent of children studied in Malawi were stunted, 42 percent in Tanzania, and 33 percent in Zimbabwe. In all three countries wasting was a relatively small problem, affecting 4 percent of sampled children in Malawi, 5 percent in Tanzania, and 6 percent in Zimbabwe. The prevalence rate of underweight among the sampled children was 12 percent in Malawi and Zimbabwe, and 16 percent in Tanzania.

The average age of the sampled children in each of the three countries was 29 months, and children were fairly equally distributed by gender. The average age of mothers of the sampled children was 28 years in Malawi and Zimbabwe, and 30 in Tanzania, living in households with an average of six members in Malawi and Zimbabwe, and seven in Tanzania. The proportion of female household heads in the sample was highest in Zimbabwe (33 percent) and lowest in Malawi (8 percent). Further, in all three countries the sample population was predominantly rural, at over 80 percent in Malawi and Tanzania, and 74 percent in Zimbabwe.

Mother's education is a key variable in this study. The percentage of women with no education was highest in Tanzania (26 percent), followed by Malawi (18 percent), and lowest in Zimbabwe (4 percent). While 53 percent of the women in Zimbabwe had at least a junior secondary school education, the proportion of women with similar educational attainment was much lower in Malawi (15 percent) and in Tanzania (7 percent).

Among the environmental determinants of child nutritional status reported in the literature are access to safe water and improved toilet facilities. The results indicate that access to safe water was highest in Malawi (78 percent) and lowest in Tanzania (53 percent). Further, the proportion of households with improved toilet facilities was highest in Zimbabwe (54 percent) and lowest in Tanzania (14 percent).

Table 3. Descriptive statistics

	Malawi		Tanzania		Zimbabwe	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Child nutritional status						
Stunted	0.44	0.01	0.42	0.01	0.33	0.01
Wasted	0.04	0.00	0.05	0.00	0.06	0.00
Underweight	0.12	0.01	0.16	0.01	0.12	0.01
Child demographic factors						
Age of child (in months)	28.89	0.27	28.56	0.19	28.90	0.36
Male child	0.49	0.01	0.50	0.01	0.51	0.01
Size of the child at birth- Small	2.69	0.07	3.03	0.03	2.73	0.02
Child is of multiple birth	0.03	0.00	0.02	0.00	0.02	0.00
Birth order	3.60	0.05	3.89	0.05	2.88	0.05
Child health factors						
Had diarrhoea recently	0.15	0.01	0.15	0.01	0.13	0.01
Maternal demographic factors						
Mother's current age	28.40	0.13	29.54	0.15	28.07	0.12
Number of under-five children	1.84	0.02	2.23	0.05	1.80	0.03
Currently breastfeeding	0.65	0.01	0.62	0.01	0.50	0.01
Socioeconomic factors						
Household head is female	0.08	0.01	0.14	0.01	0.33	0.01
Total number of people in the household	5.94	0.05	7.23	0.19	6.05	0.09
Rural residence	0.85	0.01	0.82	0.01	0.74	0.02
Husband's education (in single years)	8.05	0.29	6.25	0.17	9.47	0.26
Mother's education –None	0.18	0.01	0.26	0.01	0.04	0.01
Mother's education –Junior Primary	0.29	0.01	0.10	0.01	0.06	0.01
Mother's education –Senior Primary	0.38	0.01	0.57	0.01	0.37	0.02
Mother's education –Junior Secondary	0.08	0.01	0.04	0.00	0.50	0.03
Mother's education –Senior Secondary +	0.07	0.01	0.03	0.00	0.03	0.00
Household with safe water	0.78	0.01	0.53	0.02	0.70	0.03
Household with improved toilet facility	0.17	0.01	0.14	0.01	0.54	0.02
N	4,563		4,821		3,473	

Bivariate Analysis Results

In all three countries stunting was highly associated with mother's educational level. Table 4 shows that the prevalence of stunting decreases as the mother's educational level increases. In all three countries child stunting was highest for children whose mothers had no schooling and was lowest among children whose mothers had senior secondary education and above. These results are consistent with findings from other studies, including Kabubo-Mariara

et al. (2009) in Kenya and Mbuya et al. (2010) in Zimbabwe. The results of the Pearson Chi-square test show that the two variables are statistically significantly related.

While child wasting was statistically significantly related to maternal education in Tanzania and Zimbabwe, the relationship was not statistically significant in Malawi. Although in all three countries the prevalence of wasting appears to fall as maternal education increases, the Pearson Chi-square test of independence shows that the two variables are only associated in Tanzania and Zimbabwe. This result, that stunting is more associated than wasting with the mother's education is consistent with the literature. In particular, Frost et al. (2005) argue that stunting depicts chronic malnutrition that is influenced more by the mother's demographic and socioeconomic characteristics than is wasting.

The prevalence of underweight in under-five children in Malawi, Tanzania, and Zimbabwe was also negatively associated with the mother's educational attainment, and the relationship is statistically significant. This result is consistent with DHS findings from other countries, regardless of the continent (for more details see Kothari and Abderrahim 2010).

Table 4. Nutritional status of children by mother's educational level in Malawi, Tanzania and Zimbabwe

	Malawi (2010)			Tanzania (2009/10)			Zimbabwe (2005/06)		
Variable	Height-for-age (% below -2SD)	Weight-for-height (% below -2SD)	Weight-for-age (% below -2SD)	Height-for-age (% below -2SD)	Weight-for-height (% below -2SD)	Weight-for-age (% below -2SD)	Height-for-age (% below -2SD)	Weight-for-height (% below -2SD)	Weight-for-age (% below -2SD)
Mother's educational level									
No education	50.3	4.8	15.1	44.9	6.1	18.9	33.8	7.0	17.6
Junior primary	46.9	0.4	12.9	46.3	6.4	17.0	34.5	7.3	11.6
Senior primary	42.9	3.7	11.8	41.2	4.0	14.7	34.1	8.2	14.2
Junior secondary	41.7	2.4	7.3	30.4	4.9	9.6	32.5	5.1	10.9
Senior secondary +	29.9	2.1	6.7	12.5	3.8	5.8	16.7	1.5	1.3
Total	44.5	3.9	12.0	41.4	4.8	15.6	32.9	6.4	12.2
Pearson χ2	46.9	7.6	26.1	97.1	16.0	40.0	14.0	18.1	25.4
Prob	0.00	0.23	0.01	0.00	0.02	0.00	0.07	0.01	0.00
N		4,563			4,821			3,473	

Table 5. Nutritional status by place of residence and age of the child in Malawi, Tanzania and Zimbabwe

	Malawi (2010)			Tanzania (2009/10)			Zimbabwe (2005/06)		
Variable	Height-for-age (% below -2SD)	Weight-for-height (% below -2SD)	Weight-for-age (% below -2SD)	Height-for-age (% below -2SD)	Weight-for-height (% below -2SD)	Weight-for-age (% below -2SD)	Height-for-age (% below -2SD)	Weight-for-height (% below -2SD)	Weight-for-age (% below -2SD)
Place of residence									
Urban	38.2	2.4	10.1	30.6	5.0	11.5	26.6	5.2	8.4
Rural	45.6	4.2	12.4	44.0	4.8	16.6	35.1	6.8	13.5
Pearson χ2	13.8	5.4	3.0	79.6	0.12	20.8	25.2	3.1	18.7
Prob	0.01	0.09	0.25	0.00	0.79	0.00	0.00	0.18	0.00
Age of the child									
Less than 6 months	14.2	5.7	5.3	18.1	6.1	8.2	13.8	9.3	7.7
6-11 months	25.1	6.2	9.6	24.3	9.9	14.9	23.5	9.0	11.4
12-23 months	52.5	6.3	15.1	49.3	7.0	18.4	38.8	6.4	12.7
24-35 months	54.1	2.3	12.8	53.2	3.3	15.6	39.8	6.7	15.5
36-47 months	48.6	2.4	12.2	47.7	2.0	15.8	39.5	4.8	11.8
48-59 months	46.1	2.0	12.0	37.7	3.0	16.9	28.5	4.5	11.6
Pearson χ2	316.7	50.3	32.0	401.7	99.0	42.2	133.1	18.6	16.0
Prob	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08
N		4,826			6,924			3,969	

As Table 5 shows, in all three countries the prevalence of stunting, wasting, and underweight was lower in urban areas than in rural areas. The Chi-square test of independence shows that the relationship between the different measures of children's nutritional status and place of residence is statistically significant at the 5 percent level. This result is consistent with findings from other studies. For example, using DHS data from 36 countries, Kothari and Abderrahim (2010) showed that nutritional status of children was better in urban areas than in rural areas, in part because mothers in urban areas had better access to nutritional information and were more educated than mothers in rural areas, and they were more likely to take a child with fever or diarrhoea to a health facility.

Multivariate Analysis Results

Determinants of Stunting

Table 6. Logistic regression analysis for the determinants of stunting among children (0-59 months) in Malawi, Tanzania and Zimbabwe

	Height- for-Age (% below -2SD) =1; 0 otherwise					
	Malawi		Tanzania		Zimbabwe	
Dependent variable	**Odds ratio**	**t**	**Odds ratio**	**t**	**Odds ratio**	**t**
Explanatory variables						
Child demographic factors						
Age of child (in months)	1.02	7.57***	1.02	6.38***	1.01	3.07***
Male child	1.36	4.04***	1.50	5.56***	1.39	4.12***
Large size of the child at birth	0.48	-5.94***	0.56	-3.74***	0.66	-3.60***
Child is of multiple birth	2.75	2.56***	3.11	2.73***	2.67	2.79***
Birth order	1.05	1.46	1.07	2.30**	1.05	1.23
Maternal demographic factors						
Mother's current age	0.98	-1.39	0.97	-2.31**	1.00	-0.36
Mother's body mass - underweight	1.20	1.18	1.29	1.89	0.98	-0.14
Mother's body mass - normal	1..00		1.00		1.00	
Mother's body mass - overweight	0.69	-2.76**	0.83	-1.56	0.81	-1.90
Mother's body mass – pregnant and postpartum	0.90	-0.86	0.79	-2.13**	0.73	-2.04**
Number of under-five children	1.05	0.77	1.02	0.42	1.04	0.49
Socioeconomic factors						
Household head is female	0.94	-0.44	1.21	1.59	0.90	-1.05
Total number of people in the household	0.97	-1.43	0.99	-0.39	0.98	-0.66
Rural residence	0.89	-0.81	1.05	0.39	1.12	0.56
Wealth	0.87	-3.45***	0.90	-2.39**	0.92	-1.10
Mother's education – None	1.00		1.00		0.87	-0.59
Mother's education – Junior Primary	0.85	-1.25	1.06	0.45	0.84	-0.78
Mother's education – Senior primary	0.82	-1.57	0.90	-1.02	1.00	
Mother's education – Junior secondary	0.89	-0.56	0.70	-1.50	1.03	0.28
Mother's education – Senior secondary +	0.56	-2.24**	0.31	-4.00***	0.51	-2.00**
Household with safe water	0.91	-0.93	1.05	0.46	1.22	1.65
Household with improved toilet facility	1.03	0.26	0.74	-2.10**	1.10	0.52
F statistic	6.70***		5.61***		3.16***	
N	4,563		4,821		3,472	

Note: *** significant at 1% level; ** significant at 5% level; RC is the reference category

Other variables included in the model but not reported include marital status and region.

Table 6 presents the results of multivariate analysis on the determinants of child stunting in Malawi, Tanzania, and Zimbabwe. While the concern of this paper is not on analyzing the different determinants of child nutritional status, it is important to highlight the major child demographic factors, maternal factors, and other household socioeconomic factors that influence child nutritional status in the three countries. The results show that child nutritional factors are important determinants of stunting. In particular, older children, boys and multiple-birth children were all significantly more likely to be stunted than their counterparts. These findings are consistent with the literature (see Kabubo-Mariara et al. 2009, Mbuya et al. 2010). Further, the size of the child at birth is inversely related to stunting in all three countries.

Among the maternal demographic factors studied, the age of the mother was inversely related to stunting in all three countries but the result was statistically significant only in Tanzania. The results show no clear pattern between the mother's body mass and child stunting in the three countries. While mothers who were overweight (BMI ≥25.00) were less likely to have stunted children, the results were only significant for Malawi and Tanzania.

The main socioeconomic factor that seems to explain whether a child is stunted or not in the three countries is wealth. In Malawi and Tanzania, wealth was significantly associated with a lower likelihood of being stunted, while in Zimbabwe the result was not statistically significant. Improved toilet facility was the only environmental factor associated with a lower likelihood of being stunted, and only in Tanzania.

Maternal Education and Stunting

The multivariate results (Table 6) show that in all three countries, while maternal education was inversely related to child stunting, the results were only significant at high levels of education (secondary education and above). In particular, higher levels of maternal education compared with no education reduced the odds of stunting in Malawi and Tanzania but the results were significant only at the highest level of education. In Zimbabwe[1], higher levels of maternal

[1] While the reference category for maternal education in the multivariate analyses was "no education" in Malawi and Tanzania, it was changed to "senior primary" in Zimbabwe because there were few cases of women (only 4 percent) who had no education in Zimbabwe. Using "no education" as the reference category would not therefore yield any significant results for Zimbabwe.

education compared with senior primary education reduced the odds of child stunting, with significant results obtained only at the highest level of maternal education.

These findings support the results of Kabubo-Mariara et al. (2009). Using a pooled sample from 1998 and 2003 Kenya DHS datasets, with two mothers' education variables in their model, the researchers found a positive but not significant relationship between mothers' years of primary education and stunting. They also found that mothers' years of post-primary education were significantly inversely related to stunting. A similar study by Mbuya et al. (2010) that used Zimbabwe 2005/06 DHS data also found an inverse, but not significant, relationship between child stunting and mother's education.

In the present study, the interaction between maternal education and other variables such as wealth was tried in the modelling but did not yield any significant result. These were therefore dropped in the final model.

Determinants of Wasting

Table 7 shows that, unlike stunting, only a few child demographic variables were statistically significant in explaining variation in child wasting in Malawi, Tanzania, and Zimbabwe. In particular, in all three countries the age of the child was the only statistically significant child demographic variable in explaining the inverse relationship with child stunting. The size of the child at birth was inversely associated with reduced wasting but the result was only statistically significant for Zimbabwe. Among the maternal demographic factors used in the model, the only variables that were statistically significant in explaining wasting were the various categories of mother's body mass. These were significant in Tanzania and partially significant in Malawi, but not in Zimbabwe. The only socioeconomic factor that was significant besides maternal education was the total number of people in the household. This was significant only in Zimbabwe, showing an inverse relationship with stunting.

Table 7. Logistic regression analysis for the determinants of wasting among children (0-59 months) in Malawi, Tanzania and Zimbabwe

	Weight-for-Height (% below -2SD) =1; 0 otherwise					
	Malawi		Tanzania		Zimbabwe	
Dependent variable	**Odds ratio**	**t**	**Odds ratio**	**t**	**Odds ratio**	**t**
Explanatory variables						
Child demographic factors						
Age of child (in months)	0.97	-4.45***	0.97	-4.16***	0.98	-3.96***
Male child	1.18	0.94	1.39	1.94	1.17	0.92
Large size of the child at birth	0.63	-1.75	0.61	-1.82	0.55	-3.27***
Child is of multiple birth	2.22	1.51	0.68	-0.71	1.47	0.88
Birth order	1.01	0.11	1.02	0.21	0.99	-0.10
Child health factors						
Had diarrhoea recently	0.84	-0.73	1.20	0.71	1.51	2.33**
Maternal demographic factors						
Mother's current age	0.95	-1.57	1.00	0.03	1.02	1.06
Mother's body mass - underweight	1.55	1.16	2.32	3.48***	1.53	1.80
Mother's body mass - normal	1.00		1.00		1.00	
Mother's body mass - overweight	0.65	-1.04	0.55	-1.94	1.05	0.21
Mother's body mass – pregnant and postpartum	0.94	-0.20	1.11	0.46	1.31	1.21
Number of under-five children	0.76	-1.94	1.01	0.06	1.07	0.64
Socioeconomic factors						
Household head is female	1.37	0.90	0.92	-0.27	0.84	-0.98
Total number of people in the household	1.08	1.36	1.01	0.40	0.84	-3.63***
Rural residence	1.37	0.79	1.32	1.04	1.05	0.13
Wealth	0.97	-0.40	1.05	0.57	1.04	0.37
Mother's education – None	1.00		1.00		0.79	-0.56
Mother's education – Junior Primary	0.75	-1.19	0.95	-0.15	0.97	-0.09
Mother's education – Senior Primary	0.69	-1.36	0.55	-2.76***	1.00	
Mother's education – Junior Secondary	0.43	-1.75	0.33	-2.24**	0.61	-2.22**
Mother's education – Senior secondary +	0.34	-2.04**	0.33	-1.98**	0.15	-240**
Household with safe water	0.82	-0.74	1.03	0.14	0.96	-0.22
Household with improved toilet facility	1.25	0.77	1.04	0.19	0.85	-0.74
F statistic	3.40***		4.74***		3.52*	
N	4,531		4,739		3,473	

Note: *** significant at 1% level; ** significant at 5% level; RC is the reference category

Other variables included in the model but not reported include marital status and region.

Maternal Education and Wasting

As with stunting, maternal education was inversely related to wasting but the results were significant only at high levels of education. Table 7 shows that, while higher levels of maternal education were associated with reduced wasting compared with no education, the results were only significant at the senior secondary and above level in Malawi, at the senior primary level and above in Tanzania, and at the junior secondary level and above in Zimbabwe. These results are comparable to other findings in the literature. For example, in their study using the Cambodia 2005 DHS, Miller and Rodgers (2009) did not find any significant inverse association between maternal education and wasting, but found a significant inverse relationship between mother's education and stunting. In the present study, the interaction between maternal education and wealth did not yield any meaningful result and was finally dropped in the final model.

Determinants of Underweight

Table 8 shows that many of the child demographic factors were statistically significant in explaining underweight among the sampled children. Older children had higher odds of being wasted but the result was only statistically significant for Malawi. Boys had higher odds of being underweight in all three countries but the results were only statistically significant in Malawi and Tanzania. Size of the child at birth was statistically inversely associated with underweight in all three countries. Further, children of multiple births had higher odds of being underweight in all three countries.

Among maternal demographic factors, in all three countries children born to underweight mothers had higher odds of being underweight themselves compared with children whose mothers were of normal weight. Children of overweight mothers had lower odds of being underweight compared with mothers of normal weight.

Table 8. Logistic regression analysis for the determinants of underweight among children (0-59 months) in Malawi, Tanzania and Zimbabwe

	Weight-for-Age (% below -2SD) =1; 0 otherwise					
	Malawi		Tanzania		Zimbabwe	
Dependent variable	**Odds ratio**	**t**	**Odds ratio**	**t**	**Odds ratio**	**t**
Explanatory variables						
Child demographic factors						
Age of child (in months)	1.01	2.26**	1.01	1.69	1.00	1.67
Male child	1.29	2.20**	1.50	4.01***	1.24	1.31
Large size of the child at birth	0.38	-6.70***	0.40	-5.54***	0.47	-4.87***
Child is of multiple birth	2.27	2.35**	2.65	3.98***	2.09	2.51**
Birth order	1.05	0.94	1.05	1.07	1.03	0.62
Child health factors						
Had diarrhoea recently	1.58	3.28***	1.19	1.22	1.54	2.84***
Maternal demographic factors						
Mother's current age	0.98	-1.13	0.99	-0.36	1.00	0.23
Mother's body mass - underweight	1.77	2.87***	1.96	3.89***	1.89	3.29***
Mother's body mass - normal	1.00		1.00		1.00	
Mother's body mass - overweight	0.57	-2.32***	0.54	-3.23***	0.76	-1.51
Mother's body mass – pregnant and postpartum	0.98	-0.14	0.97	-0.21	0.76	-1.25
Number of under-five children	1.09	0.93	1.06	0.77	1.28	2.59**
Socioeconomic factors						
Household head is female	1.62	2.18**	1.42	1.75	0.90	-0.79
Total number of people in the household	0.97	-0.84	0.98	-0.81	0.92	-2.73***
Rural residence	0.78	-1.17	0.95	-0.28	1.00	-0.01
Wealth	0.38	-0.96	0.87	-2.09**	0.95	-0.62
Mother's education – None	1.00		1.00		0.95	-0.14
Mother's education – Junior Primary	0.78	-1.49	0.91	-0.43	0.68	-1.30
Mother's education – Senior Primary	0.77	-1.46	0.79	-1.71	1.00	
Mother's education – Junior Secondary	0.46	-2.34**	0.57	-1.58	0.85	-1.22
Mother's education – Senior secondary +	0.45	-1.99**	0.40	-2.18**	0.12	-2.78***
Household with safe water	0.92	-0.57	0.84	-1.46	1.41	1.73
Household with improved toilet facility	0.84	-0.97	0.88	-0.83	0.86	-0.70
F statistic	4.79***		3.65***		4.70***	
N	4,563		4,821		3,473	

Note: *** significant at 1% level; ** significant at 5% level; RC is the reference category

Other variables included in the model but not reported include marital status and region.

Among the socioeconomic factors used in the model, only a few were statistically significant in one or two countries. In Malawi children from female-headed households had higher odds of being underweight. The result was similar for Tanzania but was not statistically significant, while in Zimbabwe the opposite was true, although not statistically significant. Wealth was inversely associated with underweight and was statistically significant only in Tanzania.

Maternal Education and Underweight

Table 8 also shows that, consistent with results from other measures of child nutritional status in this study, higher levels of maternal education compared with no education reduced the odds of children being underweight in Malawi and Tanzania, but the results were significant only at the junior secondary and above level in Malawi and senior secondary level and above in Tanzania. In Zimbabwe, while higher levels of education compared with senior primary level were associated with reduced odds of being underweight, the result was only significant at the highest category of maternal education. As with stunting and wasting, the interaction between maternal education and wealth did not yield any significant result and was therefore dropped in the final model.

Maternal Education Threshold Level

The multivariate results for the three measures of child nutritional status have shown that while the education of the mother is an important determinant of the nutritional status of their children, the relationship is statistically significant only at high levels of education. For stunting, the effect of increasing maternal education appears only at the senior secondary and above level, in all three countries. In the case of wasting, maternal education shows a significant impact at the senior primary level and above in Tanzania, at the junior secondary level and above in Zimbabwe, and at the senior secondary and above category in Malawi. This result suggests that lower levels of maternal education do not have a significant impact in reducing child wasting. Similarly, maternal education is significantly associated with reduced odds of being underweight

at the junior secondary and above level in Malawi and at the highest category of maternal education in Tanzania and Zimbabwe but is not significant at lower levels of maternal education.

The multivariate results show that the threshold level of maternal education necessary to make significant reductions in child malnutrition is at least junior secondary school level (at least nine years of schooling) in Malawi; senior primary school level (at least five years of schooling) in Tanzania; and junior secondary school level in Zimbabwe (at least eight years of schooling). These minimum threshold levels are derived from the wasting model, which showed a significant relationship between maternal education and wasting at lower levels of maternal education. If we consider the more commonly used measures of child nutritional status, which are stunting and underweight, the minimum threshold level rises to junior secondary in Malawi and senior secondary level and above in Tanzania and Zimbabwe. Below these threshold levels, maternal education has no significant impact on child nutrition.

POLICY SIGNIFICANCE

The study has shown that maternal education is important in addressing child malnutrition in Malawi, Tanzania, and Zimbabwe. Bivariate results have shown a negative significant association between maternal education and the three measures of child nutritional status in all three countries. Multivariate analysis has also shown that higher levels of maternal education are required before the impact of maternal education on child nutritional status begin to accrue. The following are implications for policy:

In all three countries, if maternal education is to play a significant role in reducing child malnutrition, women need to be educated beyond the primary school level. While there is free primary school education in all three countries, having been introduced in 1994 in Malawi, 2002 in Tanzania, and 1980 in Zimbabwe, this policy may not be sufficient in itself to significantly reduce levels of child malnutrition. The threshold level of maternal education in all three countries is beyond the primary school level. Policies to ensure that girls remain in school beyond the primary school level, therefore, hold more promise in addressing child nutritional problems in the three countries.

Child nutritional programs should be encouraged among women whose levels of education fall below the minimum threshold. These would help women with little formal schooling to gain the child nutritional knowledge necessary to attain better nutritional outcomes for their children.

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