Why is Child Malnutrition Persistent in Malawi? Explanation from the 1992-2010 Demographic Health Surveys

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Background

Malnutrition produces significant health, social and economic consequences throughout the life course as well as across generations, making it the leading risk factor among children under five worldwide. In Malawi, child malnutrition remains one of the important health problems and account for about half of all child deaths. Between 2008 and 2012, almost 23% of all child deaths were estimated to be directly associated with malnutrition and hunger-related diseases (World Food Programme, 2015). The consequences for stunting or height-for-age (an indicator of growth) have been particularly devastating. As a key indicator of chronic malnutrition, stunting has long-enduring effects, including frequent illness, poor educational performance and low productivity at work. At 50%, stunting rate for children in Malawi is 24 times the level expected in a healthy, well-nourished population (ORC Macro 2010), and the situation has not improved since 1992. Underweight has equally stalled in Malawi. About a quarter of Malawian under-five children were underweight for their age in both the 1992 and 2000 DHSs (National Statistical Office, 2001). Between 1992 and 2004, percentage of those underweight dropped only 3 percentage points to 22% in 2004 (National Statistical Office, 2005). However, a striking drop in the percentage of underweight children was realized, to 13% in 2010 (National Statistical Office, 2011). The rates for wasting, an indicator of malnutrition that describes current nutrition status, show equally sluggish progress between 1992 and 2010.

Objectives

In this paper, we set out to study the evolution and the determinants of child malnutrition in Malawi, using demographic and health surveys. In particular, we ask why malnutrition among Malawian children has remained persistently high over the past two decades. The major contribution of the paper is to better understand why child malnutrition persists in Malawi despite nutrition programs and policies. Our analyses focus on two indices of child malnutrition, namely, stunting and underweight. Underweight is particularly interesting because it is an overall indicator of a population's nutritional health and has equally long-term burdens as stunting.

Literature review

While there are numerous studies on the determinants of malnutrition, very little is known about the persistence of child malnutrition in Malawi and elsewhere. In Tanzania, Muhimbula and Issa-Zacharia (2010) reviewed previous studies to highlight the risks associated with traditional complimentary foods to understand the persistence of child malnutrition. First, they used data from the Tanzania DHSs to show how breastfeeding and timing of introduction of complimentary foods are practiced. They show that in Tanzania, exclusive breastfeeding during the first 6 months is rarely practiced, despite the recommendation by the World Health Organization and the benefits in promoting optimal growth, development and health. Only 41% of the infants below the age of 6 months were exclusively breastfed. As a result, children were introduced to complimentary foods too early. In the 2004/2005 Tanzania DHS, complementary feeding is recorded in 7% of children under the age of 2 months; 32% of children aged 2 to 3 months; and 58% of children aged 4 to 5 months. Muhimbula and Issa-Zacharia (2010) emphasize that raw foods are frequently a source of contamination. Also, water used for the preparation of food is a source of pathogenic agents, and in most regions of Tanzania, water is often contaminated. Improper storage and handling of cooked food is equally responsible for food-borne illnesses. Also, the micronutrients in complementary foods are not absorbed as well as those in breast milk.

In India, Svedberg (2008) tried to understand why child malnutrition had persisted, despite the shining performance of the country's economy. In India, child malnutrition has not declined more rapidly since the early 1990s, considering an impressive overall growth of net state domestic product per capita in India of about 4.5% per annum. His empirical analysis is based on state-level panel data from three survey rounds. He defines the outcome variable as the prevalence of child stunting or underweight among 0-3 year old children in a state. The estimates from the OLS and instrumental variable regressions show that poverty significantly determines stunting and underweight. The results from the first-difference regression suggest that the persistence of malnutrition in India is mainly explained by minimal poverty reduction. A percentage point reduction in the incidence of poverty translates into a decline in the prevalence of child stunting by about 0.5 percentage point. He attributes this finding to slow growth of household real consumption expenditures among the poorest quintiles that are predominately employed in the agricultural sector, a sector where labor productivity growth has been much slower than in the rest of the Indian economy and even declined since the late 1990s. Widespread rural female illiteracy and restricted autonomy for women were other significant explanations. Compared to the rest of India, female illiteracy had not fallen much in the rural areas since the 1990s while women autonomy, proxied as sex ratio had changed only marginally from 107.9 in the 1991 census to 107.1 in the 2001 census to the estimated 106.8 in 2006.

Analytical framework

Using past studies and data availability, the empirical strategy for this study is conceptualized in the context of how resources are allocated within a household. Understanding the factors that influence decisions at the household level about the allocation of scarce resources and how they affect nutritional outcomes of children can lead to better policies in child nutrition.

The assumption is that a household is faced with a utility maximization problem (Becker, 1965; Behrman et al., 1988; Strauss and Thomas, 1995). The utility function depends on consumption of a vector of commodities, X, leisure, L, and quality of children represented by their nutritional status, N, and is specified as follows:

(1)

The household utility is maximized subject to several constraints, including a time specific nutrition production function and income constraints. The nutritional outcome of each child is measured by standard anthropometric measures and is captured by the following function:

(2)

Where I is a vector of child-specific characteristics, H is a vector of household specific characteristics, C is a vector of community-level variables and e is a disturbance term. In equation 2, N is measured by standardized anthropometric measures of height-for-age Z-score (HAZ), and weight-for-age z-score (WAZ). The Z-scores are calculated from information on the weight and height of children between 6 and 60 months. HAZ, is a measure of growth. Children whose HAZ-score is below minus two standard deviations (-2 SD) are considered short for their age, or stunted, a condition reflecting chronic malnutrition. WAZ represents a measure of underweight. Children whose WAZ-scores are below minus two standard deviations (-2 SD) from the median of the reference population are classified as underweight. Underweight, is an overall indicator of nutritional health is the one of the Millennium Development Goal indicators. We leave out Weight-for-height (WHZ) in the analysis because it reflects recent nutritional deficit.

Equation (2) is used to examine the determinants of child nutritional status in each cross-sectional data set from the Malawi DHS. Individual characteristics of children, household level characteristics and community variables are entered into this equation.

Individual child characteristics include age and gender of the child. The age of the child is categorized into dummy variables, namely, less than 6 months old; between 6 and 12 months; between 12 and 18 months; between 18 and 24 months; between 24 and 59 months and gender of child is captured by a dummy variable equal to 1 for female child and zero for male child.

Characteristics in the child's household include mother's and her partner's level of education attainment, gender of household head and type of toilet facility. The gender of the household head is measured by a dummy variable equal to 1 for female headed households and zero for male headed households. For a male head, some education is vital and adequate for acquiring information on childcare issues. The education of the mother and the mother's partner are measured by dummies representing three education categories, with no education as the reference category, primary schooling and at least secondary schooling. Secondary and post-secondary schooling are combined because of few observations in the latter category. Education affects care giving practices through the ability to process information, ability to acquire skills and the ability to model behavior. Better educated parents or caregivers are associated with high child nutritional status as they are better able to use health care facilities and ensure high standards of environmental sanitation. There is also an income effect with the better educated more able to provide food. However, (Glick and Sahn, 1998) note that women, as a result of their high education levels, tend to join the working population, an activity that makes them not to have adequate time for breastfeeding and preparing nutritious foods for their children, or making use of public services that would enhance the nutrition status of their children. For a male head, some education is vital and adequate for acquiring information on childcare issues. Type of toilet facility is also included in the models to capture the effect of sanitation in the household. The dummy variables are flush toilet, pit latrine, no toilet and other. Flush is the reference category and includes both shared and private toilets.

Community-level characteristics are captured by time taken to get to the water source. The water source is measured by dummy variables categories for utmost 15 minutes, between 15 and 30 minutes, between 31 and 59 minutes and at least 60 minutes. The base category is utmost 15 minutes. This captures the effect of sanitation on child nutrition and good potable water is likely to enhance the nutrition status of children.

Ordinary Least Squares regressions are estimated to obtain the betas in each survey year; Seemingly Unrelated Estimations (suest command in stata) model is estimated to understand the variation of beta coefficients between survey years.

Data

We use data from the 1992, 2000, 2004 and 2010 Malawi DHS. In 2010, the survey covered a total of 27,000 households, involving 24,000 female respondents aged between 15 and 49 years and 7,000 male respondents aged between 15 and 54. The 2004 DHS captured 11,698 women aged 15-49 and 3,261 men age 15-54. The 2000 DHS covered 14,213 households, 13,220 women age 15-49, and 3,092 men age 15-54. The 2000 DHS is similar, but much expanded in size and scope, to the 1992 DHS. In 1992, 5323 households were sampled. In these households, 4849 women age 15-49 years and 1151 men age 20-54 years were interviewed. The Household Questionnaire was also used to record height and weight measurements for eligible children age 0-59 months.

These data are nationally representative. The sampling frame used for the 2010 DHS was the 2008 Malawi Population and Housing Census (PHC), which was provided by the National Statistical Office and was designed to produce estimates for key health indicators for all the 27 districts in addition to estimates for national, regional, and rural-urban domains (NSO and ORC Macro 2011). The earlier DHSs were based on the 1998 Malawi Census.

Although these surveys are independent, we can use them to tell an intertemporal story explaining persistence of child malnutrition over the period. The surveys were generally designed to provide information on, among other things, early childhood mortality as well as various indicators of maternal and child health and nutrition. The samples are sufficiently large to allow for estimates of certain indicators to be produced for the country as a whole, by rural-urban residence, by region, as well as at district level. All analyses use sampling weights to capture population estimates. Given that the existing literature on child malnutrition has been restricted to examining the determinants of child malnutrition, explaining persistence of child malnutrition from the perspective of "pooled" data set are potentially valuable in that they give a new understanding to what is driving the persistence of child malnutrition, a problem challenging most countries in the sub-Saharan Africa region[1]. Understanding the impact and evolution of the determinants of child malnutrition in different survey waves has policy implications. The results from this paper will locate the relative importance of these variables and inform nutrition policies and programs on effectively reducing child stunting.

Methods

Descriptive and regression analysis are employed to achieve the objectives of the study.

A bivariate analysis is undertaken to analyze the association between stunting on explanatory variables. Further, a series of ordinary least squares regressions are estimated. This is done by regressing stunting on a set of variables, separately in each cross-section. The coefficients across the cross-sectional years are compared to assess how the effect of each variable on stunting and underweight changes over the years.

Preliminary results

The analysis will start by presenting some descriptive results to highlight the persistence of child malnutrition. A bivariate analysis is also undertaken to analyze the association between stunting and underweight, on explanatory variables. Further, a series of ordinary least squares regressions is estimated. This is done by individually regressing stunting and underweight on a set of variables, separately in each cross-section. The coefficients across the cross-sectional years are

[1] The majority of sub-Saharan African countries show no improvement in stunting since 1990 and/or have very high levels, with more than 40% of young children moderately and severely stunted.

compared to assess how the effect of each variable on stunting and underweight changes over the years.

Descriptive results of dependent variables

Table 1 reports the percentages of stunted and underweight children in 1992, 2000, 2004 and 2010. Means of the two nutrition indicators are also displayed. The results show a declining trend in stunting between 1992 and 2010. However, there are minimal differences in the proportion of stunted children in 1992, 2000 and 2004. About 51% of children are stunted in 1992, 2000 and 2004, compared to 40% in 2010. Underweight also declined between 1992 and 2010, although the differences in the proportions are not big between all the years. In fact, the proportion of children who are underweight remained the same (17%) between 2004 and 2010. In 1992, 21% of the children were underweight and in 2000, the proportion of underweight was 19%. The results also indicate that the differences between proportions are statistically insignificant between 1992, 2000 1nd 2004. However, differences are statistically significant between 1992 and 2010 for both stunting and underweight.

The means of the malnutrition indicators in the last two columns of Table 1 tell a similar story to the malnutrition prevalence rates. Stunting declines marginally between 1992, 2000 and 2004 and dramatically in 2010. In contrast, underweight declines marginally between 1992, 2000 and 2004 and marginally goes up in 2010. The results also indicate that mean differences are statistically significant for 1992 and 2010. The results seem to suggest that the temporal differentials for both stunting and underweight in 1992, 2000 and 2004 are small, but jumps in 2010, indicating that the persistence of the stunting and underweight problems were intense in the first three survey years.

Figures 1 and 2 report the differences in prevalence rates of stunting and underweight in the four survey years by plotting Cummulative Density Functions (CDFs). The CDF shows whether or not the distribution of a malnutrition indicator in one survey year first order stochastically dominates that of another survey year. A CDF for year X which is everywhere below that of year Y means that year Y has a higher proportion of malnourished children than year X irrespective of cut-off point chosen. That is, year X first order stochastically dominates year Y. Looking at the CDFs for stunting in Figure 1 below, we see that 2010 first order stochastically dominates 1992. This means that the proportion of children who are stunted is higher in 1992 than in 2010 regardless of cut-off point used. Similarly, 2010 first order stochastically dominates 2000 and 2004. On the other hand, the CDFs for 1992, 2000 and 2004 nearly coincided with each other, indicating that the proportion of children who are stunted either remained the same or minimally changed over these years. The picture is different for underweight. In Figure 2, we see that there is minimal variation in the CDFs for all the survey years, indicating that the proportion for children who were underweight was not very different in the four surveys.

Further, I present the kernel density plots for each malnutrition indicator, in order to get a better sense of the persistence of child malnutrition in the past two decades. The kernel density plots estimate the empirical distribution of each malnutrition indicator. While the plots for stunting in Figure 3 show that the distribution is skewed to the right in all the survey years, the plots for underweight show that the indicator is normally distributed in the four years. This suggests that in the past two decades, stunting is a more serious problem compared to underweight. We also observe that the kernel plots for stunting reveal that the 2010 plots are below the plots for the other years for high levels of malnutrition (z-scores≤-2), while the opposite holds for low levels of malnutrition (z-scores≥-2). This implies that there is a higher chance of finding stunted children respectively in 1992, 2000 and 2004 than in 2010. On the other hand, the kernel plots for 1992, 2000 and 2004 are almost similar, indicating that it is equally likely to find stunted children in these years. Again, no consistent pattern of dominance by one survey year emerges for underweight. In Figure 4, the kernel plots highlight the persistence of the underweight problem, as it is equally likely to find underweight children in the four survey years.

A Kolmogorov-Smirnov test of the null hypothesis that the distributions of HAZ-score and WAZ-score for the 2010 and each one of the other survey years are statistically the same gives a p-value of 0.00 for both malnutrition indicators. This implies that the distributional differences as depicted by the kernel plots are statistically significant. This suggests that the likelihood of observing a stunted or underweight child in 2010 is different from that in 1992 or 2000 or 2004. However, with 1992 as a comparison year to 2000 and 2004, the p-values indicate that the distibutional differences depicted by the kernel plots re not statistically significant. This result continues to highlight the earlier finding that the proportions of stunted and underweight children in 1992 were not different from those in 2000 and 2004.

Descriptive statistics of explanatory variables

Table 2 presents descriptive statistics of explanatory variables used to predict malnutrition indicators of under-five children in 1992, 2000, 2004 and 2010 DHSs. The statistics do not show much variation in the attributes of children in these years. There is a nearly equal distribution of boys and girls in all the cross-sections. More than 50% of the children are at least 24 months old. The rest are distributed in the under 6 months, between 6 and 11 months, between 12 and 17 months and between 18 and 24 months child age dummy categories. Most of the children live in households headed by males (at least 80% in all the years). In all the years, most of the children's mothers have only up to primary schooling, followed by no education. The least of the mothers have at least a secondary education (7%, 11% and 15% in 2000, 2004 and 2010, respectively). Similarly, most of the fathers have only a primary education. However, fewer fathers have no education compared to secondary schooling. Over half (ranging from 72% in 1992 to 89% in 2010) of the households in which the children live in use pit latrines for their sanitation needs. Households with flush toilet are only around 2%. In 1992, there were relatively more households (26%) with no toilet. By 2010, the results show that this proportion declined 16 percentage points to around 10%. In terms of community-level characteristics, we find that in all the years, most households take up to 15 minutes to get to the water source. The proportion of households who had water on their premises jumped from 8% in 1992 to 10% in 2010. Over the years, between 5% and 9% of the households take at least an hour to get to a water source; and around 30% of the households take about a quarter to half an hour. In all the years, the samples are dominantly rural, represented by at least 80% share.

Bivariate analysis results

Table 3 displays the association between the two child malnutrition indices and explanatory variables. In all the survey years, both stunting and underweight were highly associated with children characteristics, household characteristics and community characteristics, except in very few cases. The prevalence of both stunting and underweight was higher for male children than for female children in all the years, except in 2010, which was higher for girls for stunting. In all the years, except in 1992 for stunting, both stunting and underweight increased with age of a child up to the age of 23 months, after which the prevalence begins to decline. Prevalence for both stunting and underweight was highest for children whose mothers had no schooling and was lowest among children whose mothers had at least secondary education. These results are similar to those for father's education and are consistent with findings from other studies, including Kabubo-Mariara et al. (2008) in Kenya and Mbuya et al. (2010) in Zimbabwe. The results of the In all the four surveys, the prevalence of stunting and underweight was lower in urban areas than in rural areas. The Chi-square test of independence shows that the relationship between the two indicators 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. We also observe that the Northern region has the least prevalence of stunted and underweight in all the years. Pearson Chi-square test show that stunting and underweight are each statistically significantly related to these variables.

Regression results

Tables 4 and 5 report the coefficient estimates from the ordinary least squares regressions of stunting and underweight, respectively. The columns in the tables contain estimation results for each of the survey years, from 1992 to 2010.

In both stunting and underweight models, gender of the child is statistically significant at 1% level of significance in all the years. The effect is negative, implying that being a male child decreases the malnutrition indicators, compared to being a female child. This suggests that female child is better nourished than is the male child in both indicators, implying the possibility of the existence of some form of discrimination in favor of female children in the households. This finding is in line with earlier evidence in Africa (for example Chirwa and Ngalawa, 2008; Garrett and Ruel, 1999 and Glick and Sahn, 1998). Age of a child is a categorical dummy variable. The reference category is less than 6 months old. The results show that in all the years, age of the child is an important determinant of both stunting and underweight. In both models, all the age dummy categories are statistically significant at 1 percent level of significance. The effect is negative, meaning that, compared to children who are less than 6 months old, the malnutrition indicators are decreased for those children who are at least 6 months old. Between 6 and 23 months, the magnitude of the effect is increasing with age, indicating that the older the child gets, the more likely they will be malnourished. Beyond the age of 23 months, the magnitude of the negative effect begins to decrease, suggesting that there is some critical age beyond which a child's nutrition status improves as the child grows older. Chirwa and Ngalawa (2008) estimate the critical ages at 34 months for underweight, 43 months for stunting and 35 months for wasting. As expected, parents' education has a positive effect on children's nutrition, although the effects are positive and significant for at least secondary education in some of the years. The positive and significant coefficient in the secondary education dummy category indicates that having a secondary education increases the size of the malnutrition indicator. This suggests that children whose parents have at least a secondary education are better nourished compared to with no education. From the results, there appears to be no difference in the effect of education of those parents with no education and those with only primary education. (Makoka, 2013) found similar results for maternal education in Malawi, Tanzania and Zimbabwe. He estimated that 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, all of which are in the secondary school education category. Compared to living in the urban area, residing in the rural area decreases the size of both malnutrition indicators. This implies that children who reside in the urban areas are better nourished than those living in the rural areas. In the stunting model, the effect on the rural residence dummy is statistically significant in all the years, while in the underweight model, the positive effect is significant in the 1992 and 2000 samples. Similarly, with Northern region as the reference dummy category for region, the negative coefficient in the South and Central dummy categories suggest that children who live in these regions are likely to be stunted and underweight than children who live in the Northern region. Looking closely at the stunting model, we observe that the negative magnitude of the effect is larger for the Central region category in the stunting model, suggesting that a child is more likely to be stunted when they live in Central region than in Southern region.

Seemingly unrelated estimation results

Seemingly unrelated estimation is undertaken to establish the variation of beta coefficients between survey years. We test the hypothesis that the coefficients between the two years are equal to each other. We do this both for 2000, 2004 and 2010, in comparison with 1992. For both stunting and underweight models, the p-values across all years are less than 0.05, indicating that the coefficients do not vary across the years. These results suggest that since 1992, behaviours that would affect child malnutrition did not change. This likely explains why malnutrition remained stable in the first survey years. Using 2000 and 2004 survey years as the base year yield same conclusions for both models.

Conclusion

This paper set out to shed light on the evolution of malnutrition among under-five children in Malawi using the 1992, 2000, 2004 and 2010 DHS datasets. The study focuses on two indicators of malnutrition, HAZ for stunting and WAZ for underweight. We investigate the persistence, the determinants and how the coefficients of the determinants of child malnutrition have evolved since 1992. The major contribution of this paper to existing literature on child nutrition is the study of persistence of the problem. The results show that the proportion of stunted and underweight children remained high in the 1992, 2000 and 2004 survey years, although some improvement start showing in 2010. A comparison of the coefficients across the years established that the behaviours that would affect child malnutrition did not change since 1992. This likely explains why malnutrition remained stable in the first survey years. This means that in order to reduce child malnutrition, attention should focus more on ensuring that there is improvement in the distribution of characteristics over the years.

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Table 1: Percentage of under-five children who stunted and underweight

	Percentage		Mean	
	Stunting	**Underweight**	**Stunting**	**Underweight**
1992	51.4	20.7	-1.96	-0.99
2000	51.3	19.0	-1.91	-1.01
2004	51.5	16.8	-1.90	-0.92
2010	39.9***	17.2***	-1.57***	-0.98

*Notes: We test the hypothesis that the proportion of malnourished children in 1992 is greater than that of 2010. We also test the hypothesis that the mean of a malnutrition indicator is greater (that is more negative) in 1992 than that of 2010. These tests also compared differences between the other years. The significance asterisks are defined as: * p<0.10, ** p<0.05, *** p<0.01.*

Figure 2: Temporal cumulative distributions of stunting

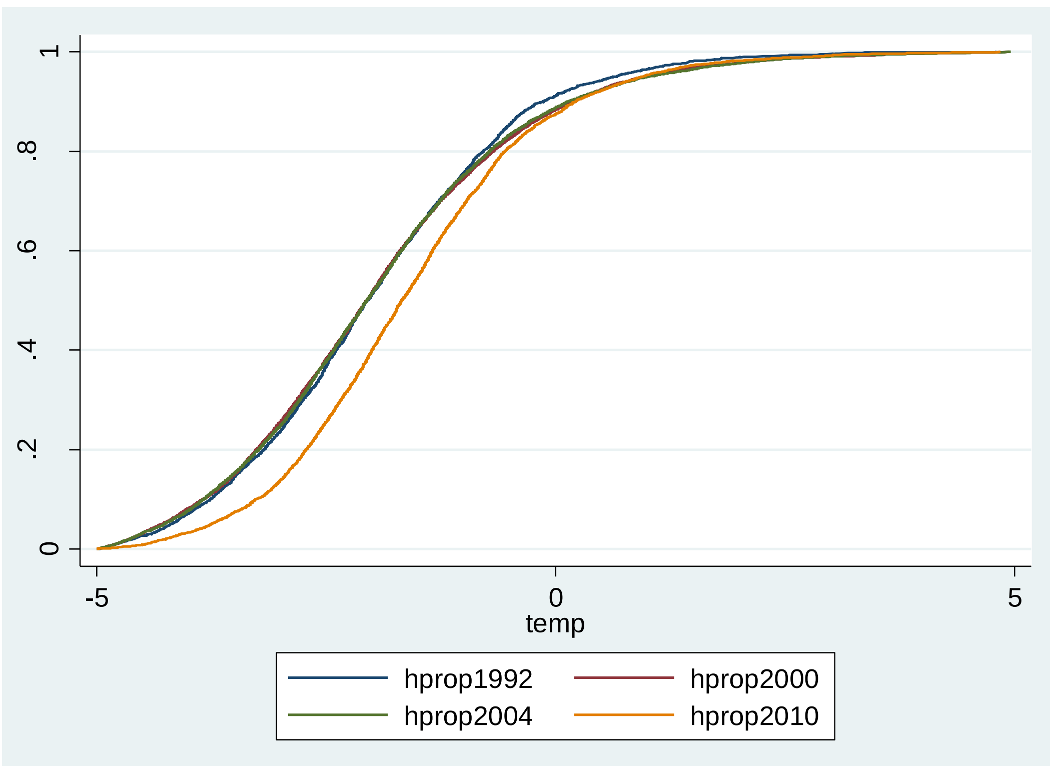
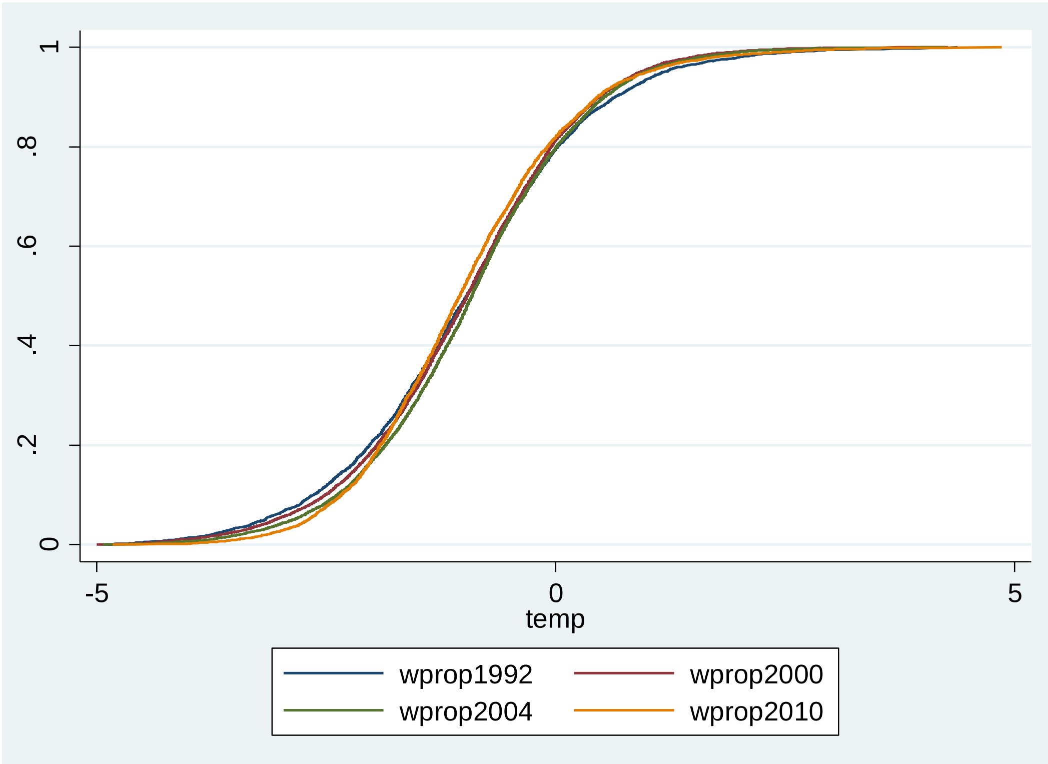


Figure 2: Temporal cumulative distributions of underweight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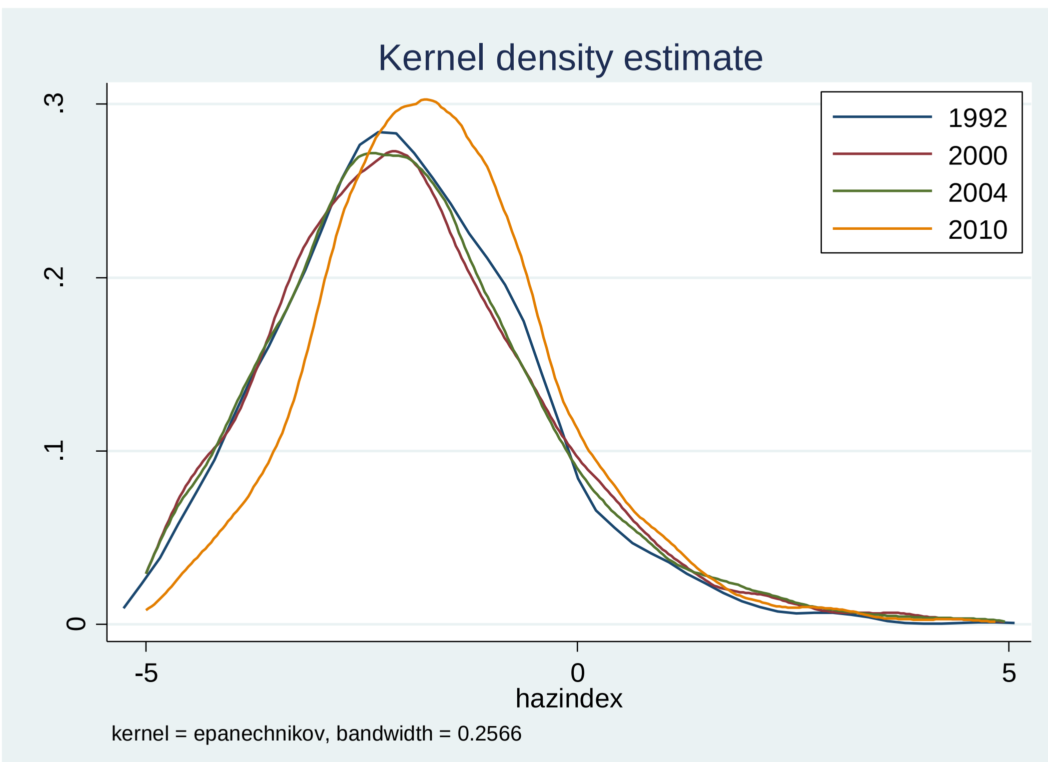
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kernel = epanechnikov, bandwidth = 0.2566

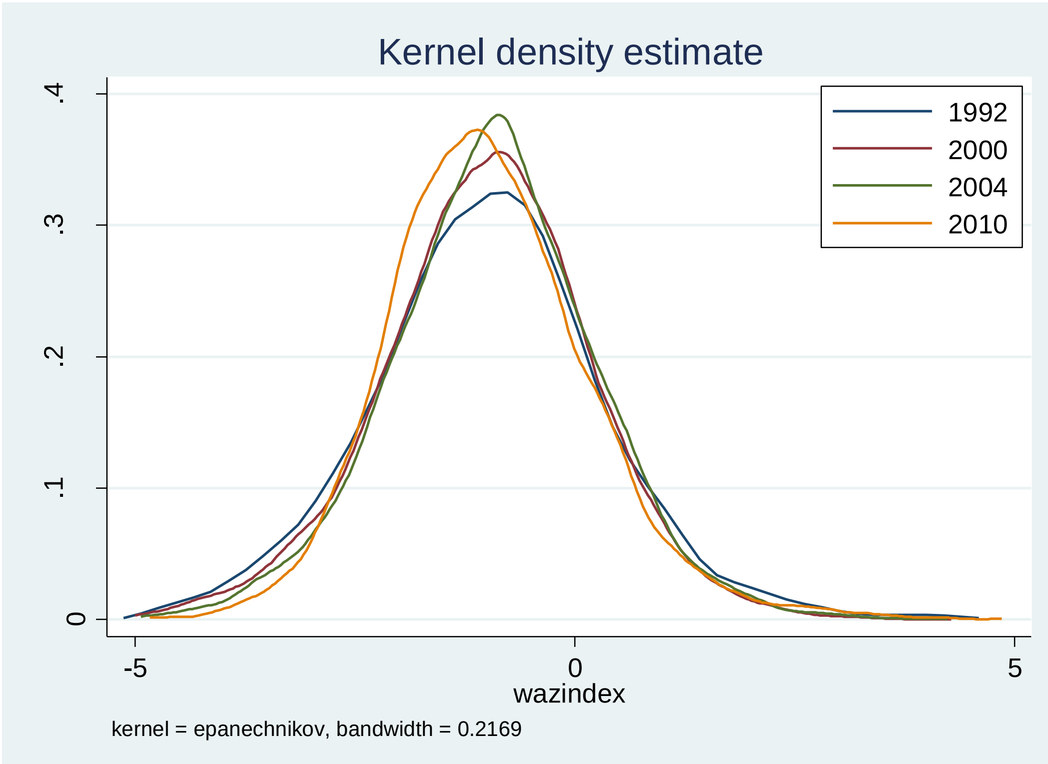

Table 2: Descriptive statistics of explanatory variables

	1992	2000	2004	2010
Gender of child				
Female	.51	.51	.50	.51
Male	.49	.49	.50	.49
Age of Child in months				
Under 6	.13	.11	.09	.08
Between 6 and 11	.13	.12	.12	.11
Between 12 and 17	.10	.11	.13	.10
Between 18 and 23	.11	.11	.11	.12
Between 24 and 59	.53	.55	.55	.59
Gender of household head				
Female	.19	.20	.18	.08
Male	.81	.80	.82	.92
Mother's education				
No education	-	.32	.25	.17
Primary	-	.62	.64	.68
Secondary	-	.07	.11	.15
Father's education				
No education	-	.16	.15	.09
Primary	-	.66	.62	.63
Secondary	-	.18	.23	.27
Religion				
Protestant	-	.24	.24	.23
Muslim	-	.14	.13	.13
Catholic	-	.23	.23	.21

Other	-	.39	.40	.44
Ethnicity				
Chewa	-	.33	.34	.38
Lomwe	-	.17	.17	.14
Yao	-	.14	.13	.13
Ngoni	-	.12	.11	.11
Tumbuka	-	.08	.09	.09
Other	-	.16	.16	.16
Time to water source in minutes				
On premises	.08	.03	.01	.10
Utmost 15	.41	.36	.39	.35
Between 16 and 30	.28	.31	.32	.32
Between 31 and 60	.17	.20	.20	.18
At least 60	.05	.09	.08	.05
Type of toilet				
Flush toilet	.02	.02	.02	.01
Pit latrine	.72	.80	.82	.89
No toilet	.26	.18	.16	.10
Residence				
Rural	.89	.87	.87	.85
Urban	.11	.13	.13	.15
North	.12	.11	.14	.11
Region				
Central	.40	.43	.39	.46
South	.47	.46	.47	.43

Table 3: **Association between malnutrition status and background variables**

	Stunting				**Underweight**			
	1992	**2000**	**2004**	**2010**	**1992**	**2000**	**2004**	**2010**
Gender of child								
Male	**55.5**	**54.7**	**49.6**	**38.0**	**19.3**	**17.3**	**15.9**	**16.7**
Female	**49.4**	**50.7**	**56.0**	**43.1**	**22.3**	**20.9**	**18.0**	**17.8**
Pearson chi2	***11.8***	***14.8***	***33.0***	***12.7***	***4.35***	***19.3***	***6.3***	***1.03***
p-value	***0.00***	***0.00***	***0.00***	***0.00***	***0.04***	***0.00***	***0.01***	***0.3***
Age of child								
Under 6	**19.7**	**21.9**	**22.4**	**8.7**	**14.0**	**13.0**	**9.1**	**0.9**
6 to 11 months	**27.5**	**30.3**	**38.1**	**23.9**	**20.4**	**20.9**	**17.8**	**14.3**
12 to 17 months	**43.0**	**48.4**	**54.7**	**44.4**	**21.2**	**23.0**	**16.8**	**24.2**
18 to 23 months	**60.4**	**62.9**	**64.3**	**56.8**	**22.5**	**23.1**	**19.0**	**21.5**
24 to 59 months	**66.3**	**62.3**	**58.5**	**43.4**	**22.1**	**18.3**	**17.7**	**17.7**
Pearson chi2	*413.4*	*823.6*	*466.9*	*281.9*	*13.4*	*49.3*	*37.1*	*92.8*
p-value	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
Gender of household head								
Male	**55.5**	**51.6**	**52.5**	**42.3**	**20.1**	**18.1**	**16.5**	**17.1**
Female	**49.4**	**56.6**	**54.2**	**40.4**	**24.3**	**23.1**	**18.8**	**18.9**
Pearson chi2	***11.8***	***14.7***	***1.4***	***0.5***	***4.7***	***23.8***	***4.6***	***0.8***
p-value	***0.00***	***0.00***	***0.24***	***0.48***	***0.03***	***0.00***	***0.03***	***0.38***
Mother's education								
No education	**-**	**58.2**	**56.4**	**48.4**	**-**	**22.2**	**20.0**	**19.2**

Primary	-	**52.4**	**53.2**	**40.6**	-	**19.0**	**16.7**	**17.9**
Secondary	-	**33.0**	**40.9**	**31.3**	-	**8.0**	**10.7**	**12.2**
Pearson chi2	-	*141.7*	*57.5*	*41.1*	-	*72.7*	*36.5*	*13.9*
p-value	-	*0.00*	*0.00*	*0.00*	-	*0.00*	*0.00*	*0.00*
Father's education								
No education	-	**60.0**	**56.2**	**46.8**	-	**24.6**	**20.9**	**16.4**
Primary	-	**54.8**	**55.2**	**41.6**	-	**20.1**	**17.7**	**18.3**
Secondary	-	**41.2**	**44.6**	**35.6**	-	**11.7**	**12.4**	**15.0**
Pearson chi2	-	133.6	63.1	20.9	-	92.3	40.6	6.7
p-value	-	0.00	0.00	0.00	-	0.00	0.00	0.03
Religion								
Pentecostal	-	**49.2**	**50.8**	**37.4**	-	**16.6**	**15.7**	**16.9**
Muslim	-	**55.0**	**51.6**	**44.7**	-	**22.4**	**16.7**	**19.9**
Catholic	-	**53.2**	**52.2**	**42.0**	-	**17.5**	**16.2**	**16.3**
Other	-	**53.6**	**54.8**	**49.5**	-	**20.2**	**18.2**	**17.2**
Pearson chi2	-	*15.3*	*9.02*	*9.06*	-	*24.8*	*6.3*	*3.2*
p-value	-	*0.00*	*0.03*	*0.03*	-	*0.00*	*0.10*	*0.4*
Ethnicity								
Chewa	-	**57.8**	**56.9**	**42.4**	-	**21.6**	**17.9**	**17.9**
Lomwe	-	**52.0**	**51.3**	**39.7**	-	**19.3**	**18.9**	**18.0**
Yao	-	**53.2**	**52.3**	**45.0**	-	**21.9**	**16.6**	**18.9**
Ngoni	-	**55.3**	**53.0**	**40.9**	-	**17.7**	**15.5**	**17.4**
Tumbuka	-	**45.0**	**49.8**	**37.2**	-	**12.3**	**11.8**	**12.5**
Other	-	**47.9**	**48.0**	**37.1**	-	**17.2**	**17.1**	**17.1**
Pearson chi2	-	*66.9*	*32.2*	*13.6*	-	*48.8*	*21.9*	*9.1*
p-value	-	*0.00*	*0.00*	*0.02*	-	*0.00*	*0.00*	*0.10*
Time to water source								
On premises	**46.0**	**67.1**	**53.3**	**35.4**	**13.5**	**25.6**	**15.6**	**12.6**
Utmost 15 minutes	**54.6**	**51.6**	**53.9**	**39.9**	**22.5**	**17.6**	**17.2**	**16.7**
16 to 30 minutes	**57.6**	**54.1**	**52.7**	**41.9**	**24.2**	**21.3**	**17.3**	**18.2**
31 to 60 minutes	**56.3**	**57.3**	**55.7**	**41.6**	**23.9**	**21.5**	**18.8**	**19.0**
At least 60 minutes	**53.0**	**56.4**	**51.8**	**36.5**	**17.2**	**20.4**	**15.7**	**15.0**
Pearson chi2	*11.9*	*27.0*	*4.00*	*7.50*	*17.3*	*20.1*	*3.25*	*9.8*
p-value	*0.02*	*0.00*	*0.41*	*0.11*	*0.00*	*0.00*	*0.52*	*0.04*
Type of toilet facility								
Flush	**31.5**	**30.8**	**39.1**	**13.0**	**4.7**	**6.0**	**8.7**	**2.9**
Pit latrine	**52.0**	**52.1**	**52.1**	**40.1**	**19.3**	**18.2**	**16.3**	**16.6**
No toilet	**58.2**	**59.0**	**58.9**	**45.3**	**29.4**	**24.9**	**21.4**	**24.0**
Pearson chi2	31.0	69.9	30.3	27.0	52.5	62.3	25.9	28.3
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residence								
Rural	**56.2**	**55.3**	**54.0**	**41.5**	**23.5**	**21.1**	**17.5**	**17.8**
Urban	**41.3**	**41.0**	**42.3**	**32.1**	**12.9**	**10.5**	**11.8**	**12.6**
Pearson chi2	*51.9*	*114.3*	*41.2*	*15.3*	*40.2*	*100.3*	*17.5*	*8.1*
p-value	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Region								
North	**49.3**	**46.2**	**46.9**	**36.5**	**15.9**	**13.5**	**12.4**	**14.2**
Central	**53.9**	**58.1**	**57.1**	**42.2**	**21.0**	**21.2**	**16.9**	**18.1**
South	**53.8**	**50.7**	**51.3**	**40.8**	**25.0**	**19.4**	**18.2**	**17.8**
Pearson chi2	*5.57*	*71.2*	*40.3*	*7.63*	*25.6*	*40.2*	*20.3*	*6.8*
p-value	*0.06*	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*	*0.03*
Observations	**2,709**	**7,796**	**6,780**	**4,308**	**2,709**	**7,796**	**6,780**	**4,308**

Table 4: Determinants of Stunting

VARIABLES	(1) 1992	(2) 2000	(3) 2004	(4) 2010
Male child	-0.158***	-0.157***	-0.185***	-0.223***
	(0.0550)	(0.0382)	(0.0418)	(0.0525)
Age of child				
6 to 11 months	-0.441***	-0.415***	-0.850***	-0.669***
	(0.125)	(0.0927)	(0.104)	(0.126)
12 to 17 months	-0.905***	-1.171***	-1.478***	-1.513***
	(0.125)	(0.0919)	(0.100)	(0.131)
18 to 23 months	-1.568***	-1.646***	-1.880***	-1.857***
	(0.121)	(0.0861)	(0.102)	(0.123)
24 to 59 months	-1.675***	-1.658***	-1.667***	-1.458***
	(0.0981)	(0.0712)	(0.0830)	(0.101)
Male household head	0.000295	0.168***	0.102*	0.0149
	(0.0725)	(0.0484)	(0.0550)	(0.113)
Mother's education				
Primary	-	-0.0227	-0.00364	0.0285
		(0.0449)	(0.0503)	(0.0830)
Secondary	-	0.287**	0.131	0.142
		(0.116)	(0.0960)	(0.112)
Father's education				
Primary	-	0.100*	-0.0761	-0.0165
		(0.0574)	(0.0630)	(0.106)
Secondary	-	0.306***	0.115	0.0678
		(0.0781)	(0.0826)	(0.120)
Religion				
Muslim	-	-0.100	-0.0725	-0.114
		(0.0794)	(0.0958)	(0.143)
Catholic	-	-0.0382	-0.0735	-0.0559
		(0.0561)	(0.0649)	(0.0790)
Other	-	-0.0212	-0.147***	0.0256
		(0.0521)	(0.0562)	(0.0689)
Ethnicity				
Lomwe	-	0.0843	0.256***	-0.113
		(0.0758)	(0.0908)	(0.104)
Yao	-	0.0557	0.0979	-0.0574
		(0.0900)	(0.104)	(0.155)
Ngoni	-	0.0210	0.0706	0.0913
		(0.0644)	(0.0757)	(0.0995)
Tumbuka	-	0.189*	-0.0846	-0.111
		(0.0979)	(0.103)	(0.123)
Other	-	0.151*	0.170**	0.0214
		(0.0777)	(0.0812)	(0.101)
Time to water source				
Utmost 15 minutes	-0.248**	0.460***	0.231	0.0149
	(0.0968)	(0.145)	(0.309)	(0.0962)
16 to 30 minutes	-0.335***	0.424***	0.233	0.0306
	(0.0998)	(0.145)	(0.310)	(0.0977)
31 to 60 minutes	-0.319***	0.411***	0.190	0.0372

	(0.107)	(0.148)	(0.311)	(0.102)
At least 60 minutes	-0.275*	0.380**	0.324	0.174
	(0.143)	(0.153)	(0.318)	(0.150)
Type of toilet facility				
Pit latrine	-0.439	-0.112	-0.146	-0.626***
	(0.514)	(0.190)	(0.380)	(0.190)
No toilet	-0.493	-0.234	-0.265	-0.731***
	(0.517)	(0.195)	(0.383)	(0.210)
Rural	-0.359***	-0.314***	-0.236***	-0.129
	(0.0723)	(0.0772)	(0.0832)	(0.0956)
Region				
Central	-0.238***	-0.289***	-0.297***	-0.0962
	(0.0650)	(0.0887)	(0.0925)	(0.109)
South	-0.103	-0.0531	-0.234***	-0.0505
	(0.0654)	(0.0820)	(0.0906)	(0.0947)
Constant	0.381	-0.804***	-0.115	0.596**
	(0.512)	(0.297)	(0.516)	(0.280)
Observations	**2,709**	**7,796**	**6,780**	**4,308**
R-squared	0.209	0.178	0.132	0.128

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Determinants of underweight

	(1)	(2)	(3)	(4)
VARIABLES	1992	2000	2004	2010
Male child	-0.127**	-0.0323	-0.0844***	-0.116***
	(0.0519)	(0.0304)	(0.0313)	(0.0426)
Age of child				
6 to 11 months	-0.573***	-0.464***	-0.569***	-1.121***
	(0.114)	(0.0751)	(0.0797)	(0.126)
12 to 17 months	-0.673***	-0.608***	-0.730***	-1.644***
	(0.119)	(0.0772)	(0.0754)	(0.131)
18 to 23 months	-0.816***	-0.597***	-0.802***	-1.738***
	(0.106)	(0.0735)	(0.0771)	(0.122)
24 to 59 months	-0.711***	-0.493***	-0.798***	-1.535***
	(0.0835)	(0.0609)	(0.0613)	(0.111)
Male household head	0.0847	0.186***	0.0380	0.0435
	(0.0673)	(0.0366)	(0.0415)	(0.0796)
Mother's education				
Primary	-	-0.0308	0.109***	0.0404
		(0.0354)	(0.0389)	(0.0614)
Secondary	-	0.280***	0.188***	0.177**
		(0.0859)	(0.0711)	(0.0867)
Father's education				
Primary	-	0.118***	0.00800	-0.00440
		(0.0451)	(0.0495)	(0.0767)
Secondary	-	0.233***	0.103*	-0.0134

		(0.0620)	(0.0609)	(0.0897)
Religion				
Muslim	-	-0.104	-0.0682	-0.152
		(0.0669)	(0.0718)	(0.104)
Catholic	-	0.0296	-0.0395	-0.0585
		(0.0444)	(0.0454)	(0.0631)
Other	-	-0.0337	-0.0816**	-0.0118
		(0.0416)	(0.0413)	(0.0570)
Ethnicity				
Lomwe	-	-0.0246	0.0362	-0.105
		(0.0594)	(0.0642)	(0.0762)
Yao	-	0.00744	0.0776	-0.100
		(0.0751)	(0.0784)	(0.110)
Ngoni	-	0.0748	0.0114	0.0465
		(0.0517)	(0.0569)	(0.0744)
Tumbuka	-	0.0462	-0.0298	-0.0133
		(0.0765)	(0.0740)	(0.102)
Other	-	-0.00773	-0.0601	-0.147**
		(0.0598)	(0.0619)	(0.0729)
Time to water source				
Utmost 15 minutes	-0.177**	-0.0863	0.149	-0.163*
	(0.0874)	(0.127)	(0.225)	(0.0863)
16 to 30 minutes	-0.187**	-0.139	0.134	-0.114
	(0.0895)	(0.128)	(0.225)	(0.0891)
31 to 60 minutes	-0.156	-0.0746	0.0553	-0.0622
	(0.101)	(0.129)	(0.226)	(0.0949)
At least 60 mins	-0.0216	-0.0939	0.242	-0.0563
	(0.133)	(0.135)	(0.230)	(0.120)
Type of toilet facility				
Pit latrine	-0.382	-0.267	-0.451*	-0.388**
	(0.418)	(0.238)	(0.244)	(0.175)
No toilet	-0.615	-0.404*	-0.586**	-0.538***
	(0.421)	(0.241)	(0.246)	(0.188)
Rural	-0.307***	-0.225***	-0.0662	-0.130*
	(0.0713)	(0.0579)	(0.0596)	(0.0751)
Region				
Central	-0.169***	-0.149**	-0.160**	-0.151*
	(0.0653)	(0.0684)	(0.0649)	(0.0804)
South	-0.447***	-0.0407	-0.209***	-0.0946
	(0.0630)	(0.0612)	(0.0628)	(0.0734)
Constant	0.660	-0.134	0.264	1.233***
	(0.421)	(0.306)	(0.352)	(0.247)
Observations	**2,709**	**7,796**	**6,780**	**4,308**
R-squared	0.074	0.047	0.061	0.155

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The key finding is that the distribution of the behaviors that affect child malnutrition did not change since 1992. For example, education of the mother positively affected nutrition of the child, only if it was post-secondary. This was the case in 1992 as it was in the subsequent survey years. Our findings suggest that, if Malawi is to achieve her strategic health objectives and millennium development target of reducing the prevalence of malnutrition, it should focus on improving the impact of the determinants of child malnutrition that improve nutrition of children. For example, pre-secondary education of mother or father should also influence nutrition status of children.

Table 1: Descriptive statistics of explanatory variables

	1992	**2000**	**2004**	**2010**
Gender of child				
Female	.51	.51	.50	.51
Male	.49	.49	.50	.49
Age of Child in months				
Under 6	.13	.11	.09	.08
Between 6 and 11	.13	.12	.12	.11
Between 12 and 17	.10	.11	.13	.10
Between 18 and 23	.11	.11	.11	.12
Between 24 and 59	.53	.55	.55	.59
Gender of household head				
Female	.19	.20	.18	.08
Male	.81	.80	.82	.92
Mother's education				
No education	-	.32	.25	.17
Primary	-	.62	.64	.68
Secondary	-	.07	.11	.15
Father's education				
No education	-	.16	.15	.09
Primary	-	.66	.62	.63
Secondary	-	.18	.23	.27
Religion				
Protestant	-	.24	.24	.23
Muslim	-	.14	.13	.13
Catholic	-	.23	.23	.21
Other	-	.39	.40	.44
Ethnicity				
Chewa	-	.33	.34	.38
Lomwe	-	.17	.17	.14
Yao	-	.14	.13	.13
Ngoni	-	.12	.11	.11
Tumbuka	-	.08	.09	.09
Other	-	.16	.16	.16
Time to water source in minutes				
On premises	.08	.03	.01	.10
Utmost 15	.41	.36	.39	.35
Between 16 and 30	.28	.31	.32	.32
Between 31 and 60	.17	.20	.20	.18
At least 60	.05	.09	.08	.05

Type of toilet				
Flush toilet	.02	.02	.02	.01
Pit latrine	.72	.80	.82	.89
No toilet	.26	.18	.16	.10
Residence				
Rural	.89	.87	.87	.85
Urban	.11	.13	.13	.15
North	.12	.11	.14	.11
Region				
Central	.40	.43	.39	.46
South	.47	.46	.47	.43

Table 2: **Association between malnutrition status and background variables**

	Stunting				**Underweight**			
	1992	**2000**	**2004**	**2010**	**1992**	**2000**	**2004**	**2010**
Gender of child								
Male	55.5	54.7	49.6	38.0	19.3	17.3	15.9	16.7
Female	49.4	50.7	56.0	43.1	22.3	20.9	18.0	17.8
Pearson chi2	*11.8*	*14.8*	*33.0*	*12.7*	*4.35*	*19.3*	*6.3*	*1.03*
p-value	*0.00*	*0.00*	*0.00*	*0.00*	*0.04*	*0.00*	*0.01*	*0.3*
Age of child								
Under 6	19.7	21.9	22.4	8.7	14.0	13.0	9.1	0.9
6 to 11 months	27.5	30.3	38.1	23.9	20.4	20.9	17.8	14.3
12 to 17 months	43.0	48.4	54.7	44.4	21.2	23.0	16.8	24.2
18 to 23 months	60.4	62.9	64.3	56.8	22.5	23.1	19.0	21.5
24 to 59 months	66.3	62.3	58.5	43.4	22.1	18.3	17.7	17.7
Pearson chi2	*413.4*	*823.6*	*466.9*	*281.9*	*13.4*	*49.3*	*37.1*	*92.8*
p-value	*0.00*	*0.00*	*0.00*	*0.00*	*0.01*	*0.00*	*0.00*	*0.00*
Gender of household head								
Male	55.5	51.6	52.5	42.3	20.1	18.1	16.5	17.1
Female	49.4	56.6	54.2	40.4	24.3	23.1	18.8	18.9
Pearson chi2	*11.8*	*14.7*	*1.4*	*0.5*	*4.7*	*23.8*	*4.6*	*0.8*
p-value	*0.00*	*0.00*	*0.24*	*0.48*	*0.03*	*0.00*	*0.03*	*0.38*
Mother's education								
No education	-	58.2	56.4	48.4	-	22.2	20.0	19.2
Primary	-	52.4	53.2	40.6	-	19.0	16.7	17.9
Secondary	-	33.0	40.9	31.3	-	8.0	10.7	12.2
Pearson chi2	-	*141.7*	*57.5*	*41.1*	-	*72.7*	*36.5*	*13.9*
p-value	-	*0.00*	*0.00*	*0.00*	-	*0.00*	*0.00*	*0.00*
Father's education								
No education	-	60.0	56.2	46.8	-	24.6	20.9	16.4
Primary	-	54.8	55.2	41.6	-	20.1	17.7	18.3
Secondary	-	41.2	44.6	35.6	-	11.7	12.4	15.0
Pearson chi2	-	133.6	63.1	20.9	-	92.3	40.6	6.7
p-value	-	0.00	0.00	0.00	-	0.00	0.00	0.03
Religion								
Pentecostal	-	49.2	50.8	37.4	-	16.6	15.7	16.9
Muslim	-	55.0	51.6	44.7	-	22.4	16.7	19.9
Catholic	-	53.2	52.2	42.0	-	17.5	16.2	16.3
Other	-	53.6	54.8	49.5	-	20.2	18.2	17.2

Pearson chi2	*-*	*15.3*	*9.02*	*9.06*	*-*	*24.8*	*6.3*	*3.2*
p-value	*-*	*0.00*	*0.03*	*0.03*	*-*	*0.00*	*0.10*	*0.4*
Ethnicity								
Chewa	**-**	**57.8**	**56.9**	**42.4**	**-**	**21.6**	**17.9**	**17.9**
Lomwe	**-**	**52.0**	**51.3**	**39.7**	**-**	**19.3**	**18.9**	**18.0**
Yao	**-**	**53.2**	**52.3**	**45.0**	**-**	**21.9**	**16.6**	**18.9**
Ngoni	**-**	**55.3**	**53.0**	**40.9**	**-**	**17.7**	**15.5**	**17.4**
Tumbuka	**-**	**45.0**	**49.8**	**37.2**	**-**	**12.3**	**11.8**	**12.5**
Other	**-**	**47.9**	**48.0**	**37.1**	**-**	**17.2**	**17.1**	**17.1**
Pearson chi2	*-*	*66.9*	*32.2*	*13.6*	*-*	*48.8*	*21.9*	*9.1*
p-value	*-*	*0.00*	*0.00*	*0.02*	*-*	*0.00*	*0.00*	*0.10*
Time to water source								
On premises	**46.0**	**67.1**	**53.3**	**35.4**	**13.5**	**25.6**	**15.6**	**12.6**
Utmost 15 minutes	**54.6**	**51.6**	**53.9**	**39.9**	**22.5**	**17.6**	**17.2**	**16.7**
16 to 30 minutes	**57.6**	**54.1**	**52.7**	**41.9**	**24.2**	**21.3**	**17.3**	**18.2**
31 to 60 minutes	**56.3**	**57.3**	**55.7**	**41.6**	**23.9**	**21.5**	**18.8**	**19.0**
At least 60 minutes	**53.0**	**56.4**	**51.8**	**36.5**	**17.2**	**20.4**	**15.7**	**15.0**
Pearson chi2	*11.9*	*27.0*	*4.00*	*7.50*	*17.3*	*20.1*	*3.25*	*9.8*
p-value	*0.02*	*0.00*	*0.41*	*0.11*	*0.00*	*0.00*	*0.52*	*0.04*
Type of toilet facility								
Flush	**31.5**	**30.8**	**39.1**	**13.0**	**4.7**	**6.0**	**8.7**	**2.9**
Pit latrine	**52.0**	**52.1**	**52.1**	**40.1**	**19.3**	**18.2**	**16.3**	**16.6**
No toilet	**58.2**	**59.0**	**58.9**	**45.3**	**29.4**	**24.9**	**21.4**	**24.0**
Pearson chi2	**31.0**	**69.9**	**30.3**	**27.0**	**52.5**	**62.3**	**25.9**	**28.3**
p-value	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Residence								
Rural	**56.2**	**55.3**	**54.0**	**41.5**	**23.5**	**21.1**	**17.5**	**17.8**
Urban	**41.3**	**41.0**	**42.3**	**32.1**	**12.9**	**10.5**	**11.8**	**12.6**
Pearson chi2	*51.9*	*114.3*	*41.2*	*15.3*	*40.2*	*100.3*	*17.5*	*8.1*
p-value	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Region								
North	**49.3**	**46.2**	**46.9**	**36.5**	**15.9**	**13.5**	**12.4**	**14.2**
Central	**53.9**	**58.1**	**57.1**	**42.2**	**21.0**	**21.2**	**16.9**	**18.1**
South	**53.8**	**50.7**	**51.3**	**40.8**	**25.0**	**19.4**	**18.2**	**17.8**
Pearson chi2	*5.57*	*71.2*	*40.3*	*7.63*	*25.6*	*40.2*	*20.3*	*6.8*
p-value	*0.06*	*0.00*	*0.00*	*0.02*	*0.00*	*0.00*	*0.00*	*0.03*
Observations	**2,709**	**7,796**	**6,780**	**4,308**	**2,709**	**7,796**	**6,780**	**4,308**

Table 3: Determinants of Stunting

VARIABLES	(1) 1992	(2) 2000	(3) 2004	(4) 2010
Male child	-0.158***	-0.157***	-0.185***	-0.223***
	(0.0550)	(0.0382)	(0.0418)	(0.0525)
Age of child				
6 to 11 months	-0.441***	-0.415***	-0.850***	-0.669***
	(0.125)	(0.0927)	(0.104)	(0.126)
12 to 17 months	-0.905***	-1.171***	-1.478***	-1.513***
	(0.125)	(0.0919)	(0.100)	(0.131)
18 to 23 months	-1.568***	-1.646***	-1.880***	-1.857***
	(0.121)	(0.0861)	(0.102)	(0.123)
24 to 59 months	-1.675***	-1.658***	-1.667***	-1.458***

	(0.0981)	(0.0712)	(0.0830)	(0.101)
Male household head	0.000295	0.168***	0.102*	0.0149
	(0.0725)	(0.0484)	(0.0550)	(0.113)
Mother's education				
Primary	-	-0.0227	-0.00364	0.0285
		(0.0449)	(0.0503)	(0.0830)
Secondary	-	0.287**	0.131	0.142
		(0.116)	(0.0960)	(0.112)
Father's education				
Primary	-	0.100*	-0.0761	-0.0165
		(0.0574)	(0.0630)	(0.106)
Secondary	-	0.306***	0.115	0.0678
		(0.0781)	(0.0826)	(0.120)
Religion				
Muslim	-	-0.100	-0.0725	-0.114
		(0.0794)	(0.0958)	(0.143)
Catholic	-	-0.0382	-0.0735	-0.0559
		(0.0561)	(0.0649)	(0.0790)
Other	-	-0.0212	-0.147***	0.0256
		(0.0521)	(0.0562)	(0.0689)
Ethnicity				
Lomwe	-	0.0843	0.256***	-0.113
		(0.0758)	(0.0908)	(0.104)
Yao	-	0.0557	0.0979	-0.0574
		(0.0900)	(0.104)	(0.155)
Ngoni	-	0.0210	0.0706	0.0913
		(0.0644)	(0.0757)	(0.0995)
Tumbuka	-	0.189*	-0.0846	-0.111
		(0.0979)	(0.103)	(0.123)
Other	-	0.151*	0.170**	0.0214
		(0.0777)	(0.0812)	(0.101)
Time to water source				
Utmost 15 minutes	-0.248**	0.460***	0.231	0.0149
	(0.0968)	(0.145)	(0.309)	(0.0962)
16 to 30 minutes	-0.335***	0.424***	0.233	0.0306
	(0.0998)	(0.145)	(0.310)	(0.0977)
31 to 60 minutes	-0.319***	0.411***	0.190	0.0372
	(0.107)	(0.148)	(0.311)	(0.102)
At least 60 minutes	-0.275*	0.380**	0.324	0.174
	(0.143)	(0.153)	(0.318)	(0.150)
Type of toilet facility				
Pit latrine	-0.439	-0.112	-0.146	-0.626***
	(0.514)	(0.190)	(0.380)	(0.190)
No toilet	-0.493	-0.234	-0.265	-0.731***
	(0.517)	(0.195)	(0.383)	(0.210)
Rural	-0.359***	-0.314***	-0.236***	-0.129
	(0.0723)	(0.0772)	(0.0832)	(0.0956)
Region				
Central	-0.238***	-0.289***	-0.297***	-0.0962
	(0.0650)	(0.0887)	(0.0925)	(0.109)

South	-0.103	-0.0531	-0.234***	-0.0505
	(0.0654)	(0.0820)	(0.0906)	(0.0947)
Constant	0.381	-0.804***	-0.115	0.596**
	(0.512)	(0.297)	(0.516)	(0.280)
Observations	**2,709**	**7,796**	**6,780**	**4,308**
R-squared	0.209	0.178	0.132	0.128

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Determinants of underweight

VARIABLES	(1) 1992	(2) 2000	(3) 2004	(4) 2010
Male child	-0.127**	-0.0323	-0.0844***	-0.116***
	(0.0519)	(0.0304)	(0.0313)	(0.0426)
Age of child				
6 to 11 months	-0.573***	-0.464***	-0.569***	-1.121***
	(0.114)	(0.0751)	(0.0797)	(0.126)
12 to 17 months	-0.673***	-0.608***	-0.730***	-1.644***
	(0.119)	(0.0772)	(0.0754)	(0.131)
18 to 23 months	-0.816***	-0.597***	-0.802***	-1.738***
	(0.106)	(0.0735)	(0.0771)	(0.122)
24 to 59 months	-0.711***	-0.493***	-0.798***	-1.535***
	(0.0835)	(0.0609)	(0.0613)	(0.111)
Male household head	0.0847	0.186***	0.0380	0.0435
	(0.0673)	(0.0366)	(0.0415)	(0.0796)
Mother’s education				
Primary	-	-0.0308	0.109***	0.0404
		(0.0354)	(0.0389)	(0.0614)
Secondary	-	0.280***	0.188***	0.177**
		(0.0859)	(0.0711)	(0.0867)
Father’s education				
Primary	-	0.118***	0.00800	-0.00440
		(0.0451)	(0.0495)	(0.0767)
Secondary	-	0.233***	0.103*	-0.0134
		(0.0620)	(0.0609)	(0.0897)
Religion				
Muslim	-	-0.104	-0.0682	-0.152
		(0.0669)	(0.0718)	(0.104)
Catholic	-	0.0296	-0.0395	-0.0585
		(0.0444)	(0.0454)	(0.0631)
Other	-	-0.0337	-0.0816**	-0.0118
		(0.0416)	(0.0413)	(0.0570)
Ethnicity				
Lomwe	-	-0.0246	0.0362	-0.105
		(0.0594)	(0.0642)	(0.0762)
Yao	-	0.00744	0.0776	-0.100
		(0.0751)	(0.0784)	(0.110)
Ngoni	-	0.0748	0.0114	0.0465
		(0.0517)	(0.0569)	(0.0744)

Tumbuka	-	0.0462	-0.0298	-0.0133
		(0.0765)	(0.0740)	(0.102)
Other	-	-0.00773	-0.0601	-0.147**
		(0.0598)	(0.0619)	(0.0729)
Time to water source				
Utmost 15 minutes	-0.177**	-0.0863	0.149	-0.163*
	(0.0874)	(0.127)	(0.225)	(0.0863)
16 to 30 minutes	-0.187**	-0.139	0.134	-0.114
	(0.0895)	(0.128)	(0.225)	(0.0891)
31 to 60 minutes	-0.156	-0.0746	0.0553	-0.0622
	(0.101)	(0.129)	(0.226)	(0.0949)
At least 60 mins	-0.0216	-0.0939	0.242	-0.0563
	(0.133)	(0.135)	(0.230)	(0.120)
Type of toilet facility				
Pit latrine	-0.382	-0.267	-0.451*	-0.388**
	(0.418)	(0.238)	(0.244)	(0.175)
No toilet	-0.615	-0.404*	-0.586**	-0.538***
	(0.421)	(0.241)	(0.246)	(0.188)
Rural	-0.307***	-0.225***	-0.0662	-0.130*
	(0.0713)	(0.0579)	(0.0596)	(0.0751)
Region				
Central	-0.169***	-0.149**	-0.160**	-0.151*
	(0.0653)	(0.0684)	(0.0649)	(0.0804)
South	-0.447***	-0.0407	-0.209***	-0.0946
	(0.0630)	(0.0612)	(0.0628)	(0.0734)
Constant	0.660	-0.134	0.264	1.233***
	(0.421)	(0.306)	(0.352)	(0.247)
Observations	**2,709**	**7,796**	**6,780**	**4,308**
R-squared	0.074	0.047	0.061	0.155

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1