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Proportional Odds of Nutritional Status of Under-Five Children in Nigeria Indexed by MUAC

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Abstract

This paper present results regarding the impacts of some anthropometric, epidemiological and demographic factors on the nutritional status of under-five children which were categorized into three ordinal groups of Severe Acute Malnutrition (SAM), Moderate Acute Malnutrition (MAM) and Global Acute Malnutrition (GAM) in Kazaure Local Government Area of Nigeria. An ordinal logit model that depicted the log-odds in favour of GAM (normal) child was fitted to the data based on a surveillance indexed by Mid-Upper Arm Circumference (MUAC). By this, the proportional odds of being in either of the nutritional status based on age, sex and measles when malnutrition surveillance is indexed by MUAC were determined. The results showed that, the proportional odd of measuring malnutrition prevalence using the MUAC index is (OR = 1.138, with $p < 0.001$). The sex of a child does not play a major role in determining the nutritional status of a child. Being vaccinated for Measles did not play a major role in classifying a child's malnutrition status. Rather, variables that has to do with access to potable water, access to household food for children and other socioeconomic variable could be considered. Edema as a morbid state was found to be redundant in the study.

Keywords: Statistical surveillance, severe acute malnutrition, anthropometrics, bilateral edema.

Introduction

Nutritional status is the best global indicator of well-being especially in children (De Onis et al. 2005). It is an integral component or reflection of the overall health of an individual and provides an indicator of the well-being of children living in a particular area. Nutritional status of a population is used to determine the magnitude of malnutrition that is prevailing (prevalence of malnutrition) at a particular time in a population.

Malnutrition refers to disorders resulting from an inadequate (under nutrition) or excessive diet (over nutrition) or from failure to absorb or assimilate dietary elements. Malnutrition remains a public health problem in most developing countries. Also, one of the global health problem faced by developing countries today is malnutrition and Nigeria is not an exception (UNICEF, Child survival 2008 Report).

Nutritional status can be assessed using any of the following indicators: (i.) dietary intake (ii) biomarkers (iii.) anthropometry and (iv.) morbidity. Anthropometry has become a practical tool for evaluating the nutritional status of a population, particularly of children in developing countries (Hakeem et al. 2004).

Nutritional status is measured by the prevalence rates of stunting, wasting and underweight obtained through anthropometric measurement of children under five years. Research has focused on the three anthropometric indicators above.

Due to resent global attention on nutritional surveillance and monitoring as a result of war, insurgencies, civil unrest and disease outbreaks around the world and particularly in Nigeria, this research therefore, seeks to use the Ordinal Logistics Regression (OLR) technique to model demographic factors (Age and Sex of the child), Anthropometric factor (Height, Weight, and Mid-Upper-Arm-Circumference) and epidemiological factor (Measles and edema) with the outcome variable- nutritional status categorized into Severe Acute Malnutrition (SAM), Moderate Acute Malnutrition (MAM) and Global Acute Malnutrition (GAM) respectively.

Model and Analysis

The main aim of this research work was to establish the impact of some demographic, anthropometric and epidemiological variables on the malnutrition status of children in Kazaure Local Government Area (LGA) of Jigawa state in north western Nigeria indexed by Mid-Upper Arm Circumference (MUAC).

To meet this aim the following objectives shall be met:

- Present graphical summary of the mal-nutritional status of under 5 children indexed by MUAC.
- Fit a suitable illustrative model for the log-odds in favour of a normal child indexed by MUAC.

This research attempts at modeling a categorical response i.e., nutritional status in terms of three major predictor variables, determine the goodness-of-fit of the model as well seek a classification for the proportional odds of the various categories of the dependent and independent variables using the Ordinal Logit approach.

The data used in this paper are secondary data that emanated from a nutritional and mortality cross-sectional survey of children below five years of age (6-59 months) in Kazaure local government area of Jigawa state in the North Western Nigeria. The primary data sets were collected from a cross-sectional nutritional survey on under-five children with the use of Emergency Nutrition Assessment (ENA for SMART) software carried out in Kazaure LGA of Jigawa state in 2012. In that survey, trained surveyors were used in the field to collect anthropometrics and other related variable from 604 children aged between 6-59 months with funding from Gunduma Health System and technical assistance from Epi-Centre in Paris.

Data collation was done with ENA for SMART software and further analysis was carried out using the IBM-SPSS Statistics version 21 software, specifically the Ordinal Logistic Regression (OLR)–Polytomous Universal Model (PLUM) procedure. (Enhanced SPSS guides in Laerd Statistics)

Firstly, the independent and dependent variables selected for this study were subjected to these four assumptions below and were tested using SPSS to ascertain that:

1. The dependent variable is measured at the ordinal level.
2. one or more of the independent variables is continuous, ordinal or categorical (including dichotomous variables)
3. There are no issues of multicollinearity.
4. The variables satisfies the test for proportional odds

Analysis and Discussions

In the modeling based on MUAC the four assumption in 10.0 were tested, analysis and interpretation carried out using nutritional status as dependent variable with Likert (1, 2 and 3) referred to as the threshold in combination with MUAC which is continuous, Age, sex and Measles which were referred to as the independent variable and location. The summary statistics of all the variables are presented in Tables 1 to 4 with their graphical representations given by Figs 1 to 4 respectively.

Table 1. Summary Statistics of MUAC

Category based on MUAC	Frequency	Percent	Cumulative Percent
MUAC<110mm	1	0.2	0.2
MUAC 110-125mm	45	7.5	7.7
MUAC > 125mm	558	92.3	100.0
Total	604	100.0	

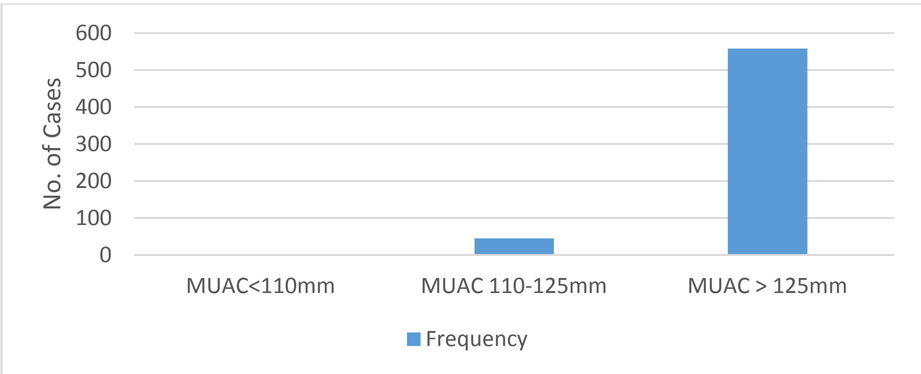

Figure 1: Bar chart showing Nutritional Status Based on MUAC

Table 2: Summary Statistics of Age based on MUAC

Age Interval	Frequency	Percent	Cumulative Percent
6-17	120	19.9	19.9
18-29	136	22.5	42.4
30-41	134	22.2	64.6
42-53	115	19.0	83.6
54-59	99	16.4	100.0
Total	604	100.0	

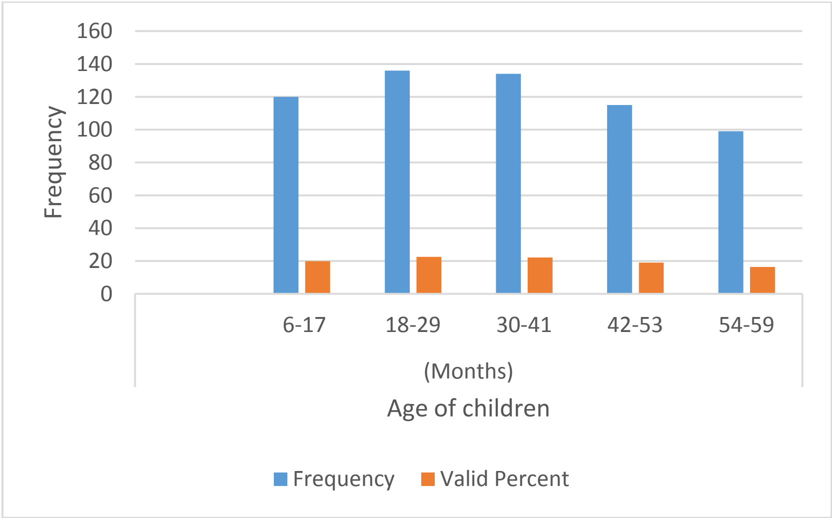

Figure 2: Bar chart showing age distribution of children Based on MUAC

Table 3: Summary Statistics of Sex based on MUAC

Sex	Frequency	Percent	Cumulative Percent
Male	304	50.2	50.2
Female	300	49.8	100.0
Total	604	100.0	

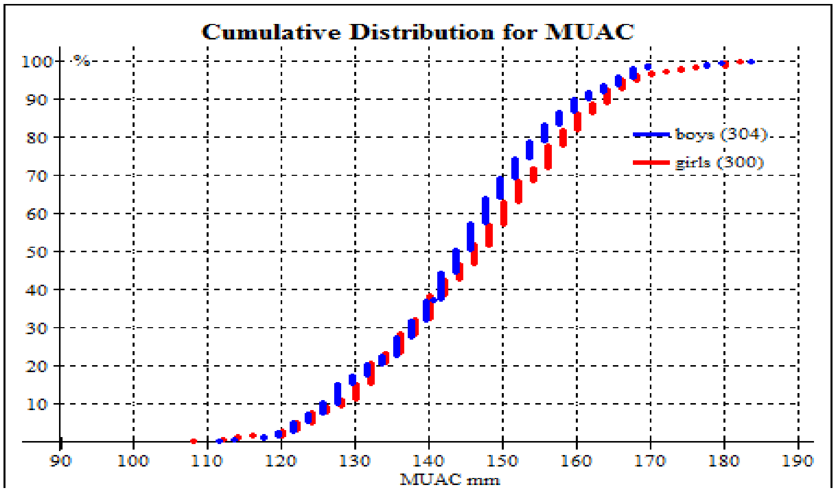

Figure 3: Cumulative distribution showing age distribution of children Based on MUAC

Table 4: Summary of Measles Vaccination based on MUAC

	Frequency	Percent	Percent	Cumulative Percent
No	18	2.2	3.0	3.0
Yes but no card	225	28.0	37.3	40.2
Yes	361	45.0	59.8	100.0
Total	604	75.2	100.0	

A check for multicollinearity among the four identified risk factors was performed by determining their Variance Inflation Factor (VIF). In all the cases, VIF was less than 5 with each having a tolerance that is more than 0.5. Hence there are no issues of multicollinearity in the data. Classifying the Nutritional Status of a child to be GAM versus MAM and SAM is 1.138 times greater (95% CI, 1.113 to 1.165) likewise, the odds of the combined MAM and GAM versus SAM, with Wald $\chi^2(1)$ =123.166, p<0.001, hence a statistically significant effect.

Table 5: Results of Ordinal Logit Regression modeling of nutritional status - GAM against SAM and MAM - of under-five children

Variables	**Estimate**	**Std. error**	**Wald**	**df**	**P-value**	**Lower B**	**Upper B**	**Exp_B**	**Lower**	**Upper**
MUAC <=125mm	0			0*				1		
MUAC > 125mm	0.129	0.012	123.166	1	<0.001	0.107	0.152	1.138	1.113	1.165
[Age_Cat=1]	0.615	0.439	1.957	1	0.162	-0.246	1.476	1.849	0.782	4.376
[Age_Cat=2]	-0.701	0.411	2.911	1	0.088	-1.507	0.104	0.496	0.222	1.11
[Age_Cat=3]	-1.295	0.398	10.598	1	0.001	-2.074	-0.515	0.274	0.126	0.597
[Age_Cat=4]	-0.628	0.418	2.262	1	0.133	-1.447	0.19	0.534	0.235	1.21
[Age_Cat=5]	0			0*				1		
[Sex= Male]	-0.118	0.195	0.368	1	0.544	-0.499	0.263	0.889	0.607	1.301
[Sex= Female]	0			0*				1		
[Measles=1]	-0.032	0.568	0.003	1	0.956	-1.145	1.082	0.969	0.318	2.951
[Measles=2]	0.182	0.203	0.803	1	0.37	-0.216	0.58	1.2	0.806	1.786
[Measles=3]	0			0*				1		

Summary of Findings based on the Mid-Upper-Arm-Circumference (MUAC)

In fitting an illustrative model with the data from under-five nutritional survey and based on the illustrative examples of Dayton (1992) and the SPSS PLUM result on table 9 the following illustrative models are given:

$$\log_e\left(\frac{\hat{\pi}}{1-\hat{\pi}}\right) = 32.663 + 0.129 * MUAC - 2.009 * AGE - 0.118 * SEX(Male) + 0.51 * MEASLES$$

Present the goodness-of-fit of the model:

Based on the approach of Ante (2011) and the result on table 6 we can see that for MUAC both Pearson and deviance Chi-square statistics were not significant, hence MUAC would give just a good prediction of the child's nutritional status.

To find out whether the number of independent variables considered here predict the ordinal dependent variable, "nutritional status" we observed that the reported standard error for the estimates in table 9, the standard error for the estimate, 0.398 as given for age category 3 alone, with a statistical significance can be assessed by the Wald chi-squares 10.598 is significant at conventional levels (the empirical 2-tailed p-values reported to be 0.001) also supports the fact that a child's age is a useful predictor of children's nutritional status.

To determine whether MUAC have a statistically significant effect on the dependent variable, we observed that at the significance (p-values) on tables 9 only age at category 3 were statistically significant on the dependent variable with p=0.000 and 0.001 respectively.

In determine how well the ordinal regression model predicts the dependent variable based on MUAC, we noticed that the ordinal regression models as supported by the model fitting information in tables 5 showed that the model is good enough for predicting the dependent variable with a significance of 0.000. But the -2 Log likelihoods model intercept-only and final differed by 41.09%.

In classifying the proportional odds of being in either of the nutritional status, we found out that cumulatively, an increase in the age of a child was associated with the increase in the odds of considering his nutritional status to be either severely malnourished versus moderately malnourished and globally malnourished (normal) was 4.153 times greater when MUAC was used as the index for measuring the prevalence of malnutrition, likewise, the odds of the combined moderately malnourished and globally malnourished (normal) versus severely malnourished. Thus giving an indication of the highest odds ratio for age when surveillance was based on MUAC.

Again the odds of the sex of a child being male as a consideration of his nutritional status is 1.889 times that of the females when MUAC is used as the index for measuring the prevalence of malnutrition. This is an indication of the higher odds ratio for sex when MUAC is used.

Finally, the odds of a child who was not vaccinated for measles to be considered as either severely malnourished, moderately malnourished or globally malnourished is 3.161 times greater than that of not being vaccinated and vaccinated but with no evidence when MUAC was used as the index for measuring the prevalence of malnutrition.

Conclusion

Based on the results and summary of findings, it can be concluded that age is a major predictor of the malnutrition status of a child in a nutritional study when the surveillance is based on MUAC unlike sex and measles that do not play a major role. Similarly, the effect of the age interval of 54-59 months is not highly felt as class of predictor variables in terms of age. Again, measuring malnutrition prevalence using the MUAC index happens to give higher odds. Again, based on the results and findings in this study, we recommend that Age should always be included as a variable in measuring a child's nutritional status but with more emphasis on the first four age groups. Sex does not play a major role in determining the nutritional status, it can only give an idea of the summary statistics of gender considered in the study. Measles as an epidemiological state did not play major role in classifying a child's malnutrition status hence it could be excluded from the list of variables, rather variables that has to do with access to potable water, access to household food for children and other socioeconomic variable should be considered.

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