



# The Impact of Household Food Security on Child Nutritional Status in Zambia

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**Abstract:** Though Zambia is mainly an agricultural country, there still exists the lack of adequate nutrition among Zambian children. To analyse the impact of household food security on nutritional status of Zambian children, the linear probability regression model and the probit model are used. This is done by using anthropometric measures of insufficient weight-for-height (wasting) and insufficient weight-for-age (underweight). The results from both models show that male children are more likely to be underweight in comparison to females. The presence of diarrhoea plays a significant role in child nutritional status that is the wasting measurement. A Women Dietary Diversity Score (WDDS) is created which is a proxy of household food security that reflects food availability. The probability that a child is malnourished reduces as dietary diversity increases that are from medium dietary diversity (4-5 food groups) to high dietary diversity ( $\geq 6$  food groups). Therefore, if a child is to increase their consumption from 4-5 food groups to  $\geq 6$  food groups, the probability of the occurrence of malnutrition can reduce.

**Keywords:** household food security, nutrition security, chronic malnutrition, anthropometric measures, women dietary diversity score.

## 1. INTRODUCTION

In Zambia, about 70% of the population are dependent on agriculture for their livelihood yet there still exists the lack of adequate nutrition among Zambian Children (Mofya-Mukuka and Kuhlitz, 2015:1). Children may experience chronic hunger and energy deficiency because they do not consume the right type of food or do not have access to the correct quantity and quality of food. Therefore, household food security is an important issue in Zambia. In addition to household food security, community characteristics such as sanitation and household characteristics maternal care and education also play a role in childhood nutritional status (Fukunda-Parr and Taylor, 2015:7).

To determine nutritional status of children, anthropometric measures are often used. These include insufficient height-for-age (stunting) an indication of chronic malnutrition, insufficient weight-for-height (wasting), an indication of acute malnutrition; and insufficient weight-for-age, an indication of chronic and/or acute under-nutrition (Adebayo, 2003:228).

This research is conducted from a health perspective that focuses on food security from

an availability perspective. Section 2 provides a descriptive study of child malnutrition in Zambia. According to the CSO et al. (2015:161), 40% of Zambian children under the age of five are stunted, 15% are underweight and 6% are wasted. Mothers with no education have a higher percentage of children who are malnourished in comparison with those who have an education. In addition, the percentage malnourished children living in rural areas is higher than urban areas (CSO, 2015:159).

Section 3 presents the data methodology, and section 4 discusses the regression results. Using the linear regression model and the probit model, the results show males are more likely to be stunted and underweight than females. Furthermore, the presence of diarrhoea plays a role in child nutritional status. Diarrhoea increases the probability of a child being wasted in comparison to a child who does not have diarrhoea. Other sanitation measures, such as drinking water source and toilet facility are insignificant yet sanitation should be considered when improving child nutritional status.

Section 4 concludes by giving policy recommendations. The main limitation of the study was finding a suitable proxy for household

food security and the inclusion of sufficient variables that affect child’s nutritional status. Therefore, one recommendation is that for future study, additional information that corresponds to anthropometric measure should be included. Another recommendation is economic empowerment of poor households and households located in rural areas because most malnourished children live in such households and the encouraging child caregivers to give children a diverse group of healthy food

## 2. CHILD MALNUTRITION IN ZAMBIA

### 2.1. Nutritional Status of Zambian Children

Chronic malnutrition or stunting is a major problem experienced by Zambian children. Nationally, there are approximately 40 percent of children under 5 years who are stunted and 17

**Table1:** Child nutritional status in Zambia

Background Characteristics	Height-for-age <sup>1</sup>		Weight-for-height		Weight-for-age		Number of children
	% below -3 SD	% below -2 SD <sup>2</sup>	% below -3 SD	% below -2 SD <sup>2</sup>	% below -3 SD	% below -2 SD <sup>2</sup>	
<b>Age (Months)</b>							
<6	5.3	13.6	3.1	8.0	0.9	5.8	1,032
6-8	9.6	25.1	2.5	9.0	3.9	11.4	585
9-11	17.6	38.5	2.3	10.1	5.7	17.4	606
12-17	19.6	43.1	2.3	7.6	2.2	13.5	1,300
18-23	25.4	54.0	2.2	6.1	4.1	17.8	1,206
24-35	24.8	51.0	2.2	5.2	3.9	17.1	2,450
36-47	16.4	41.6	1.9	5.1	2.8	15.2	2,496
48-59	12.3	34.6	1.8	4.5	2.8	14.9	2,653
<b>Sex</b>							
Male	19.0	42.4	2.5	6.2	3.5	16.0	6,188
Female	15.4	37.6	1.8	5.8	2.8	13.5	6,140
<b>Mother's education</b>							
No education	23.1	44.7	2.0	7.0	4.9	19.9	1,307
Primary	18.3	42.0	2.2	5.8	3.1	15.5	6,518
Secondary	13.7	36.9	1.9	6.1	2.4	11.9	3,334
More than secondary	7.8	18.1	2.6	5.1	0.9	4.6	407

**Note:** Source from CSO (2014:159), Zambia Demographic Health Survey, Preliminary Key Findings. Indices are expressed in standard deviation units (SD) from the median of the WHO child growth standards adopted in 2006.

<sup>1</sup>Recumbent length is measured for children under 2, or in the few cases when the age of the child is unknown and the child is less than 87cm; standing height is measured for all other children.

<sup>2</sup>Includes children who are below -3 standard deviations (SD) from the WHO child growth standards population median.

In relation to the weight-for-height index, children aged 9-11 months have the highest percentage of wasting at about 10 percent and children aged 48-59 months are the lowest wasted at approximately 5 percent. Within each age group, about 2 percent of children are severely wasted. The percentage of male children who are wasted and severely wasted is higher than that of females but the differences are minimal.

percent, who are severely stunted (CSO, 2015:157). Table 1 presents the nutritional status of children in Zambia under the age of 5, controlling for various background characteristics, expressed in percentages. Within each age group, children aged 18-23 months have the highest percentage of stunting at 54 percent and the lowest are those less than 6 months. Furthermore, stunting is higher in males at approximately 42 percent than females at 38 percent.

The mother’s educational attainment also has an impact on the stunting levels. Stunting in children is higher at about 45 percent for mothers who have no education level and is lowest at about 18 percent for mothers who have more than secondary education.

In table 1, 15 percent of children under age 5 are underweight, while about 3 percent of children under 5 are severely wasted. The highest proportion of those that are underweight within each age group is 18 percent. These are children in the age group 18-23 months. The percentage of male children who are underweight is higher at 16 percent than females at 14 percent.

Figure 1 illustrates the nutritional status of children in urban and rural areas. As is

indicated, the percentage of stunting in both areas is high at 42 percent in rural areas and 36 percent in urban areas. This is higher than the percentage of children who are wasted or underweight. The percentage of children who

are underweight is higher in rural areas at 16 percent than in urban areas at 13 percent. For wasting, the percentage difference between rural and urban areas is small though it is higher in urban areas than rural areas.

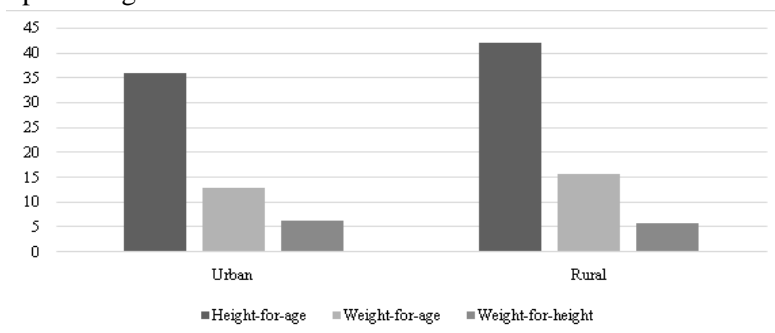


Figure1: Anthropometric measures of Urban-Rural Zambia, 2013-2014 (%)

Source: CSO (2014:159), Zambia Demographic Health Survey, Preliminary Key Findings

Figure 2 shows the nutritional status of Zambian children according to provinces. The percentage of stunting in children is higher in all the provinces than the percentage of wasted and underweight children. The Northern Province has the highest percentage of stunted children at 49 percent. Western, North-Western, Lusaka

and Copperbelt provinces have the lowest percentage of stunting at 36 percent on average. The percentage of wasted and underweight is highest among children in Luapula at 13 percent and 21 percent respectively. Wasting among children is lowest in Muchinga, Northern and Southern provinces at 4 percent. For underweight percentage, it is lowest in Lusaka at 11 percent.

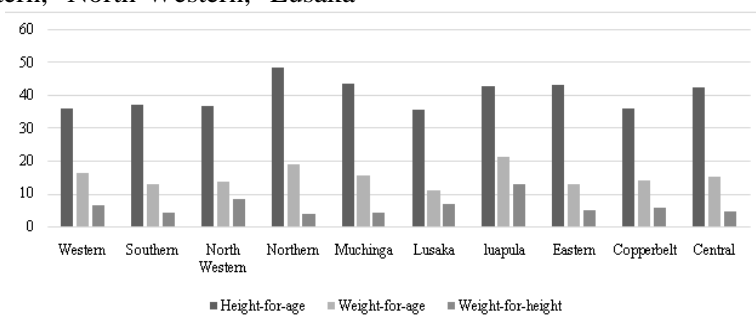


Figure2: Anthropometric measures of Zambian provinces, 2013-2014

Source: CSO (2014:159), Zambia Demographic Health Survey, Preliminary Key Findings

The nutritional status of Zambian children under age 5 from 1992 to 2014 is illustrated in figure 3. Overall, the percentage of children who are stunted is higher than the other anthropometric measures. The percentage of stunted children increased from about 46 percent in 1992 to 53

percent in 2001-2002 and then decreased in 2013-2014. The proportion of children who are underweight declined in 2007 and 2013-2014. The percentage of wasted children increased slightly in 2007 from 5 percent to 6 percent in 2013-2014. Child obesity in Zambia has been low and has remained at the same level since 1992.

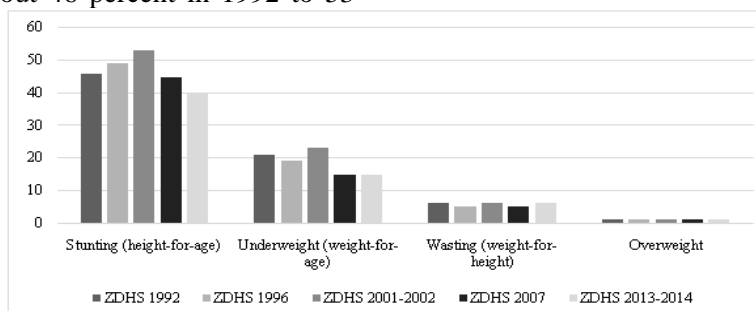


Figure3: Trends in child nutritional status under age 5, Zambia 1992-2014

### 3. DATASET AND METHODOLOGY

#### 3.1. Data Description

The data used in this analysis is from the 2013-2014 Zambia Demographic Health Survey (ZDHS). The representative sample for the 2013-2014 ZDHS included 18,052 households. The survey was conducted in the whole country.

In this survey, the dataset on children is used. It includes information on each child of eligible women under the age of 5 years (0-59 months). Other information include immunisation coverage, vitamin A supplementation, and recent occurrences of diarrhoea, fever and cough as well as treatment. The dataset also includes community characteristics such as sanitation, source of drinking water, the toilet facility and household characteristics such as maternal education, assets, household head occupation and residential type. Height and weight measurements represented in z-score standard deviations are included in the dataset.

#### 3.2. Model Description

In the analysis of the impact of household food security on nutritional status of Zambian children, linear probability regression models (LPM) and probit regression methods are used. The sampling methods are first adjusted to control for the effects of sample design of the survey. This is done by sampling weights, clustering and stratification. Three LPM regressions and probit regression models are created with child nutritional outcomes as the dependent variables for each regression.

In this research, the household production function is used as the base model as specified by Adewara and Visser, 2011:5; Robert, 2014:5; and Babu and Sanyal, 2012:182. The child's nutritional status outcome is affected by the household's decision of inputs such as nutritional intake; care; and health environment and services. It is also affected by available resources and information constraints faced by the household. Therefore, the functional form of child nutritional status is:

$$Y_i = f(X_i, X_c, X_h, W_i, U_i) \quad (1)$$

Equation 1 expressed as a linear regression function;

$$Y_i = \alpha + \beta_1 X_i + \beta_2 X_c + \beta_3 X_h + \beta_4 W_i + U_i \quad (2)$$

is the child nutritional status outcomes determined by anthropometric measures weight-for-height and weight-for-age. A child that has a weight-for-height and weight-for-age Z-scores below -2 standard deviations is considered wasted and underweight respectively. A dichotomous variable for wasting is created where the value 1 is assigned to a weight-for-height Z-score that is  $\leq -2$  and 0 when  $\geq -2$ . The dichotomous variable for underweight is 1 if the weight-for-age is  $\leq -2$  and 0 when  $\geq -2$ .

$X_i$ , is a vector of child specific characteristics such as age (in months), gender, birth order and multiple births (child has siblings). Gender is a dichotomous variable for males where male takes the value 1 and females the value 0. Birth order and multiple births are included as proxies of childcare. The rationale is that the more children in a household, the less childcare can be given to a single child by the caregiver. In addition, the birth order of a child is important because the younger a child is, the more care would be needed to be given by the caregiver in comparison to an older child.

$X_c$ , is a vector of community characteristics that consists of water source, type of toilet facility and diarrhoea. These community characteristics should be considered because in as much as a child may live in a household where they have access to food; the child may not be able to retain the necessary nutrients due to poor sanitation.

Drinking water source includes thirteen options in the survey which are piped into a dwelling, piped into a yard, public tap/standpipe, tube well/borehole, (un)protected dug well, (un)protected spring, river/dam, rainwater, bottled water, tanker truck and cart with small tank. These options are categorised into two groups, namely improved drinking water source and unimproved water source according to the WHO/UNICEF Joint Monitoring Programme (JMP) method (WHO and UNICEF, 2013:12). An improved drinking water source includes piped into dwelling, piped into yard, public tap/stand pipe tube well/borehole, protected well, protected spring and river water. Unimproved water source includes unprotected well, unprotected spring, river/dam, tanker truck, cart with a small tank and bottled water.

Toilet facility responses include flush to piped sewer, flush to septic tank, flush to pit latrine, flush to somewhere, flush don't know, ventilated improved pit latrine, pit latrine with(out) slab, composting toilet, hanging

toilet/hanging latrine and no facility/bush/field. Toilet facility is also grouped into improved toilet facility and unimproved toilet facility according to the JMP method (WHO and UNICEF, 2013:12). An improved toilet facility includes flush to piped sewer, flush to septic tank, flush to pit latrine, ventilated improved pit latrine, pit latrine with slab and composting toilet. Unimproved toilet facilities include flush to somewhere, flush do not know, pit latrine without slab, hanging toilet and no facility/bush/field.

Diarrhoea is a dichotomous variable indicating whether the child had diarrhoea recently where the value 1 indicates that the child had diarrhoea recently and 0 the child did not have diarrhoea recently.

$X_h$ , is a vector of household specific characteristics such as type of residential place, maternal education, household head occupation, household assets and household size. The type of residential place consists of whether the child is located in a rural or urban area. A dichotomous variable for type of residential place is created where rural takes the value 1 if the child lives in a rural residence and the value 0 if a child lives in an urban residence. Maternal education consists of the educational level of a mother that is no education, primary, secondary and higher education, which take the values 0, 1, 2 and 3 respectively. The rationale for including it is that mothers influence hygienic practices and types of foods consumed hence it is expected that higher education levels should positively influence these practices which also in turn improve the nutritional status of a child.

The household assets and household head occupation are proxies for income. In relation to household assets, the wealth index in the survey is used. It is a continuous variable comprising of options of poorest, poorer, middle, richer and richest. Unfortunately, the data did not contain information concerning the occupation of the household head. It is expected that children who come from poorer households may not be able to access the appropriate food required for the improvement of their nutritional status.

The rationale for including household size is that in larger households, food demands are higher than in smaller households therefore it may be difficult for supply of food to meet demand. Children who come from larger households will be affected by the ability to meet demand for food.

$W_i$ , is the Women Dietary Diversity Score (WDDS). It is a proxy of household food security, which reflects food availability, and the probability of micronutrient adequacy of a diet. It is determined by enquiring of the respondent whether they gave the child a range of different foods during the previous day or night. These foods are cereals, white roots and tubers; dark green leafy vegetables; other vitamin A rich foods and vegetables; organ meat; meat and fish; eggs; legumes, nuts and seeds; milk and milk products. To generate the WDDS, each food is dichotomous variable indicating whether a child was given that particular food where 1 is the value assigned if the child was given the type of food and 0 the child was not given. These dichotomous variables are added up to create a score ranging from 0 to 9 then households are categorised into three groups where a score  $\leq 3$  food groups are lowest dietary diversity, 4-5 food groups are medium dietary diversity and  $\geq 6$  are high dietary diversity.

$U_i$ , is the effect of unobservable variables on child's nutrition.

### 3.3. Child Nutritional Outcomes: Anthropometric Measurements

$$\text{Weight-for-height Z-score: } z = \frac{W-X}{\sigma} \quad (3)$$

Where  $W$  is weight of the child,  $X$  is the median weight-for-height of the reference population and  $\sigma$  is the standard deviation weight-for-height of the reference population (Robert, 2014:8). The weight-for-height index measures body mass in terms of body height or length. A z-score measure below -2 standard deviation from the WHO child growth standard population median indicates that a child is wasted. Wasting reflects the lack of adequate nutrition in the short-term immediately after the survey and may be because of inadequate intake of food or recent illness that has caused loss of weight of the child. Children's weight-for-height z-score that is below -3 standard deviations are referred to as severely wasted and those above + 2 standard deviations, overweight or obese (CSO, 2015:156-157).

$$\text{Weight-for-age Z-score: } z = \frac{W-MW}{\sigma} \quad (4)$$

Where  $W$  is weight of the child,  $MW$  is the median weight-for-age of the reference

population and is the standard deviation weight-for-age of the reference population (Adewara and Visser, 2011:7). The weight-for-age index is a combination of the height-for-age and weight-for height measurements. It measures both chronic and acute under-nutrition. Children below -2 standard deviations from the reference population median are classified as underweight and those below -3 standard deviations, severely underweight (CSO, 2015:157).

### 3.4. Study Limitations

A major limitation of this study is that using a suitable proxy for food security is difficult hence making causal inferences was challenging. The shortcoming of the woman's dietary diversity score is that it considers one aspect of food security, which is food access, rather than the other aspects of food availability, food utilization and food stability. Furthermore, the woman's dietary diversity score only captures short-term access of food that is food given to a child during the previous day or night. A dietary diversity score that captures access of food over a month or year would be more preferable than a day because inferences can be made on anthropometric measure of stunting which measures chronic malnutrition. Another limitation of the study is that the dataset did not include sufficient variables that affect child's nutritional status. The variables that can be included are home health practices, health-seeking behaviours by caregivers, access to a health facility, utilization of healthcare, maternal care, household head occupation and education. The inclusion of these variables would have improved the dataset and the results generated and hence reduce potential bias.

**Table 2:** Summary statistics by anthropometric measure

Variable	Mean	Standard deviation	Standard deviation	Standard deviation
<b>Child specific characteristics</b>				
Child age (months)	3.198	1.369	1.369	1.369
Male	0.507	0.500	0.500	0.500
Birth order	3.689	2.398	2.398	2.398
Number of children (5 years and under)	2.201	0.875	0.875	0.875
<b>Community characteristics</b>				
Drinking water source				
<i>Unimproved</i>	0.449	0.497	0.497	0.497
<i>Improved</i>	0.551	0.497	0.497	0.497
Toilet facility				
<i>Unimproved</i>	0.662	0.473	0.473	0.473
<i>Improved</i>	0.338	0.473	0.473	0.473
Diarrhoea	0.187	0.390	0.390	0.390
<b>Household specific characteristics</b>				
Rural	0.676	0.468	0.468	0.468

## 4. REGRESSION MODELLING AND DISCUSSION OF RESULTS

### 4.1. Descriptive Statistics of Estimation Sample

Table 2 contains the summary statistics of the independent variables of the estimation sample. The average age of a child in the estimation sample is about 3 months and the average number of children 5 years and under living in a household is 2. In relation to community characteristics, the mean value of the unimproved drinking water source is about 0.45 and for improved drinking water source about 0.55, which indicates that on average, most households have improved drinking water sources in comparison to unimproved water sources. For the type of toilet facility, the mean value of unimproved and improved toilet facilities is about 0.66 and 0.34 respectively. This indicates that most households have unimproved toilet facilities in comparison to improved toilet facilities.

Concerning household specific characteristics, the average maternal education for children whose mothers have no education is about 12 percent whereas for higher education. This shows that on average few mothers have higher education. Yet the average maternal education for children whose mothers have primary and secondary education is about 58 percent and 28 percent respectively. Hence indicating that on average, at least most mothers have primary education. The average value of the wealth index for the poorest is about 27 percent and richest 1 percent. This shows that on average, most households are poor.

Maternal education				
<i>No education</i>	0.118	0.323	0.323	0.323
<i>Primary</i>	0.583	0.495	0.495	0.495
<i>Secondary</i>	0.278	0.448	0.448	0.448
<i>Higher</i>	0.031	0.171	0.171	0.171
Wealth index				
<i>Poorest</i>	0.269	0.444	0.444	0.444
<i>Poorer</i>	0.258	0.438	0.438	0.438
<i>Middle</i>	0.223	0.416	0	1
<i>Richer</i>	0.151	0.358	0	1
<i>Richest</i>	0.098	0.298	0	1
Household size	6.700	2.620	2	23
<b>Household food security</b>				
Woman's dietary diversity score				
<i>Lowest dietary diversity</i>	0.801	0.399	0	1
<i>Medium dietary diversity</i>	0.148	0.355	0	1
<i>High dietary diversity</i>	0.505	0.219	0	1
Number of observations	6758			

Source: Own estimations using the 2013-2014 ZDHS dataset

In terms of the woman's dietary diversity score (WDDS); the mean value of low dietary diversity, medium dietary diversity and high dietary diversity is about 0.80, 0.15 and 0.51 respectively. This indicates that on average, most households in the estimation sample have low dietary diversity in comparison to that of medium and high dietary diversity.

#### 4.2. Coefficient Estimation using Linear Probability Models

Table3, shows the abridged linear probability regressions where wasted and underweight are dependent variables. Full detailed information of the linear probability regression are in appendix A.1. The male dummy is positively related to underweight. The probability of being underweight increases for male children by about 0.5 percent in comparison to female children. This is consistent with the finding of CSO (2014:159) which indicates that males are

more likely to be underweight than females. This most probably due to biological factors (Bwalya et al., 2015:127; Masiye et al., 2010:39).

For community characteristics, that is drinking water source, type of toilet facility and diarrhoea, only diarrhoea is significant in the wasted model. Holding other variables constant, having diarrhoea increases the probability of wasting by about 7 percent in comparison to whether a child did not have diarrhoea. Though toilet facility and drinking water source are not significant, the presence of diarrhoea indicates that sanitation does affect a child's nutritional status. Studies conducted by Masiye et al. (2010:39) and Van de Poel (2007:9) also found no significant effect of toilet facility and drinking water source but Merchant et al.(2003:1565) reported a significant effect of sanitation.

**Table3:** Linear probability model of anthropometric measures

	<b>Wasted</b>	<b>Underweight</b>
	(1)	(2)
Male dummy	-0.005	0.005***
	(0.013)	(0.002)
Drinking water source		
Unimproved <sup>a</sup>		
Improved	-0.000	0.003
	(0.016)	(0.002)
Toilet facilities		
Unimproved <sup>a</sup>		
Improved	-0.020	0.001
	(0.017)	(0.002)
Diarrhoea	0.073***	0.002
	(0.018)	(0.001)
Rural	-0.050**	-0.000
	(0.025)	(0.003)

Wealth index		
Poorest <sup>a</sup>		
Poorer	-0.017 (0.020)	-0.004* (0.002)
Middle	-0.078*** (0.024)	-0.009*** (0.004)
Richer	-0.060* (0.032)	-0.003 (0.003)
Richest	-0.108** (0.045)	-0.005 (0.004)
Household size	0.006 (0.004)	0.001 (0.000)
Woman's dietary diversity score		
Lowest dietary diversity <sup>a</sup>		
Medium dietary diversity	0.038* (0.021)	0.001 (0.002)
High dietary diversity	-0.033 (0.039)	-0.004 (0.005)
Constant	0.488*** (0.045)	0.990*** (0.005)
R-squared	0.014	0.007
Number of observations	6754	5259
F-statistic	3.208	0.753
Source: Own estimations using the 2013-2014 ZDHS dataset.		

**Notes:** Linearized standard errors in parentheses. <sup>a</sup> Omitted category of coefficient and standard error. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$  indicates coefficient significance at 1%, 5% and 10% levels respectively.

For household characteristics, living in a rural area was significant for the wasted coefficient and insignificant for the underweight coefficient. The probability of a being wasted child reduces by about 5 percent and is significant at the 5 percent significance level. This is similar to the findings of the CSO (2014: 159) where wasting is higher in urban areas than rural areas. This is probably because of the increasing urban poverty though urban children have nutritional advantages such as access to health care, improved water and toilet sanitation in comparison to rural children (Smith et al., 2004:1). As compared to poorest households, a household with the richest wealth index significantly reduces the probability of being wasted by about 11 percent. Generally, the probability of a child being malnourished reduces as the wealth index increases that is from poorer to richer.

In terms of the woman's dietary diversity score, when compared to low dietary diversity, the probability of a child being wasted increases by about 4 percent for medium dietary diversity at a 1 percent significance level. Therefore, this result suggests that the probability of wasting increases as the woman's dietary diversity changes from low dietary diversity to medium dietary diversity. This is seen in the positive relationship between medium dietary diversity and wasting. These results are similar to those

found by Mofya-Mukaka and Kulhartz (2015:12) who indicated a positive relationship between high levels of diversification and wasting. Still interpretation of this result must be done with caution. For the underweight measure, none of the woman's dietary diversity scores is significant.

#### 4.3. Limitations of the Linear Probability Model

The main problems with using the linear probability model are the non-normality and heteroscedasticity of the error term; the possibility of the dependent variables lying outside the 0 to 1 probability range; and low R-squared values (Gujarati, 2004:584-586). Since the dependent variables are dichotomous variables, the error term also takes on two values and hence follows a Bernoulli distribution. The mean and variance are  $p$  and  $p(1 - p)$  respectively where  $p$  is the probability of success occurring. This indicates that the variance is a function of the mean and leading to heteroscedastic error variance (Gujarati, 2004:584-585).

Another problem arising is that the predicted probabilities may be outside the 0 to 1 probability range, hence making interpretation difficult (Gujarati, 2004:586; Wooldridge 2012:251). Furthermore, the R-squared values in linear probability models are usually very low as



can be seen in the linear probability models in table 3. Other variables that could be explaining the nutrition measures are household head occupation, maternal care, health-seeking behaviour by caregivers, access to a health facility and utilization of healthcare. Unfortunately, the survey data did not include such information.

#### 4.4. Coefficient Estimation Using Probit Models

Table 4 presents the abridged probit regression model and its marginal effects where wasted and underweight are dependent variables. Full detailed information of the probit regression model and probit marginal effects are in appendix A.2 and A.3 respectively. The first column shows that for the male dummy, there is a positive relationship between a male child and the underweight measure. The probit marginal effect indicates that the probability of a male child being underweight is 0.2 percent. This is also consistent with the finding of CSO (2014:159) where males are more likely to be underweight than females.

Drinking water and toilet facility are insignificant for measures of the probit model and the probit marginal effect. In comparison to a child not having diarrhoea, the probit coefficient effect and marginal effect of

diarrhoea is positive for all determinants but is only significant for the wasted determinant at the 1 percent statistical level. This shows that diarrhoea increases the probability of a child being wasted and hence community characteristics relating to sanitation play a role in child nutrition.

Similar to the linear probability model, the probit marginal coefficient for living in a rural area is 5 percent and significant at the 5 percent significance level. This is similar to the findings of the CSO (2014: 159) where wasting is higher in urban areas than rural areas. The underweight measure is insignificant in both the probit model and the probit marginal effects. For the wealth index, the results show that for both the probit model and the marginal effects there is a negative relationship between a child being wasted and the wealth index. This suggests that children born in wealthier households are less likely to be wasted in comparison to those born in poor households. In the probit model, household size is significant only for the underweight measure at a 10 percent significance level. The positive coefficient may indicate that in more crowded households, children are more likely to be underweight probably because of the need to share household resources such as food.

**Table 4:** Probit model of anthropometric measures

	Probit model		Probit marginal effects	
	Wasted	Underweight	Wasted	Underweight
	(1)	(2)	(3)	(4)
Male dummy	-0.013 (0.034)	0.712*** (0.202)	-0.005 (0.013)	0.002*** (0.001)
Drinking water source				
Unimproved <sup>a</sup>				
Improved	-0.000 (0.041)	0.270 (0.194)	-0.000 (0.016)	0.001 (0.001)
Toilet facilities				
Unimproved <sup>a</sup>				
Improved	-0.051 (0.044)	0.193 (0.196)	-0.020 (0.017)	0.000 (0.001)
Diarrhoea	0.183*** (0.046)	0.269 (0.256)	0.073*** (0.018)	0.001 (0.001)
Rural	-0.127** (0.063)	0.010 (0.259)	-0.050** (0.025)	0.000 (0.001)
Wealth index				
Poorest <sup>a</sup>				
Poorer	-0.043 (0.050)	-0.526** (0.265)	-0.017 (0.020)	-0.001 (0.001)
Middle	-0.198*** (0.063)	-0.981*** (0.253)	-0.079*** (0.025)	-0.005** (0.002)
Richer	-0.151* (0.081)	-0.259 (0.370)	-0.060* (0.032)	-0.000 (0.001)
Richest	-0.275**	-0.196	-0.109**	-0.000

	(0.114)	(0.384)	(0.045)	(0.000)
Household size	0.015	0.074*	0.006	0.000
	(0.009)	(0.042)	(0.004)	(0.000)
Woman's dietary diversity score				
Lowest dietary diversity <sup>a</sup>				
Medium dietary diversity	0.097*	0.210	0.039*	0.000
	(0.054)	(0.311)	(0.022)	(0.001)
High dietary diversity	-0.085	-0.335	-0.034	-0.002
	(0.101)	(0.269)	(0.040)	(0.002)
Constant	-0.031	2.320***		
	(0.114)	(0.420)		
Number of observations	6754	5218	6754	5218
F-statistic	3.015	11.779	3.015	11.779
Source: Own estimations using the 2013-2014 ZDHS dataset.				

**Notes:** Linearized standard errors in parentheses. <sup>a</sup> Omitted category of coefficient and standard error. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$  indicates coefficient significance at 1%, 5% and 10% levels respectively.

The probit model results show that in comparison to the low dietary diversity, there is a positive relationship between a wasted child and the medium dietary diversity score. For the medium diversity score, the coefficient magnitude is about 0.10 and is significant at a 10 percent significance level. The marginal effects show the probability of a child being wasted increases by about 4 percent for medium dietary diversity in comparison to low dietary diversity though this is significant at the 1 percent significance level. For the underweight measure, none of the dietary diversity scores are significant in both the probit model and the marginal effects. This is probably because the underweight measure is a chronic measure of malnutrition. The probit model and the marginal effects show that in comparison to low dietary diversity, the high dietary diversity is negatively related to wasting and the underweight measure and reduces the probability of a child being malnourished but the results are insignificant for all measures.

#### 4.4.1. Limitations of the Probit Model

The main disadvantage of using probit models is that the coefficients are difficult to interpret (Wooldridge, 2012: 583). This is because the dependent variables of wasting and underweight depend on unobserved components of utility or latent variable that are normally distributed. The normal distributions in some situations are inappropriate and may lead to inaccurate forecasts (Train, 2002:101).

## 5. CONCLUSION AND RECOMMENDATIONS

Zambia is an agricultural country and though it may have sufficient supply of food, many children suffer from malnutrition (Mofya-Mukuka and Kuhlitz, 2015:2). In this study, the 2013-2014 Zambia Demographic Health

Survey (ZDHS) is used. Child nutrition is determined using anthropometric measurements. Overall the data shows that male children are more likely to be malnourished than females. Children born to mothers with no education are more likely to be malnourished than those born to mothers who have education. Furthermore, the percentage malnourished children living in rural areas is higher than urban areas (CSO, 2015:159).

To analyse the impact of household food security on nutritional status of Zambian children, the linear probability regression model and the probit model are used. The dependent variables for both models are wasting and underweight, which are regressed on child specific characteristics, household characteristics, community characteristics and the woman's dietary diversity score which is a proxy for food security. The main limitation of the linear probability model is the possibility of the dependent variables lying outside the 0 to 1 probability range and a low R-squared (Gujarati, 2004: 584-586). For the probit model, the main limitation is the difficulty of interpreting the coefficients (Wooldridge, 2012:583).

The results from both models show that male children are more likely to be underweight in comparison to females. For community characteristics, the presence of diarrhoea plays a significant role in child nutritional status that is the wasting measurement. Though the other variables relating to community characteristics such as drinking water source and toilet facility were insignificant, they still play an important role in child nutritional status.

For the woman's dietary diversity score, the linear probability model and probit model show that wasting is positively related to the medium

dietary diversity. The marginal effects show the probability of a child being wasted increases by about 4 percent for medium dietary diversity in comparison to low dietary diversity. This means that a diet of 4-5 food group is more likely to increase the probability of wasting. The probability that a child is malnourished reduces as dietary diversity increases that is from medium dietary diversity to high dietary diversity. Therefore, if a child is to increase their consumption from 4-5 food groups to  $\geq 6$  food groups, the probability of the occurrence of malnutrition can reduce.

### 6. RECOMMENDATIONS

- Additional questions included in the survey to create more variables that explain the dependent variables of wasting and underweight. These questions should include the capturing of a more suitable dietary diversity score, proxy for food security and other variables.
- ✚ The dietary diversity score should capture access of food over longer period such as a month or year rather than a day so that inferences can be made on anthropometric measure of stunting. Therefore, respondents can keep a diary where they record the type of food that they give to their children and when they give the children the food.
- ✚ A suitable proxy for food security that captures other aspects of food security such as food availability, food utilization and food stability should be included in the dataset. Therefore, the survey questionnaire should have questions that enable information on food utilization, food access, food availability and food stability to be obtained.
- ✚ Other variables that affect child nutrition should be included in the dataset. The variables that can be included are home health practices, health-seeking behaviours by caregivers, access to a health facility, and utilization of healthcare, maternal care, household head occupation and education. The inclusion of these variables can generate better results hence reduce potential bias.
- Economic empowerment of poor households and households located in rural areas are to be considered because most malnourished children live in such households. Therefore, to support such households, nutritional programmes can be set up to incentivise them to give children a diverse group of healthy food (Masiye et al., 2010:40). One such programme may provide discounts on health foods items in stores or markets for individuals who are members of the programme. The food items can include fruits, vegetables, carbohydrate-rich foods, protein-rich foods, dairy and dairy alternatives, legumes and lentils, oils, spreads, nuts and seeds. Still there should be continuous monitoring and evaluation of the nutritional programmes and its beneficiaries.
- Launch and sustenance of a nutritional education program, which has the goal of educating households on the importance of healthy food groups and awareness of the dangers of malnutrition (Sealey-Potts and Potts, 2014:5).
- Macro public health and micro public health to prevent water-borne diseases such as diarrhoea should be undertaken. The government and other stakeholders should continue to embark on macro public health projects such as the filtration and chlorination of water supplies, the improvement of drainage and sanitation systems and building of improved toilet facilities. Households in Zambia should carry out micro public health such as the boiling of utensils such as bottles used by children, boiling water and milk, washing hands and protection of food from insects such as flies that carry diseases (Cutler et al., 2006:102).

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**APPENDIX**

*A.1) Linear Probability Regression*

	<b>Wasted</b>	<b>Underweight</b>
	(1)	(2)
Child age (months)		
15-19		
20-24	0.053*	0.001
	(0.029)	(0.004)
25-29	0.023	0.003
	(0.033)	(0.004)
30-34	0.097**	0.004
	(0.039)	(0.005)
35-39	0.091**	0.004
	(0.044)	(0.006)
40-44	0.127**	0.004
	(0.060)	(0.009)
45-59	0.307***	0.009
	(0.085)	(0.007)
Male dummy	-0.005	0.005***
	(0.013)	(0.002)
Birth order	-0.006	-0.001

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	(0.006)	(0.001)
Number of children ( $\leq 5$ years)	-0.003	-0.001
	(0.011)	(0.001)
Drinking water source		
Unimproved		
Improved	-0.000	0.003
	(0.016)	(0.002)
Toilet facilities		
Unimproved		
Improved	-0.020	0.001
	(0.017)	(0.002)
Diarrhoea	0.073***	0.002
	(0.018)	(0.001)
Rural	-0.050**	-0.000
	(0.025)	(0.003)
Maternal education		
No education		
Primary	-0.015	0.005
	(0.024)	(0.004)
Secondary	0.007	0.004
	(0.028)	(0.004)
Higher	-0.069	0.001
	(0.065)	(0.005)
Wealth index		
Poorest		
Poorer	-0.017	-0.004*
	(0.020)	(0.002)
Middle	-0.078***	-0.009***
	(0.024)	(0.004)
Richer	-0.060*	-0.003
	(0.032)	(0.003)
Richest	-0.108**	-0.005
	(0.045)	(0.004)
Household size	0.006	0.001
	(0.004)	(0.000)
Woman's dietary diversity score		
Lowest dietary diversity		
Medium dietary diversity	0.038*	0.001
	(0.021)	(0.002)
High dietary diversity	-0.033	-0.004
	(0.039)	(0.005)
Constant	0.488***	0.990***
	(0.045)	(0.005)
R-squared	0.014	0.007
Number of observations	6754	5259
F-statistic	3.208	0.753
Source: Own estimations using the 2013-2014 ZDHS dataset		

**Notes:** Linearized standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$  indicates coefficient significance at 10%, 5% and 1% levels respectively

### A.2) Probit Regression

	Wasted	Underweight
	(1)	(2)
Child age (months)		
15-19		
20-24	0.135*	0.095
	(0.074)	(0.369)
25-29	0.059	0.355
	(0.084)	(0.417)

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30-34	0.247** (0.098)	0.453 (0.531)
35-39	0.230** (0.112)	0.526 (0.579)
40-44	0.323** (0.154)	0.507 (0.809)
45-59	0.790*** (0.228)	0.000 (.)
Male dummy	-0.013 (0.034)	0.712*** (0.202)
Birth order	-0.015 (0.015)	-0.072 (0.067)
Number of children ( $\leq 5$ years)	-0.007 (0.028)	-0.133 (0.106)
Drinking water source		
Unimproved		
Improved	-0.000 (0.041)	0.270 (0.194)
Toilet facilities		
Unimproved		
Improved	-0.051 (0.044)	0.193 (0.196)
Diarrhoea	0.183*** (0.046)	0.269 (0.256)
Rural	-0.127** (0.063)	0.010 (0.259)
Maternal education		
No education		
Primary	-0.038 (0.060)	0.392* (0.223)
Secondary	0.018 (0.071)	0.423 (0.259)
Higher	-0.178 (0.168)	-0.443 (0.303)
Wealth index		
Poorest		
Poorer	-0.043 (0.050)	-0.526** (0.265)
Middle	-0.198*** (0.063)	-0.981*** (0.253)
Richer	-0.151* (0.081)	-0.259 (0.370)
Richest	-0.275** (0.114)	-0.196 (0.384)
Household size	0.015 (0.009)	0.074* (0.042)
Woman's dietary diversity score		
Lowest dietary diversity		
Medium dietary diversity	0.097* (0.054)	0.210 (0.311)
High dietary diversity	-0.085 (0.101)	-0.335 (0.269)
Constant	-0.031 (0.114)	2.320*** (0.420)
Number of observations	6754	5218
F-statistic	3.015	11.779

Source: Own estimations using the 2013-2014 ZDHS dataset

**Notes:** Linearized standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$  indicates coefficient significance at 10%, 5% and 1% levels respectively

A.3) Probit Marginal Effects

	Wasted	Underweight
	(1)	(2)
Child age (months)		
15-19		
20-24	0.053*	0.001
	(0.029)	(0.003)
25-29	0.023	0.002
	(0.033)	(0.003)
30-34	0.098**	0.002
	(0.039)	(0.003)
35-39	0.091**	0.002
	(0.044)	(0.003)
40-44	0.128**	0.002
	(0.061)	(0.003)
45-59	0.302***	0.000
	(0.079)	(.)
Male dummy	-0.005	0.002***
	(0.013)	(0.001)
Birth order	-0.006	-0.000
	(0.006)	(0.000)
Number of children ( $\leq 5$ years)	-0.003	-0.000
	(0.011)	(0.000)
Drinking water source		
Unimproved		
Improved	-0.000	0.001
	(0.016)	(0.001)
Toilet facilities		
Unimproved		
Improved	-0.020	0.000
	(0.017)	(0.001)
Diarrhoea	0.073***	0.001
	(0.018)	(0.001)
Rural	-0.050**	0.000
	(0.025)	(0.001)
Maternal education		
No education		
Primary	-0.015	0.002
	(0.024)	(0.002)
Secondary	0.007	0.002
	(0.028)	(0.002)
Higher	-0.070	-0.006
	(0.066)	(0.006)
Wealth index		
Poorest		
Poorer	-0.017	-0.001
	(0.020)	(0.001)
Middle	-0.079***	-0.005**
	(0.025)	(0.002)
Richer	-0.060*	-0.000
	(0.032)	(0.001)
Richest	-0.109**	-0.000
	(0.045)	(0.000)
Household size	0.006	0.000
	(0.004)	(0.000)
Woman's dietary diversity score		
Lowest dietary diversity		
Medium dietary diversity	0.039*	0.000
	(0.022)	(0.001)

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High dietary diversity	-0.034 (0.040)	-0.002 (0.002)
Number of observations	6754	5218
F-statistic	3.015	11.779
Source: Own estimations using the 2013-2014 ZDHS dataset		

**Notes:** Linearized standard errors in parentheses. \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$  indicates coefficient significance at 10%, 5% and 1% levels respectively

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