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Master Project in Social Statistics

Modelling Mothers' Socio-Economic and Demographic Determinants of Nutritional Health of Children Under Five in Kenya

Research Report in Mathematics, Number 50, 2019

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Master of Science in Social Statistics Project

A project submitted in partial fulfillment of the requirement for the award of a Degree of Master of Science in Social Statistics

The Director
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Submitted to: School of Mathematics

Abstract

This study analyzes how socio economic and demographic factors influence Nutritional status of Kenyan children aged 0-59 months. Since malnutrition is classified as a critical health problem in sub-saharan Africa, this study answers this question through a secondary data sample of 17911 children that were a representation of the whole population through stratified random sampling method. To obtain the results, an ordinal logistic regression model is fitted with Nutritional status of children being the response variable and the socio economic and demographic factors as the predictors. Weighting of the sample was done through the women individual sample. The results have shown that there is a significant relationship between the socio economic status of mothers and their children's nutritional status. All the predictors are significant in explaining the response variable except for the mother's age. The analysis of results is done using the odds ratio on the categories of the predictors with reference to other group. Mother's aged between 15-19 have a higher percentage (30%) of children who are stunted while those in the age bracket 45-49 have a higher percentage of normal nourished children. Rift valley province is seen to be leading with the number of children that are stunted followed by Coast province. Mothers with no education are more likely to have stunting children than those that have at least some primary education. Wealth index is also seen to play a big role in the nutritional status of children with those from the poorest index being 46% more likely to either be wasted or stunted, and those from the richest family being 59% less likely to be wasted or stunted. A mother that does not watch television, listens to radio or read newspapers is 13% more likely to have stunted children compared to that who does. The Kenyan vision 2030 aims at achieving good health and adequate nutrition, the study therefore recommends for more studies to be done on the prevalence of obesity. Our main target as a country is to reach a statistical zero on malnutrition..

Declaration and Approval

This project is my original work and has not been presented for examination in any other university.

Signature

Date

Pembe Lucy Manyaza

Reg No. I56/82957/2015

This project has been submitted for examination with my approval as the University supervisor.

Signature

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Pembe Lucy Manyaza

November, 2019.

Dedication

To my husband, Mr. Vincent Wafula and to my children Raphael, Lisa and Leticia.

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1 INTRODUCTION

1.1 Background Information

To tackle the problem of poverty and promote sustainable development, the Millennium Development Goals were adopted in September 2000 by the United Nations. Goal number four is specific to child health, and it aimed to have reduced mortality in children aged less than five years by two thirds between 1990 and 2015.

After the elapse of this period, the United Nations came up with the 17 sustainable development goals in 2015. Goal number 3 is set to achieve good health and well-being. The sustainable development goals were designed in order to help attain the millennium development goals or rather get to a statistical zero on poverty, hunger, preventable children deaths and many other targets. In the Kenya vision 2030, good health, including adequate nutrition and education are identified as key to attaining the millennium and sustainable development goals.

The Kenya constitution states that “adequate food and nutrition is a human right”, Article 43 says that “every citizen has a right to get adequate food and to be free from hunger”, then article 53 talks about basic nutrition as being a right to every child. The 2011 Kenya food and nutrition security policy also states that “nutrition is central to human development in the country”.

Malnutrition is seen as a huge health problem in Africa. It reduces resistance of the body to infections which are enhanced by the environmental conditions. (Zbigniew 1972). Medically malnutrition refers to an inadequacy in the quality of a diet specifically the lack of essential nutrients or excess of it (Robson, 1972; MacLaren, 1976:7). And according to (Morgane et al. 2002) they have defined malnutrition as when the diet is missing one or more essential nutrients or they are in an in inappropriate proportion.

We go further into defining under-nutrition which is a type of malnutrition where all nutrients that the body requires are available in the diet taken but in small amounts (Morgane et al., 2002). In nutritional health, it is found that the lack of micronutrients may affect the brain maturation in early stages of life.

There is always a link between infection and malnutrition, the latter being the main cause of immune deficiency countrywide and worldwide. Infectious diseases account for more

than fifty percent of all deaths in children aged less than five years, most of them usually being malnourished.

Micronutrient deficiency lead to poor growth, reduced intelligence, and an increase in mortality and prone to infection (Goldstein et al.2008). From the time a child is born to the age of 2 years there is a lot of mental, optimal, physical, and cognitive growth taking place. But unfortunately, this is the time that a child usually suffers from nutrients deficiencies that interferes with the normal growth of life, sometimes causing common childhood illness as diarrhoea and respiratory infections. Thus the nutritional status of infants and children under-five years as a measure of children's health is an area of biggest concern as the early stages of life are critical or important for optimal growth and development (Mugo, 2012).

Socio- economic status (SES) is the level of social and economic position of people in a society as reflected by various things like education, health, crime, employment/unemployment level, occupation, housing and access to services such as utilities and infrastructure. And indicators of economic status include income, level of dependency on payments, home ownership and asset level etc. A lot of literature have analyzed factors that affect child's nutritional health. Many of these studies have stressed the importance of the mothers' education (Kassouf, 1996). More studies show that parental factors especially mothers socio-economic status like labor force participation and education have a large influence on early child health status.

In the Kenya Demographic Health Survey (KDHS) 2014 analysis show that twenty six percent of under five children are stunted, four percent are wasted and eleven percent are underweight. There is a very high percentage on breastfeeding practices, at ninety nine percent, of which only sixty-one are on exclusive breast feeding. A large percentage of parents also know the best time to introduce complementary foods that is 6-9 months but there is still a big challenge since, its only twenty two percent that are being fed in according to the recommended feeding practices for children. To obtain an overall perspective of the state of child nutritional health, it is important to view the progress of overall child nutrition against interrelated indicators such as immunization, access to health services, mother's income, family size, maternal literacy, birth spacing, breastfeeding etc.

1.2 Statement of Problem

There is an extensive body of knowledge that shows an inter-generational health effects, that is, adult health, mostly determined during childhood is influenced by socio-economic outcomes. They show that parental characteristics like labor force participation and education affect the early child health status. However not many studies have been done in the country specifically on the maternal effects on the nutritional health status of under five children apart from those carried out in selected regions and Kenyan slums. This

study seeks to fill a gap by finding out whether the nutritional status of children under five years in the country is affected by the mother's social economic status.

1.3 Objective of the Study

The general objective is to investigate mother's socio-economic determinants of child nutritional status. The specific objectives are:

- i To examine the influence of mothers socio-economic status on the child nutrition.
- ii To determine the prevalence of malnutrition in children 0 to 59 months.
- iii To analyze how each of the social economic factors differently affects under five nutritional status.

1.4 Significance of the study

This study will be of importance to the Government bodies for example, the Ministry of health, Ministry of social services and the Ministry of Planning and devolution. It will also be useful to Non-governmental organizations like the World Health Organization, UNICEF and others. They may use the findings for policy formulation and intervention on Children Nutritional health concerns.

2 LITERATURE REVIEW

Lisa et al. (2002) studied the status of women and the role it plays in child nutrition in the developing countries. They found out that the ability of a mother to make decisions in the household and at the community level affects the nutritional well-being of herself and that of her children. Women status is very low in the southern part of Asia, thus their report found out that improvements in women or women empowerment at the household level and at the community level strongly influences nutritional status of children. If there were equal rights and status for both women and men in that part of the country, controlling for all the other factors, then there would be a decline in the percentage of children who are underweight by 13 percent. There is a compromise in the women's status in that country thus the higher rates of children malnutrition when compared to other African countries.

Vinod et al. (2015) conducted a descriptive study in Bastward village of Belgaum district in India. They wanted to see the level of awareness and attitude about malnutrition among parents of children who are under five years. Their findings showed that more than fifty percent or precisely fifty eight percent of the parents had moderate awareness, with a mean of 8.6 and an sd of 2.6. On attitude a very high percentage (86) of parents had a positive attitude on malnutrition with a mean of 33 and sd of 3.4. It also showed a strong positive correlation between attitude and knowledge about malnutrition among these parents. After an intervention, on health education about malnutrition, there was a high increase in knowledge.

Samuel et al. (2015) performed a systematic review on malnutrition for a period of 15 years. This study was to analyze the determinants and effects of malnutrition, under nutrition and over nutrition and their intervention in the middle and low income countries. There seemed to be a rise in obesity and overweight among children who are under five years. This was also seen even in areas that were experiencing under nutrition. Under nutrition was seen to be low among the urban dwelling but also experienced high levels of obesity. Exclusive and breastfeeding on time were found to help in reduction of malnutrition. Method used was uploading publication that were relevant to the study on the Zotero software and only longitudinal data was used.

Davidson et al. (2007) studied the socio-economic differences of nutrition and health on the populations in the developing countries. The study used different indicators like, child mortality rates, malnutrition, immunization, antenatal visits, participation in school and media listenership. The findings were that the poor performed badly than those that

were not poor in all the indicators used. This inequality varied widely depending on the indicator and the country, but the trend or the direction was clear across economic groups. Quantiles were used to present the results, poorest quantile was set at 1.0 and the other quintiles stated as a multiple or fraction of that.

Parul et al. (1989) discusses the importance of a mother's care to her children during the early stages of life usually zero to six years. The care the mother gives will depend on her knowledge and understanding on the aspects of basic health and nutrition. They put it that mother's education status influences her child care practices. The conclusion is that literacy of the mother has an association with the child malnutrition in the period 0 to 3 years. They recommend for an uplift in the mother's literacy especially in the rural dwellings.

Yngve (1982) analyzed maternal and young child health with the United Nations Expert Group, where they looked more on the importance of breast milk to infants. They found out that poverty is the cause of ill health and poor nutrition in many countries. Their recommendations were long term interventions on factors like basic education to women, this is because their study had found out that even with minimal education women awareness on need to improve the nutritional status of their children and themselves was high than those that were illiterate. The emphasis was also on Legislative action about nutritional status. Examples were equal rights and opportunities, Marriage and family laws, improve on work conditions on women and employment for women, Family planning, and appropriate technology to reduce Material Work Load, Accessibility of Health services for provision of nutrition education/MCH services. Their conceptual framework linked Social Economic factors and biological factors to Food intake and maternal nutritional status, the outcome negative effects is a child that has low birth weight, perinatal mortality, developmental sequel or Morbidity.

Sumonkanti et al. (2011) used an ordinal logistic regression model to determine the risk factors of malnutrition. The Dependent variable (Nutritional status) was grouped as severely, moderately and nourished with several socio-economic and demographic characteristics as the independent variables. Assumptions of the proportional odds regression model were conducted and the data was fit. The predictors were all in association with the child's malnutrition. Results were identified as that, the risk of worse nutrition status was set at 6.5 and 5.0 times more among the children age-group 12 to 23 months and 24 and above months respectively with comparison to the infants. Overall despite the differences in the results of the models, the results of the proportional odds model were compared with those of the binary logistic regression model and the POM proved adequate for data analysis.

Ben et al. (2012) studied the effect of mother's education on the child's nutritional status in the slums of Nairobi. A study that involved 5156 between 0 to 42 months. They

used multiple and binomial regression models to analyze the effect of education in the univariable and multivariable models respectively. Their findings were 0.4 of the children were stunted with mothers education being the strongest predictor of children stunting. Child birth weight, gender, marital status, parity, pregnancy intentions, and health seeking behavior were also independently significant associated with stunting. The results of the odds ratios showed that there was association between education of the mother and child stunting.

The place of delivery was also a determining factor in the nutritional status of the children home deliveries were more likely to have stunted children. On the social Economic status variable, those with high SES were 84% less likely to have stunting children (odds 0.843). Mother's Parity with reference category One birth, those with 2 births were 30% more likely to have stunting children (odds 1.299) and those with 3 births and above were 40% more likely to have stunting children (odds 1.406). There was high correlation on the covariates which had an effect on the fitted logistic models.

3 METHODOLOGY

3.1 Data

This study uses Secondary data from Kenya National Bureau of Statistics (KNBS) on the 2014 Kenya demographic health survey study. The data is found in KENADA micro data (KEKR70FL)

The Kenya DHS data has information on different household characteristics and nutrition and health of women aged 15-49 years and their children. The sample of 20,964 is a national representation of all the eight provinces in Kenya (47 counties).

Data sampling method were Strata and cluster sampling, that is, the population was divided into geographical groups before sampling. Stratification helps reduce sampling errors when introduced at the initial stage of sampling. A cluster is a group of neighboring households that serves as the primary sampling unit. Each child or household were assigned to a cluster. The Case Identification was a composite of the Cluster number, household number and respondent number.

There were a total of 20964 children under age 5 eligible for weight and height measurements. Only 18647 had data on the measurements that were used to for the indicators. 2024 children had missing values and were not included in the analysis. Missing values were due to refusal, or not present during the survey. The overall analysis is based on only three nutritional indicators, namely, Stunted, Wasted and Normal with an overall sample of 17911.

3.2 Ordinal Logistic Regression Model

Ordinal logistics regression model is used when the response categories are ordered and greater than two. We use ordinal logistic regression instead of a multinomial logistic regression model because ordinal logistic model takes the ordering into account. Odds ratios are used in the interpretation of the results.

The odds of an event is the ratio of the probability that an event will occur to the probability that the event will not occur.

Let p be the probability of the event occurring, then the;

$$Odds = \frac{p}{1-p} \quad (3.1)$$

Odds ratio is a measure of the odds of an event happening in group 1 compared to the odds of the same event happening in group 2.

$$Odds \ Ratio = \frac{Odds \ of \ event \ in \ group \ 1}{Odds \ of \ event \ in \ group \ 2} \quad (3.2)$$

3.2.1 Assumptions

The following assumptions were tested before the model was applied to the data.

- i Response variable Measurement: The dependent variables is ordered from Normal, acutely malnourished (Wasted) to chronically malnourished (Stunted) thus meeting the first assumption.
- ii The independent variables are continuous and categorical fulfilling assumption number two which states that the independent variables should be continuous or categorical.
- iii No Multicollinearity assumption. The model was tested for multicollinearity between the independent variables and it was found that two or more independent variables were not highly correlated with each other. The correlation matrix is as shown in table 4.1.
- iv We have proportional odds (that is, cumulative odds ordinal regression with proportional odds). This is also called parallel lines assumptions where it is only the intercept that is different for all models while coefficient of the predictor has the same effect on all the models. That is to say the predictors do not depend on the category level but the intercept does.

3.2.2 Derivation of the model

From the multiple logistic regression model:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_kx_k \quad (3.3)$$

Where β_0 is the intercept and $\beta_1, \beta_2, \dots, \beta_k$ are regression coefficients. p is the probability of event occurring, $1 - p$ is the probability of the event not occurring.

The left side of the equation is called the logit which means the log of the odds that an event occurs. The coefficients tells how much the logit changes based on the values of the predictor variables.

We now use the multiple logistic regression model to get ordinal logistic regression model as below. An ordinal logistic regression model estimates separate binary logistic regression model for each of the cut offs (the proportional odds model) resulting in $m-1$ binary logistic regression models. Where m are the number of categories.

The ordinal logistic regression (OLR) equation therefore becomes:

$$P(Y \leq C_j) = \sum_{i=1}^j p_i \quad (3.4)$$

And the OLR model is

$$\ln \left(\frac{P(Y \leq C_j)}{P(Y > C_j)} \right) = \beta_{0j} + \beta_{1j}x_1 + \beta_{2j}x_2 + \cdots + \beta_{kj}x_k \quad (3.5)$$

For proportional odds (all cumulative logits) we have

$$\ln \left(\frac{P(Y \leq C_j)}{P(Y > C_j)} \right) = \beta_{0j} + \beta_1x_1 + \beta_2x_2 + \cdots + \beta_kx_k \quad (3.6)$$

Now for m -categories we have $m-1$ models with parallel lines.

$$p_1 = \frac{\exp(\beta_{01} + \beta_1x_1 + \beta_2x_2 + \cdots + \beta_kx_k)}{1 + \exp(\beta_{01} + \beta_1x_1 + \beta_2x_2 + \cdots + \beta_kx_k)} \quad (3.7)$$

and

$$p_j = \frac{\exp(\beta_{0j} + \beta_1x_1 + \beta_2x_2 + \cdots + \beta_kx_k)}{1 + \exp(\beta_{0j} + \beta_1x_1 + \beta_2x_2 + \cdots + \beta_kx_k)} - \frac{\exp(\beta_{0j-1} + \beta_1x_1 + \beta_2x_2 + \cdots + \beta_kx_k)}{1 + \exp(\beta_{0j-1} + \beta_1x_1 + \beta_2x_2 + \cdots + \beta_kx_k)} \quad (3.8)$$

where $j = 2, 3, \dots, m-1$

$$p_m = 1 - \sum_{j=1}^{m-1} p_j \quad (3.9)$$

In the proportional odds ordinal logistic regression model, each outcome (logit) has its own intercept but the same regression coefficients, and the predictor does not depend on the category while the intercept does. This means that the effect of the predictor is the same for different logit functions. It considers a set of dichotomies, one for each possible cut-off of the response categories into two sets, of high and low. As the level of one increases, responses on the other tend to increase towards higher levels, or to decrease towards lower levels.

For example in this study there are three response categories of the ordinal logistic regression model. Therefore we will have

$$p_1 = \left(\frac{\text{Prob}(\text{score} = 1)}{\text{Prob}(\text{score} > 1)} \right) \quad (3.10)$$

$$p_2 = \left(\frac{\text{Prob}(\text{score} = 1 \text{ or } 2)}{\text{Prob}(\text{score} > 2)} \right) \quad (3.11)$$

$$p_3 = \left(\frac{\text{Prob}(\text{score} = 1, 2 \text{ or } 3)}{\text{Prob}(\text{score} > 3)} \right) \quad (3.12)$$

And 3-1 models with parallel lines. The third probability has no odds because the probability of scoring the last score is 1.

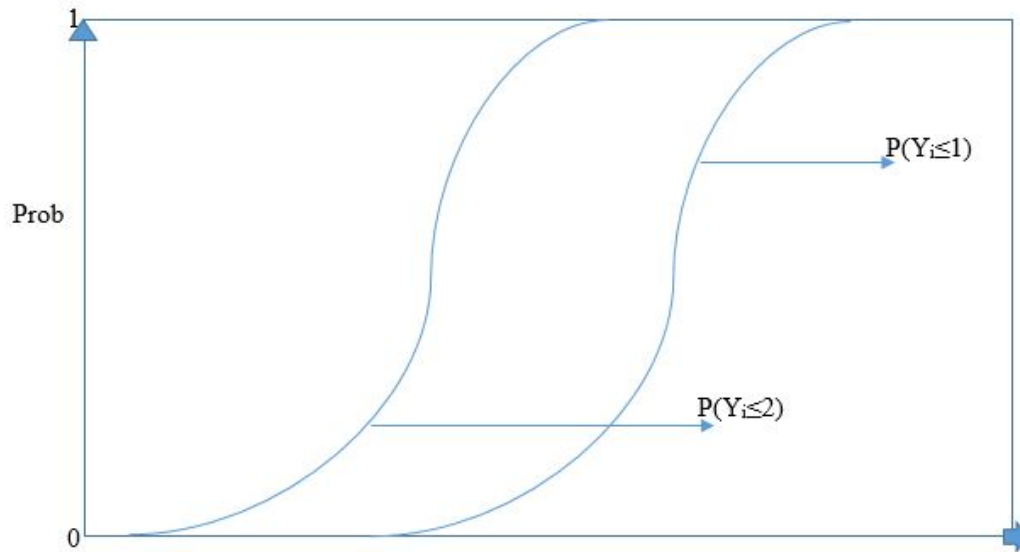


Figure 3.1. Cumulative probabilities corresponding to a three category response. The cumulative probability $P(Y_i \leq i)$ is the probability that Y is less than or equal i

3.2.3 Fitting of the model

The study will use both the log likelihood ratio test statistic and the deviance statistics in choosing the best mode. Another method to be used will be the AIC (Akaike information criterion). AIC shows how close a model's fitted values are to the true values in terms of a certain expected value. Even though a simple model is farther from the true model than is a more complex model, it may be preferred because it tends to provide better estimates of certain characteristics of the true model, such as cell probabilities. Thus, the optimal model is the one that tends to have fit closest to reality.

A hypothesis test to compare two models:

- i Fitted model and saturated model.
- ii Fitted model and null model.

A saturated model is that model with many parameters as data values. It is said to be a perfect fit.

A null model is one with the intercept only.

When comparing fitted model to the null model, with the Likelihood ratio statistics the hypotheses tests are:

H_0 : the null model is a better fit than the fitted model

H_1 : the fitted model is a better fit than the null model

The likelihood statistic has chi square distribution with number of degrees of freedom equal to the number of predictors in the fitted model.

When comparing fitted model to the saturated model, with the deviance statistic the hypotheses are:

H_0 : the fitted model is a better fit than the saturated model

H_1 : the saturated model is a better fit than the fitted model

Deviance statistics is a chi square distribution with number of degrees of freedom equal to the sample size minus number of parameters in the fitted model

$$D = 2[\log(y,y) - \log(y,x)] \quad (3.13)$$

$\log(y,y)$ = log likelihood of the saturated model

$\log(y,x)$ = log likelihood of the fitted/reduced model.

The study will also use both forward and backward stepwise procedure of model selection.

3.2.4 Significance test for predictors

We will further do a significance tests of predictors by using the confidence interval obtained for odds ratio where: $H_0 : O.R = 1$ vs. $H_1 : O.R \neq 1$ the predictor is statistically significant if the value 1 is not included in the interval, that is, if the lower confidence limit is greater than 1 or the upper confidence limit is less than 1

OR using z-test statistic for the regression coefficient corresponding to the predictor being considered.

Statistical significance of a predictor is the statistical association between the response and the predictor while adjusting for all other predictors.

Point to note here is that statistical significance may not be the only criteria for inclusion of a term in a model. It may be sensible to include a variable that is central to the purposes of this study and report its estimated effect even if it is not statistically significant. Keeping it in the model will help reduce bias in estimated effects of other predictors and may make it possible to compare the results with other studies where the effect is significant maybe because of a larger sample size or so.

3.2.5 Interpretation of parameter estimates

The parameter estimates will be interpreted using the Odds Ratios where:

- i An odds ratio with a value between 0 and 1, we interpret it by saying that the event of interest is $100 \times (1 - \text{O.R.})\%$ less likely to occur for every unit increase in the predictor.
- ii If the odds ratio is a value greater than 1 but less than 2, then we interpret it by saying that the event of interest is $100 \times (\text{O.R.} - 1)\%$ more likely to occur for every unit in the predictor.
- iii If the odds ratio is a value greater than 2, we say that the event of interest is O.R times more likely to occur for every unit increase in the predictor

3.2.6 Measuring Strength of Association

We will use the pseudo R-square statistics to measure the strength of association between the dependent variable and the predictor variables.

3.3 Software

Proportional odds ratios will be used to analyze the results obtained by R statistical software. Latex will also be used to write the whole document while SPSS and excel will be used in some of the tests, assumptions and descriptive statistics. Anthropometric measurements (human metrics for weight and height) of the response variable, that is the z scores and their descriptive will be done using WHO Anthro Survey analyzer software. The analyzed data is in the form of SAV, Excel and csv.

Why R?, because it is a free software and the stored codes can also be used for future data analysis without having to start creating new code.

4 DATA ANALYSIS

4.1 Introduction

This study looks at Nutritional status of children under five as the ordinal dependent variable based on the standard indicators provided by the World Health Organization (WHO) 2006. These indicators include stunted (Chronically Malnourished), wasted (acutely malnourished) and normal, achieved from the height and weight data.

Height for age index (stunting) is the failure to receive enough nutrition and cumulative deficit in a very long time, Z-score below (-2 SD) from median.

Weight-for-height index (wasted) that measures the current nutritional status. It is the failure to receive enough nutrition in the current period and may be the result of inadequate food intake or a recent episode of illness, drought etc., causing loss of weight and the onset of malnutrition. It has Z-scores below (-2 SD).

Weight-for-age (Underweight) is a composite index of height-for-age and weight-for-height. It takes into account both chronic and acute malnutrition. It has Z-scores below (-2 SD).

Normal nutritional status, is defined as having a weight-for-height, Height-for-age, and Weight-for-age z-score between -2SD and 2SD. This is considered as usual Z scores given by:

$$z = \frac{(X - \mu)}{\delta} \quad (4.1)$$

4.2 Descriptive Analysis

4.2.1 Prevalence of Malnutrition

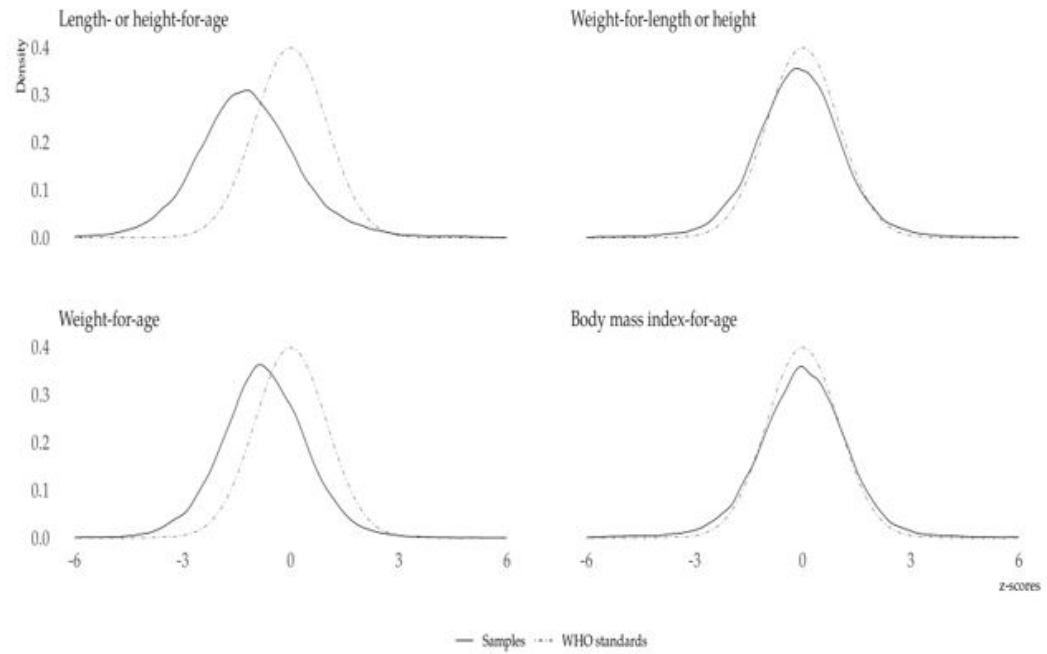


Figure 4.1. Z - Scores distributions of nutritional status indicators. Length/height-for-age (Stunting), weight for length/height (Wasted) and Weight-for-Age (Underweight). Analysis done through WHO nutrition.shinyapps.io/anthro

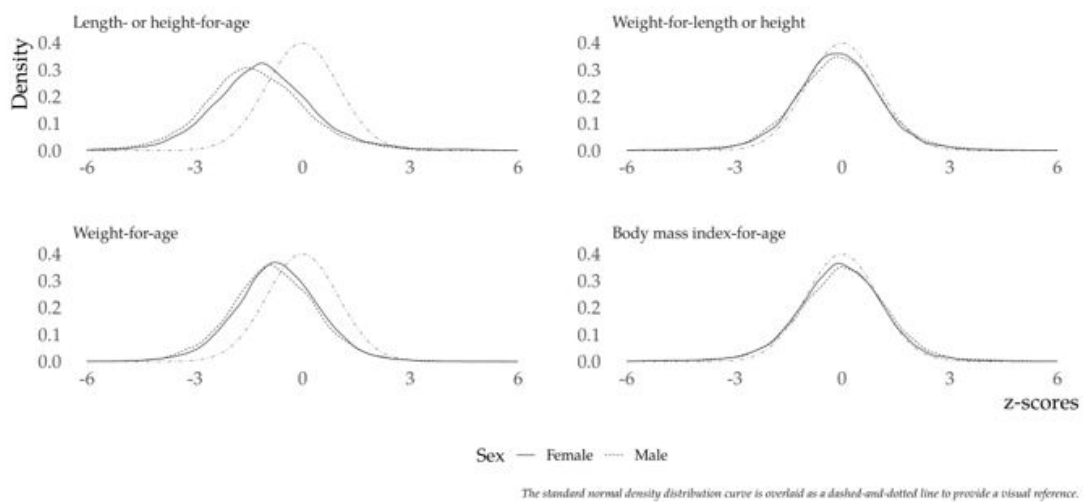


Figure 4.2. Z - score distributions of nutritional status indicators by sex. Analysis through WHO nutrition.shinyapps.io/anthro.

Table 4.1. Nutritional statuses distribution by region and children sex

	Sex of Child	Normal	Stunted	Wasted	Grand Total
Central	Female	81%	18%	1%	100%
	Male	79%	21%	1%	100%
Coast	Female	71%	27%	2%	100%
	Male	65%	33%	2%	100%
Eastern	Female	72%	25%	2%	100%
	Male	66%	32%	2%	100%
Nairobi	Female	84%	14%	2%	100%
	Male	77%	23%	1%	100%
North Eastern	Female	70%	22%	8%	100%
	Male	66%	27%	7%	100%
Nyanza	Female	78%	21%	1%	100%
	Male	73%	26%	1%	100%
Rift Valley	Female	72%	26%	2%	100%
	Male	64%	35%	2%	100%
Western	Female	79%	20%	1%	100%
	Male	69%	30%	1%	100%
Grand Total		71%	27%	2%	100%

The table above shows levels of stunting being high among male children than female children across the regions.

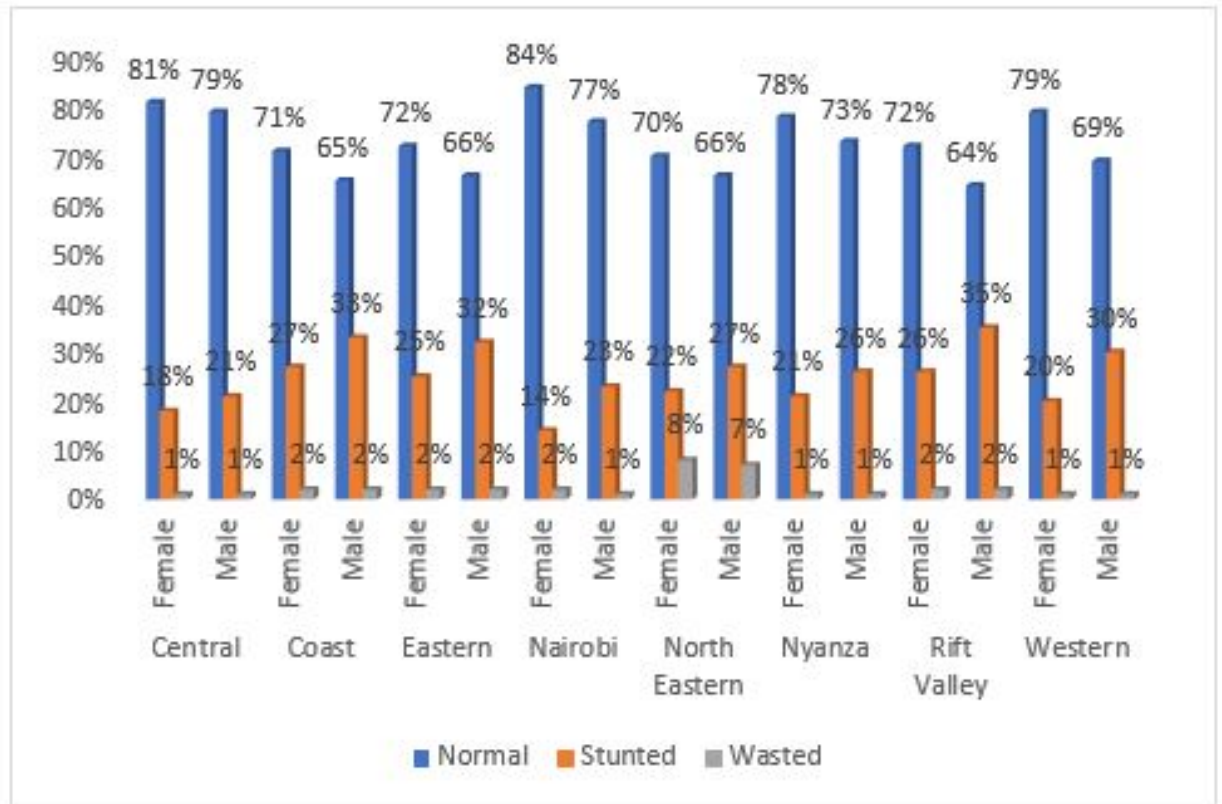


Figure 4.3. Column chart showing nutritional status of children by region and child sex.

Table 4.2. Nutritional Status by Region. Rift Valley is leading with the number of children that are stunted followed by Coast province.

Nutritional Status	Central	Coast	Eastern	Nairobi	North Eastern	Nyanza	Rift Valley	Western	Total
Normal	1001	1542	1842	340	858	1869	3950	1287	12689
Stunted	241	679	763	76	313	590	1784	427	4873
Wasted	12	37	58	5	92	22	108	15	349
Total	1254	2258	2663	421	1263	2481	5842	1729	17911

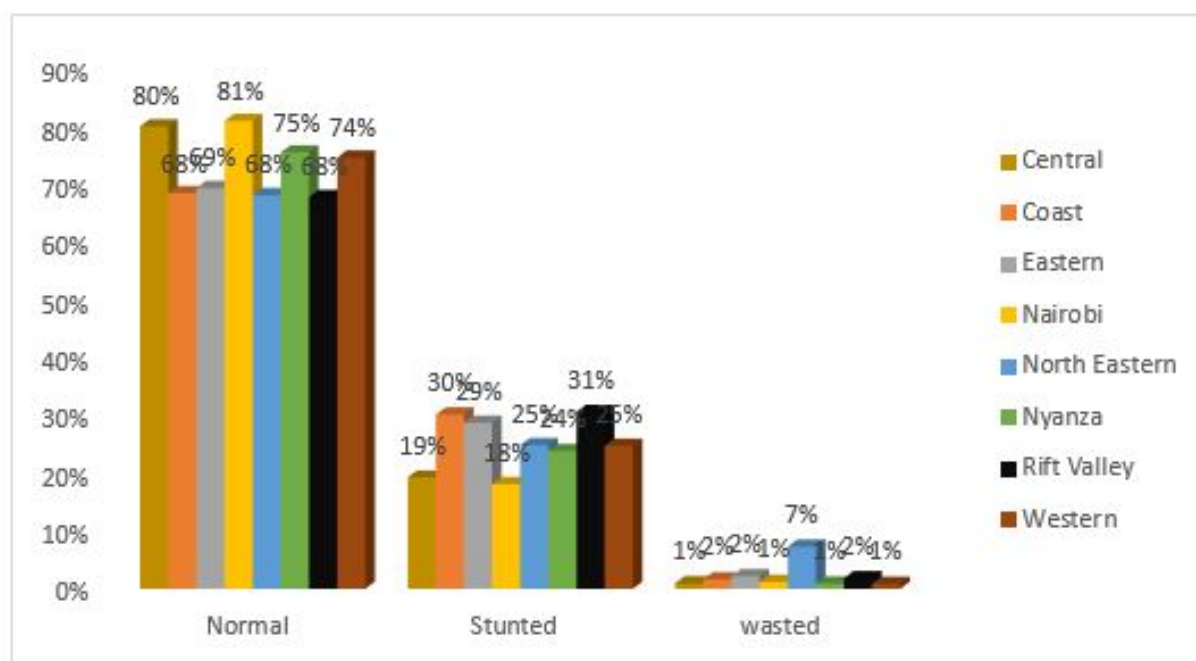


Figure 4.4. Column chart showing nutritional status of children by region. Nairobi and Central provinces showing the highest percentage of children who are normally nourished while high levels of stunting is seen in Rift valley, Coast province and Eastern provinces.

Table 4.3. Nutritional Status by Place of residence.

Nutritional Status	Rural		Urbanl		Total	
	Percentage	Count	Percentage	Count	Percentage	Count
Normal	68%	8350	77%	4339	71%	12689
Stunted	30%	3667	21%	1206	27%	4873
wasted	2%	255	2%	94	2%	349
Total	100%	12272	100%	5639	100%	17911

The table shows that children living in rural areas have a higher percentage of stunting than those living in the urban with wasting level being at an average of 2% for both rural and urban.

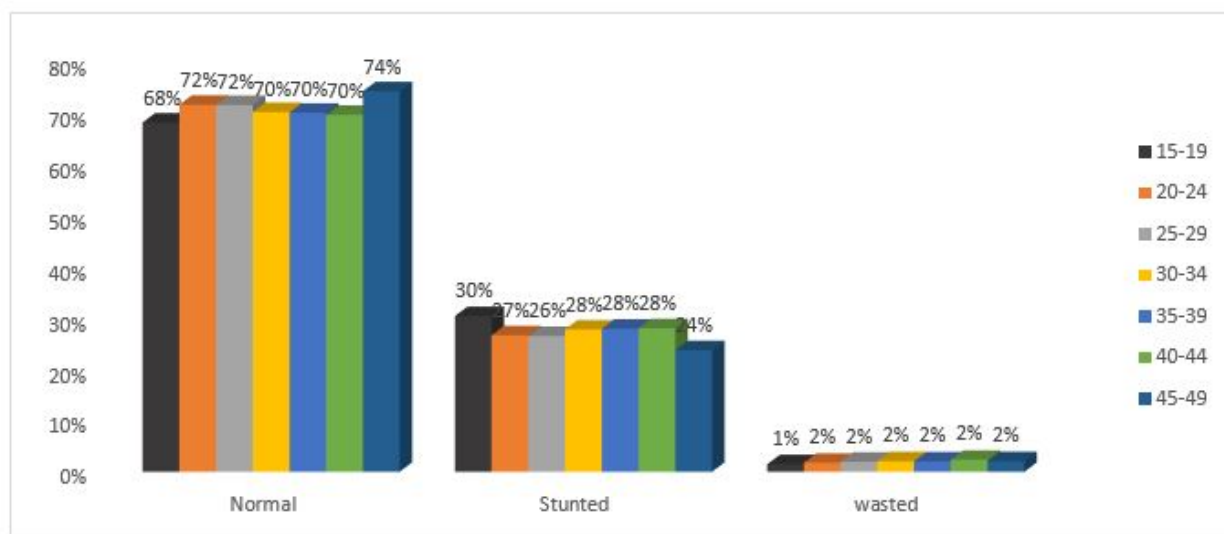


Figure 4.5. Children nutritional status by mother's age group. Mothers who are aged between 15-19 have higher percentage of children who are stunted and mothers aged 45-49 years have higher percentage of children that are normal nourished.

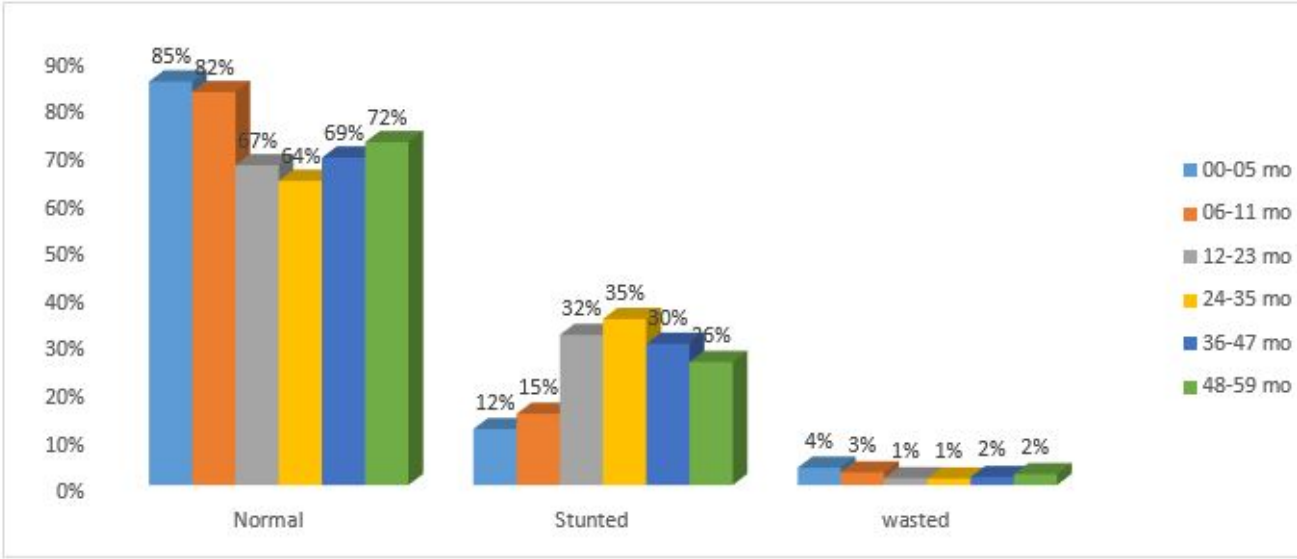


Figure 4.7. The results show that after the introduction of complementary feeding, at 6 months, the levels of stunting seem to be rising all through to around 3 years when it starts reducing.

4.3 Tests

4.3.1 Correlation

Testing for multicollinearity assumption on the Independent variables using the Pearson correlation. Below is the matrix which shows weak negative (less than -0.5) and weak positive correlation between the predictors.

** Correlation is significant at the 0.01 level (2-tailed) and * Correlation is significant at the 0.05 level (2-tailed).

4.3.2 Proportional Odds or parallel line regression Assumption

Table 4.7. Test of parallel lines, the null hypothesis states that the location parameters (slope coefficients) are the same across response categories

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	16434.375			
General	15173.015b	1261.360c	11	0

4.4 Ordinal logistic regression model

4.4.1 Fitting of the Model to the data

A hypothesis to compare the fitted model to the saturated model

- H_0 : the fitted model is a better fit than the saturated model
- H_1 : the saturated model is a better fit than the fitted model

Using both sides stepwise model selection for the best fit model

Saturated Model:

$$\begin{aligned}
 \text{NutritionalStatus} = & \text{HighestEducation} + \text{WealthIndex} + \text{Birthinlast5years} \\
 & + \text{Placeofresidence} + \text{everVaccinations} + \text{placeofdelivery} \\
 & + \text{Readership.Listenership.Viewership} + \text{Breast feeding} \\
 & + \text{Sexofchild} + \text{Ante.Natal.Visits} + \text{Birth}_{\text{weight}_i\text{ngrams}} \\
 & + \text{M.AgeGroup} + \text{MaritalStatus} + \text{Ever.Vitamin.A} + \text{Region}
 \end{aligned} \quad (4.2)$$

Fitted Model:

$$\begin{aligned}
 \text{NutritionalStatus} = & \text{WealthIndex} + \text{Sexofchild} + \text{Birth}_{\text{weight}_i\text{ngrams}} + \text{Ante.Natal.Visits} \\
 & + \text{HighestEducation} + \text{Region} + \text{placeofdelivery} \\
 & + \text{Ever.Vitamin.A} + \text{Readership.Listenership.Viewership} \\
 & + \text{MaritalStatus} + \text{M.AgeGroup}
 \end{aligned} \quad (4.3)$$

Birthinlast5years, Place of residence, Breastfeeding, ever Vaccinations were removed from the saturated model because they did not have a larger influence on the response variable (Nutritional status). And this mean there was a reduction in the residual deviance.

The response variable categorized as normal, wasted, stunted in the order,

1= Normal (N) 2=Wasted (acutely malnourished), 3= Stunted (chronically malnourished).

Normal < Wasted < Stunted

Because there are three categories we have two models of the form

$$\begin{aligned} \ln(P(Y = 1)/P(Y=2 \text{ or } Y = 3)) = & \beta_0 + \beta_1 \text{WealthIndex} \\ & + \beta_2 \text{Sexofchild} + \beta_3 \text{Birthweightingrams} + \beta_4 \text{Ante.Natal.Visits} \\ & + \beta_5 \text{HighestEducation} + \beta_6 \text{Region} + \beta_7 \text{Placeofdelivery} \\ & + \beta_8 \text{Ever.Vitamin.A} + \beta_9 \text{Readership.Listenership.Viewership} \\ & + \beta_{10} \text{MaritalStatus} + \beta_{11} \text{MotherAgeGroup} \end{aligned} \quad (4.4)$$

$$\begin{aligned} \ln(P(Y = 1) \text{ or } Y = 2 / P(Y = 3)) = & \beta_0 + \beta_1 \text{WealthIndex} \\ & + \beta_2 \text{Sexofchild} + \beta_3 \text{Birthweightingrams} + \beta_4 \text{Ante.Natal.Visits} \\ & + \beta_5 \text{HighestEducation} + \beta_6 \text{Region} + \beta_7 \text{placeofdelivery} \\ & + \beta_8 \text{Ever.Vitamin.A} + \beta_9 \text{Readership.Listenership.Viewership} \\ & + \beta_{10} \text{MaritalStatus} + \beta_{11} \text{MotherAgeGroup} \end{aligned} \quad (4.5)$$

$$\begin{aligned} \ln(P(Y = 1)/P(Y=2 \text{ or } Y = 3)) = & 0.004 + 0.236 \text{WealthIndex} \\ & + 0.358 \text{Sexofchild} + 0.033 \text{Birthweightingrams} - 0.113 \text{Ante.Natal.Visits} \\ & + 0.082 \text{HighestEducation} - 0.006 \text{Region} - 0.178 \text{Placeofdelivery} \\ & + 0.118 \text{Ever.Vitamin.A} + -0.024 \text{Readership.Listenership.Viewership} \\ & - 0.003 \text{MaritalStatus} + 0.008 \text{MotherAgeGroup} \end{aligned} \quad (4.6)$$

$$\begin{aligned} \ln(P(Y = 1) \text{ or } Y = 2 / P(Y = 3)) = & 0.104 + 0.236 \text{WealthIndex} \\ & + 0.358 \text{Sexofchild} + 0.033 \text{Birthweightingrams} - 0.113 \text{Ante.Natal.Visits} \\ & + 0.082 \text{HighestEducation} - 0.006 \text{Region} - 0.178 \text{placeofdelivery} \\ & + 0.118 \text{Ever.Vitamin.A} + -0.024 \text{Readership.Listenership.Viewership} \\ & - 0.003 \text{MaritalStatus} + 0.008 \text{MotherAgeGroup} \end{aligned} \quad (4.7)$$

Table 4.8. Parameter estimates and significance of predictors.

	Estimate	Std. Error	Wald	df	Sig.	Lower Bound 95% Confidence Interval	Upper Bound 95% Confidence Interval
Threshold	[NutritionalStatus = 1]	0.172393934	0.000440323	1	0.983258524	-0.33426841	0.341503393
	[NutritionalStatus = 2]	0.172389305	0.364947061	1	0.545771519	-0.233734987	0.442018671
Location	WealthIndex	0.015847121	221.7629673	1	3.73115E-50	0.204930913	0.267050486
	Sexofchild	0.033670017	113.2052959	1	1.94551E-26	0.292250151	0.424234193
	Birth_weight_in_grams	0.035624636	0.834768512	1	0.360897278	-0.037274317	0.102371689
	Ante.Natal.Visits	0.018890997	35.94074897	1	2.0341E-09	-0.150278344	0.076226995
	HighestEducation	0.027765151	8.731801225	1	0.003127074	0.027626274	0.136463668
	Region	0.008960621	0.428688327	1	0.512633269	-0.023429397	0.011695591
	placeofdelivery	0.030587141	33.95674744	1	5.63509E-09	-0.238188362	0.118288973
	Ever.Vitamin.A	0.039633785	8.836814695	1	0.002952139	0.040137691	0.195499273
	Readership.Listenership	0.043333624	0.301751251	1	0.582786621	-0.108736321	0.061128364
	MaritalStatus	0.016693666	0.03571163	1	0.850112246	-0.035873674	0.029564295
	M_AgeGroup	0.012567924	0.39711878	1	0.528581003	-0.016712705	0.032552653

4.4.2 Significance test for predictors at 95% Confidence interval

- i Wealth index variable is significant as the value 1 is not in the interval (0.204, 0.267).
- ii Sex of child predictor is significant with as the value 1 is not in the interval (0.292, 0.42).
- iii Birth weight is not a significant predictor as the value 1 is in the interval (-0.037, 0.42).
- iv Ante Natal Visits is a significant predictor as the value 1 is not in the interval (-0.15, -0.07).
- v Highest Education is a significant predictor with lower limit and upper limit (0.028, 0.136).
- vi Region is not a significant predictor with lower limit and upper limit (-0.023, 0.012)
- vii Place of delivery is a significant predictor as the value 1 is not in the interval (-0.238, -0.118).
- viii Ever Vitamin A is a significant predictor with lower limit and upper limit (0.040, 0.195).
- ix Readership, Listenership and Viewership is not a significant predictor with lower limit and upper limit (-0.109, 0.061).
- x Marital status is not a significant predictor with lower limit and upper limit (-0.036, 0.030).

The significant test of a predictors is to shows how much information the predictor provides to the response holding all other predictors constant. This study's results are based on the parameter estimates of predictor levels, with one level being as reference.

4.4.3 Interpretation of parameter estimates

Wealth Index

Holding all other predictors constant, a child whose family's wealth index is poorest is 46% more likely and that from poorer is 22% more likely to either be wasted or stunted.

Holding all other predictors constant, a child whose family's wealth index is poorest is 46% more likely and that from poorer is 22% more likely to be stunted.

Holding all other predictors constant, a child from a richest family is 59% less likely and that from a richer family 87% less likely to either be wasted or stunted.

Holding all other predictors constant, a child from a richest family is 59% less likely and that from a richer family 87% less likely to be stunted.

Sex of child

Holding all other predictors constant, a male child is 44% more likely to either be wasted or stunted compared to a female child.

Holding all other predictors constant, a male child is 44% more likely to be stunted compared to a female child.

Birth weight in grams

Holding all other predictors constant, a child whose birth weight was below 2500 grams is 2.6 times more likely to be wasted or stunted compared to those that were weighing above 2500.

Holding all other predictors constant, a child whose birth weight was below 2500 grams is 2.6 times more likely to be stunted compared to those that were weighing above 2500.

Ante natal visits

Controlling for all the other predictors a child whose mother has not attended any ante natal visit is 55% more likely to either be wasted or stunted compared to that whose mother attended ante natal.

Controlling for all the other predictors a child whose mother has not attended ante natal visits is 55% more likely to be stunted compared to that whose mother attended ante natal.

Highest Education

Controlling for all the other predictors a mother whose highest education is primary school is 30% more likely to either have a child who is wasted or stunted when compared to those that have not attended any school.

Controlling for all the other predictors a mother whose highest education is primary school is 30% more likely to have a child who is stunted when compared to those that have not attended any school.

Controlling for all the other predictors a mother whose highest education is secondary school is 3% more likely to either have a child who is wasted or stunted when compared to those that have not attended any school.

Controlling for all the other predictors a mother whose highest education is secondary school is 3% more likely to have a child who is stunted when compared to those that have not attended any school.

Controlling for all the other predictors a mother whose highest education is higher education is 20% less likely to either have a child who is wasted or stunted when compared to those that have not attended any school.

Controlling for all the other predictors a mother whose highest education is higher education is 20% less likely to either have a child who is stunted when compared to those that have not attended any school

Region

Controlling for all the other predictors a child from the Coast, Eastern and Rift valley regions are 20%, 22% and 29% respectively more likely to either be wasted or stunted.

Controlling for all the other predictors a child from the Coast, Eastern and Rift valley regions are 20%, 22% and 29% respectively more likely to be stunted.

Place of delivery

Controlling for all the other predictors a child born at home is 25% more likely to either be wasted or stunted compared to a child born in hospital.

Controlling for all the other predictors a child born at home is 25% more likely to be stunted compared to a child born in hospital.

Readership Listenership Viewership

Adjusting for all the other predictors a mother who does not read newspapers, listen to radio or watches television, her child is 13% more likely to either be wasted or stunted compared to a mother who at least reads newspapers, listens to radio or watches television.

Adjusting for all the other predictors a mother who does not read newspapers, listen to radio or watches television, her child is 13% more likely to be stunted compared to a mother who at least reads newspapers, listens to radio or watches television.

Marital Status

Adjusting for all the other predictors a woman that is married is 84% less likely to have a child who is either wasted or stunted compared to a divorced woman.

Adjusting for all the other predictors a woman that is married is 84% less likely to have a child who is stunted compared to a divorced woman.

Mother Age Group

Controlling for all the other predictors a women in age bracket 20-24 is 83% less likely and that in age bracket 45-49 is 64% less likely to have children that are either wasted or stunted.

Controlling for all the other predictors a women in age bracket 20-24 and 45-49 are 83% and 64% respectively less likely to have children that are stunted.

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusions

Although highest number of children are seen to be lying on the normal nutritional status level across the country, malnutrition is still seen to be a critical health problem in the Kenyan society as chronic malnutrition levels are seen to be significant. The study has seen several factors relating to the mother that are significant in explaining the level of stunting wasting or normal nutritional status. At an individual level and general level, the variables have been seen to contribute a lot on the level of nutritional status on Kenyan children. Regionally, Rift Valley, Eastern and Coast province are seen to be most affected by Malnutrition.

Education is seen to have a higher influence on the nutritional status of children, although the results show that mothers with higher education are less likely to have children who are malnourished, our descriptive statistics show that we have stunted and wasted children from mothers who have attained up to higher education. This is the same case to the wealth index, we have seen that those children from poor families are more likely while those from rich families are less likely to be stunted or wasted, but still have a number of children who are stunted and wasted from the richest families. Comparing nutritional status by the children age group, the study has seen that stunting level are rising from the age of 6 months to 49 months, this being the period when the children are being given complementary foods.

5.2 Recommendations

Malnutrition on children has been seen to pose a great danger to the Kenyan society. For the country to achieve the vision 2030 on good health, adequate nutrition and education, the study recommends for more interventions done through empowering women and creating awareness on good nutrition by educating women and holding nutritional health campaigns.

Although the government has so far done much on exclusive breast feeding awareness, as one of our variable being breastfeeding was rendered redundant, there is still more that they need to do on nutritional awareness especially on children, for the country to reach a statistical zero on under five death. The study also recommends for more studies to be done on the prevalence of obesity and also on the mother's knowledge on complementary feeding, that is, the time of introduction and the diet.

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6 APPENDIX

6.1 R-codes

6.1.1 Model selection

```
fit=glm(NutritionalStatus2 ~1,family=binomial,data= dt) \%>\%
stepAIC(trace = FALSE)
```

```
stepAIC(fit,~HighestEducation+WealthIndex +Birthinlast5years +
Placeofresidence+ everVaccinations +placeofdelivery +
Readership.Listenership.Viewership+
Breastfeeding + Sexofchild+ Ante.Natal.Visits + Birth weight in grams+
Mother AgeGroup +
MaritalStatus + Ever.Vitamin.A + Region,direction="both")
```

6.1.2 Model fit

```
polr(formula = NutritionalStatus2~ WealthIndex + Sexofchild +
placeofdelivery + HighestEducation + Ante.Natal.Visits + Region +
Birth weight in grams + Readership.Listenership.Viewership +
Ever.Vitamin.A + MaritalStatus + Mother AgeGroup + Breastfeeding,
data =dt, Hess = TRUE)
```

```
ordinal = polr(NutritionalStatus~ WealthIndex + Sexofchild +
Birth weight in grams + Ante.Natal.Visits + HighestEducation +
Region + placeofdelivery + Ever.Vitamin.A +
Readership.Listenership.Viewership +
MaritalStatus + Mother AgeGroup,data =dt, Hess = TRUE)
```

```
summary(ordinal)
```

6.1.3 Odds Ratio and confidence intervals

```
exp(cbind(OR = coef(ordinal), confint(ordinal)))
```

6.2 R-ordinal regression results

6.2.1 Summary fitting

Coefficients:

	Value	Std. Error	t value
WealthIndexPoorer	0.20226	0.05532	3.6560
WealthIndexPoorest	0.37933	0.05702	6.6531
WealthIndexRicher	-0.13992	0.06435	-2.1743
WealthIndexRichest	-0.55025	0.07902	-6.9632
SexofchildMale	0.36828	0.03386	10.8774
Birth_weight_in_gramsBelow 2500	0.98571	0.11061	8.9114
Birth_weight_in_gramsDon't know	0.13923	0.04345	3.2046
Ante.Natal.VisitsNo	0.44119	0.08137	5.4221
Ante.Natal.VisitsDont Know	0.22868	0.03842	5.9516
HighestEducationPrimary	0.25824	0.05442	4.7456
HighestEducationSecondary	0.03083	0.07140	0.4318
HighestEducationHigher	-0.21529	0.10985	-1.9598
RegionCoast	0.18909	0.08879	2.1295
RegionEastern	0.20505	0.08568	2.3932
RegionNairobi	0.27618	0.14764	1.8706
RegionNorth Eastern	0.02993	0.10443	0.2866
RegionNyanza	-0.04031	0.08793	-0.4584
RegionRift Valley	0.25725	0.08022	3.2068
RegionWestern	-0.03147	0.09314	-0.3379
placeofdeliveryHome	0.22071	0.04245	5.2000
placeofdeliveryOther	0.17570	0.08043	2.1844
Ever.Vitamin.ANo	-0.10469	0.04041	-2.5908
Ever.Vitamin.ADon't know	-0.67892	0.29231	-2.3226
Readership.Listenership.ViewershipNo	0.11747	0.04578	2.5657
MaritalStatusMarried	-0.16880	0.06971	-2.4215
MaritalStatusNever in union	-0.32306	0.10208	-3.1647
MaritalStatusWidowed	-0.07765	0.12659	-0.6134
M_AgeGroup20-24	-0.18681	0.08368	-2.2323
M_AgeGroup25-29	-0.16422	0.08340	-1.9691

M_AgeGroup30-34	-0.09261	0.08622	-1.0741
M_AgeGroup35-39	-0.15152	0.09003	-1.6831
M_AgeGroup40-44	-0.16507	0.10352	-1.5945
M_AgeGroup45-49	-0.44268	0.15779	-2.8054

Intercepts:

	Value	Std. Error	t value
Normal wasted	1.6985	0.1642	10.3429
wasted Stunted	1.8003	0.1643	10.9589

Residual Deviance: 23144.54

AIC: 23214.54

6.2.2 Odds ratios and confidence intervals

	OR	2.5 %	97.5 %
WealthIndexPoorer	1.2241619	1.0985375	1.3645976
WealthIndexPoorest	1.4613029	1.3070786	1.6344548
WealthIndexRicher	0.8694286	0.7662529	0.9859736
WealthIndexRichest	0.5768069	0.4936194	0.6729016
SexofchildMale	1.4452451	1.3525179	1.5444747
Birth_weight_in_gramsBelow 2500	2.6797118	2.1557504	3.3265453
Birth_weight_in_gramsDon't know	1.1493917	1.0557404	1.2517878
Ante.Natal.VisitsNo	1.5545615	1.3247979	1.8225512
Ante.Natal.VisitsDont Know	1.2569450	1.1656477	1.3551221
HighestEducationPrimary	1.2946515	1.1638651	1.4406016
HighestEducationSecondary	1.0313089	0.8966971	1.1862731
HighestEducationHigher	0.8063075	0.6488158	0.9981353
RegionCoast	1.2081478	1.0161628	1.4393277
RegionEastern	1.2275896	1.0389363	1.4537711
RegionNairobi	1.3180803	0.9829697	1.7535516
RegionNorth Eastern	1.0303799	0.8400630	1.2651135
RegionNyanza	0.9604955	0.8091923	1.1423390
RegionRift Valley	1.2933725	1.1066896	1.5157918
RegionWestern	0.9690210	0.8078590	1.1639703
placeofdeliveryHome	1.2469667	1.1474661	1.3551982
placeofdeliveryOther	1.1920784	1.0166863	1.3936357
Ever.Vitamin.ANo	0.9006032	0.8318606	0.9746209
Ever.Vitamin.ADon't know	0.5071625	0.2758978	0.8745504
Readership.Listenership.ViewershipNo	1.1246455	1.0280181	1.2301288
MaritalStatusMarried	0.8446757	0.7373902	0.9691759

MaritalStatusNever in union	0.7239296	0.5923393	0.8839017
MaritalStatusWidowed	0.9252875	0.7209670	1.1843764
M_AgeGroup20-24	0.8296032	0.7046667	0.9782636
M_AgeGroup25-29	0.8485572	0.7211967	1.0001666
M_AgeGroup30-34	0.9115496	0.7703882	1.0802784
M_AgeGroup35-39	0.8593980	0.7208256	1.0212678
M_AgeGroup40-44	0.8478358	0.6922131	1.0387369
M_AgeGroup45-49	0.6423116	0.4695090	0.8720055