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Survival Analysis on Nutritional Status of Children Under five Year

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ABSTRACT
Malnutrition in children is an important public health issue especially for developing countries like Nigeria. Weight-for-height (wasting), height-for-age (stunting) and weight-for-age (underweight) are three important parameters for assessing nutritional status in children. Malnutrition is estimated to contribute directly or indirectly to more than 33% of all child deaths globally. The aim of the study is to identify the prevalence of malnutrition in under five children and To test the suitability of the model. A well-structured questionnaire was used to collect data from mothers and their children at Miri primary health care Centre at Bauchi. The software packaged that has been used to process data is SPSS version 21. the test of independence between the dependent variable (nutrition) and independent variable (age, sex, occupation of the father, occupation of mother, education status of the father, education status of the mother, age of the mother, types of breast feeding, immunization status, size of the households and birth order) was performed to verify whether they are statistically significant or not at 5% level of significance to the nutrition status of under-five children. A modified cox proportional hazard model containing all the predictor variable was fitted it was found that 52(28.4%) are stunted, 65(35.5%) are wasted and 66(36.1%) are underweight The study shows that various socio-demographic and health service covariates are significant determinants of malnutrition. Accordingly, the finding of the study show that age, sex, source of drinking water, mothers age, education status of the parent, occupation of the parent, age of the mother, immunization status, breast feeding practice, family size and birth order of the child have statistically significant effect on the outcome of the nutritional status of children under-five years of age.

Keywords: *Malnutrition, Stunted, Wasting, Underweight, Survival analysis*

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I. INTRODUCTION

Malnutrition in children is an important public health issue especially for developing countries like Nigeria. Weight-for-height (wasting), height-for-age (stunting) and weight-for-age(underweight) are three important parameters for assessing nutritional status in children. Malnutrition is estimated to contribute directly or indirectly to more than 33% of all child deaths globally. Wasting implies that children are too thin for height, stunting indicates that children are too short for age while underweight means children are too thin for age.Despite existing interventions to address child malnutrition, it is still a major global public health problem (Akombiet al. 2017)[1]. Child malnutrition is an underlying cause for almost half (45%) of child deaths, particularly in low socioeconomic communities of developing countries (Blacket al. 2013)[4]. Globally in 2018, an estimated 149 million children under age 5 were stunted and 49 million children were wasted (UNICEF 2019)

Every year 7.6 million children die of such preventable malnutrition and their related causes. The other cause of dead in infants which is also preventable is low birth weight which leads to intergeneration cycle of malnutrition in population especially in females (Sibanyoni and Tabit,2017, unicef, 2014)[9]. Nutrition is an important determinant of immunological status. Under nutrition can make poorer immune competence and increase chances of susceptibility and vulnerability to infections. Inadequate dietary intake and episodes of diarrheal and respiratory diseases are the immediate causes of malnutrition and high mortality rate in children under five years (Erin et al., 2017)[8]. The consequences of hidden hunger which includes mild-to moderate malnutrition especially chronic under nutrition originating from micronutrients is not always visible but have significant effects on mortality, educability and the future productivity of children.children require adequate nutrition in order to enhance this important function of growth and development. This could be achieved if children are breastfed exclusively for at least 4-6 months after birth without introducing early complementary feeding and lactating mother use quality diets (Caballero et al., 2017, Nkirigacha et al., 2016)[2]. In community nutrition settings growth of infants and young children is measured by assessing weight and length/height, Mid

Arm Circumference (MUAC) and head circumference. Normal growth patterns from birth to adulthood vary between individuals owing to differences in bodily proportion and composition, including the timing of growth spurts. All infants demonstrate accelerations and decelerations in growth in response to changes in their environment or because of illness. The environment includes the nutrition status of the home the child is growing into. During illness, even a quite mild one, growth tends to slow down, but if the child is receiving adequate nutrition, this slow-down is followed by catch-up growth which consequently restores normal growth curve (Norman et al,. 2016, Walker et al.,2011)[13]. However if the cause of the delayed growth lasts for a long period of time, catch-up growth may never completely take place (Norman et al., 2016, Walker et al.,2011). The most dramatic period of child growth velocity is between birth and 4 months of age. Many full-term infants lose some weight shortly after birth, which they regain by day 8 to day 10 (Loretal, 2014, Norman et al., 2016)[10]. Thereafter, the average weight gain during the first year of life is 7 kilograms of which about half is gained in the first 4 months at a rate of 200 grams per week. This is followed by an average weight increase of 2 to 4 kilograms in each of the next 2 years with average weight gain per week being about 40 grams. Average birth weight babies double their weight by 6 months and treble it by one year of age (Norman et al,. 2016, Loretal, 2014). Children who start fat development earlier are at increased risk of obesity and should be monitored regularly. (Loretal,2014, Norman et al., 2016).

II. Materials and Methods

The survival analysis of time to event data however covers a wide scope which involves several parametric distributions as could be possible, but the researcher has narrowed down the study to cover four distributions. For the purpose of this research, application of the AFT models (Exponential, Wiebull, Log-logistics, and Generalized Lindely -Weibull) in analyzing neonatal jaundice data will be discussed.

2.1. Survival Function

The survival function is a probability of an individual surviving longer than a given period of time t [6]. Let T denote a continuous non-negative random variable representing time until some event of interest, with probability density function (pdf) f(t) and cumulative distribution function (cdf) $F(t) = Pr\{T \leq t\}$, the probability of being alive at t. The survival function is given by $S(t)$ and$S(t) = P$ (an individual survives longer than t)

$P(T > t)$

$$S(t) = 1 - P(T \leq t) \quad (1)$$

Using the definition of cumulative distribution function $F(t)$of , we can write;

$S(t) = 1 - F(t)$(2)HereS(t) is a non-increasing function of time t with the following properties. (i) i.e. at the beginning of the study (ii) $S(t) = 1$ for $t = 0$ $S(t) = 0$for $\rightarrow \infty$, which means that everyone will eventually experience the event. However, we will also allow the possibility that$S(\infty) > 0$.This corresponds to a situation where there is a non-negative probability of surviving or not experiencing event. For example, if the event of interest is the time from response until the disease relapse and the disease has a cure for some proportion of individuals in the population, then we have $S(\infty) = 0, S(\infty)$ corresponds to the proportion of cured individuals.

2.2 Cox Proportional Hazards

The Cox Proportional Hazards model is proposed by[5]

$$h\ (t/X) = h_0(t)\exp(\beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_r x_r$$
$$= h_0(t) exp(\beta' x) \quad (3)$$

where $h_0(t)$ is called the baseline hazard function, which is the hazard function for an individual for whom all the variables included in the model are zero, $X = (x_1, x_2 \ldots, x_r)'$ is the values of the vector of explanatory variables for a particular individual, and $\beta' = (\beta_1, \beta_2 \ldots, \beta_r)$ is a vector of regression coefficients. The corresponding survival functions are related as follows:

$$S(t/X) S_0(t) exp \sum_{i=1}^{r} \beta_{ix_i} \quad (4)$$

This model is known as the Cox regression model, it makes no assumptions about the form of h_0(t)(non-parametric part of model) but assumes parametric form for the effect of the predictors on the hazard (parametric part of model). The model is therefore referred to as semi-parametric model. The measure of effect is called hazard ratio. The hazard ratio of two individuals with different covariates $X and X^*$is

$$\widehat{HR} = \frac{h_0(t) rexp\,(\beta' X)}{h_o(t) rexp\,(\beta' X)} = \exp(\sum \hat{\beta}' (X - X^*))(5)$$

III. RESULT

Table 1: FREQUENCY AND PERCENTAGE

Variables	Frequency	Percentage
Age 0-11	84	45.9
12-23	78	42.6
24-35	17	9.3
36-47	4	2.2
Sex male	68	37.2
female	115	62.8
Source of drinking water Pipeborne	84	45.9
Well treated	8	4.4
Well-untreated	87	47.5
Stream	4	2.2
Occupation of father government	16	8.7
Non-government	167	91.3
Occupation of mother government	1	5
Non-government	182	99.5
Education status father non-formal	82	44.8
Primary	24	13.1
Secondary	60	32.8
Tertiary	17	9.3
Education status mother non-formal	119	65
Primary	37	20.2
Secondary	25	13.7
Tertiary	2	1.1
Age of mother 15-25	121	66.1
26-35	50	27.3
36-49	12	6.6
Marital status of the mother single	1	5
Monogamy	80	43.7
Polygamy	102	55.7
Immunization status yes	106	57.9
No	77	42.1
Number of household member 1-9	105	57.4
10-19	61	33.3
20-29	16	8.7
30above	1	5
Birth order 1-9	133	72.7
10-19	46	25.1
20above	4	2.2

Table 1: it shows the frequency and percentage of each of the variable

COX PROPORTIONAL HAZARD MODEL RESULT

Table 2:Wald's test of significance of the predictor variables

Variable	B	SE	Wald	Df	Sig.	Exp(B)	95.0% CI for Exp(B)	
							Lower	Upper
Initial model								
SOURCEOFWATER	.146	.135	1.178	1	.278	1.158	.889	1.507
OCCUPATIONOFFATHER	.584	.566	1.067	1	.302	1.794	.592	5.438
OCCUPATIONOFMOTHER	-1.054	1.103	.912	1	.340	.349	.040	3.031
EDUCATIONSTATUSOFFATHER	.016	.177	.008	1	.929	1.016	.718	1.438
EDUCATIONOFMOTHER	.020	.222	.008	1	.929	1.020	.660	1.577
AGEOFMOTHER	.205	.221	.859	1	.354	1.228	.795	1.895
IMMUNIZATIONSTATUS	.011	.280	.002	1	.968	1.011	.585	1.749
CHILDFEEDING	-.127	.170	.559	1	.455	.880	.631	1.229
NUMBEROFTHEHOUSEHOLDMEMBER	-.192	.329	.341	1	.559	.825	.433	1.572
BIRTHORDER	.064	.428	.023	1	.880	1.067	.461	2.470
NUTRITIONALSTATUSOFCHILDREUNDERFIVEYEARS			2.335	2	.311			
NUTRITIONALSTATUSOFCHILDREUNDERFIVEYEARS(1)	-.432	.330	1.706	1	.192	.649	.340	1.241
NUTRITIONALSTATUSOFCHILDREUNDERFIVEYEARS(2)	.048	.284	.029	1	.865	1.049	.602	1.829

The model

$H(t/x) = ho(t)x \exp (b_{sourceofwater}.sourceofwater+b_{occupationoffather}.occupation\ of\ father\ldots+b_{birthorder}.\ birthorder$

$= 0.486\exp(0.146+0.584-1.054+0.016+0.020+0.205+0.011-0.127-0.192+0.064$

IV. DISCUSSION OF THE RESULT

The regression coefficients predict the hazard for the terminal event as a function of the covariates in the model A positive coefficient (the B values) are associated with increase hazard and decrease survival time. i.e as the predictor increases the hazard of the event increases and the predicted survival duration decreases

A negative coefficient (the B values) are associated with decrease hazard and increase survival time. i.e as the

For source of drinking water (pipe borne, well treated, well untreated, stream) signify positive coefficient(b= .146) children whose source of drinking water is well untreated or stream are likely to be malnourish compare to those who take pipe borne water. World health organization (WHO 2016)[15] estimate that 50% of malnourishment is associated with infection cause by unsafe water and inadequate sanitation.

For the fathers occupation (government and non-government) signify positive coefficient (b=.584) For the mothers occupation (government and non-government) signify negative coefficient (b= - 1.054) that is children whose father are not working (non-government) worker have more malnourished children compare to those who are government workers. Mothers occupation have no impact on child malnourishments.

For the fathers education (non formal, primary, secondary, tertiary) signify positive coefficient (b= .016) .For the mothers education (non formal, primary, secondary, tertiary) signify positive coefficient (b= .020) moreover, children whose father/mother is illiterate are more likely to experience malnutrition as compared to those children whose father/mother are literate. Our result is consistent with that of (Babatunde; 2011)[3]. That educated mothers are better aware about the nutrition requirements of their children and by providing improved health care. This study also revealed that education plays an important role to improve knowledge of medical and health care particularly mothers' education enhances more effective health care practices that increases their productivity and influence infant and child mortality.

Age of the mother (15-25, 26-35, 36-49) signify positive coefficient (b= .205) age of the mother have impact on malnourishments in children Infants born to young mothers who are not fully developed are found to have low birth weights (Dewan, Manju, 2008)[7]. Low birth weight is one of the indicators of malnutrition.

Immunization status (yes or no) signify positive coefficient (b= .011) children who have no up to date immunization are likely to be malnourish compare to those who have up to date immunization Willby and Werry (2012)[14] in fully immunized children, suggesting that immunization not only helps to prevent specific disease of focus but also leads to overall improvements in health

From the result of Child feeding practise (exclusive and mixed) the significant negative coefficient (b= -.127) that is both child breast feeding practise has no effect on the child malnourishment. (WHO 2001) recommended that infant should exclusively breastfed for 4-6 months after which they can be introduce to complementary foods (any fluid or food other than breast milk)

Number of the member of the households (0-9.10-19, 20-29 30above) signify negative coefficient (b= -.192) number of house hold members does not have impact on malnourishments in children.

The For Birth order of the child (0-9, 10-19, 20-29) signify negative coefficient (b= .064) birth order of the child has no impact on the prevalence of malnourishment of the children. Zakaria et al.(2019)[16] also reported that childhood malnutrition is positively correlated to birth order. This means that children with a higher birth order have a higher chance of being malnourished.

Nutritional status (stunted, wasted, underweight) signify positive coefficient (b = .048) nutritional status have impact on the prevalence of having malnourishments in children Individuals can be broadly categorized into having optimal nutritional status, or being undernourished, over nourished, and malnourished. It is important to realize that many other life style and environmental factors, in addition to nutrition, influence health and wellbeing, but nutrition is a major, modifiable and powerful factor in promoting health, preventing and treating disease and improving quality oflife .

Considering the predictor with their respective parameters (β) from the above table after the stepwise method the final model is

$H(t/x) = ho(t)xexp(b_{sourceofwater}.sourceofwater+b_{occupationoffather}.\text{occupation of father}\ldots\ldots+b_{birthorder}.birthorder$

= 0.486exp(0.146*source of water+0.584*father occupation-1.054*mothers occupation+ 0.016*education status of father+0.020*education of mother+0.205*age of mother+0.011*immunization-0.127* feeding practise-0.192* household member+0.064*birth order

The Exp(B) column is the hazard ratio and reflects the multiplicative change in the hazard for the terminal event per unit increase on a predictor.

For source of water the hazard ratio was 1.158 this indicates that the hazard (malnutrition) rate is 15.8% high for stream water compared to the other source of drinking water it is non-significant. For occupation of the father the hazard ratio was 1.794 this indicates that the hazard (malnutrition) rate is 79.4% high for non-government worker compared to government work it is non-significant. Occupation of the mother it is statistically significant the hazard decreases by (1-0.349)*100=65.1%. Education status of the father the hazard ratio was 1.016 this indicates that the hazard (malnutrition) rate is 1.6% high for non-government worker compared to those with formal it is non-significant. Education of the mother the hazard ratio was 1.020 this indicates that the hazard (malnutrition) rate is 2% high for those in tertiary level compared to those with non-formal. it is non-significant. Age of the mother the hazard ratio was 1.228 this indicates that the hazard (malnutrition) rate is 22.8% high for 36-49 compared to those 15-25 it is non-significant. Immunization status the hazard ratio was 1.011 this indicates that the hazard (malnutrition) rate is 1.1% high for those who have no up to dates immunization compared who have up to dates immunization is non-significant. Child feeding it is statistically significant the hazard decreases by (1-880)*100=12%. Number of households member it is statistically significant the hazard decreases by (1-0.825)*100=17.5%. Birth order the hazard ratio was 1.067 this indicates that the hazard (malnutrition) rate is 6.7% high for those with child birth of 20above compared to those with birth order of 1-9it is non-significant Nutritional status(2) it is statistically significant the hazard decreases by (1-0.649)*100=35.1%.Nutritional status the hazard ratio was 1. 049 this indicates that the hazard (malnutrition) rate is 49% high for underweight compared to stunted it is non-significant.
The latter two columns contain the 95% confidence interval for the hazard ratio. The null hypothesis for testing the hazard ratio using the confidence interval is that The population value is 1.

V. CONCLUSION

The study shows that various socio-demographic and health service covariates are significant determinants of malnutrition

Accordingly, the finding of the study show that age, sex source of drinking water, mothers age, education status of the parent, occupation of the parent, age of the mother, immunization status, breast feeding practice, family size and birth order of the child have statistically significant effect on the outcome of the nutritional status of children under-five years of age

For instance, the education of the mother is important because if the mother is educated she will know how to take care of the child so that the child will not be malnourish as well as the age of the mother also contribute to the malnourishment of the child . The child that come from a large family are likely to be more malnourish due to family size and finally. The marital status, the child that come from a polygamous family are more malnourish because the father has many children so he wouldn’t care for the child nutrient.

The parent should endeavor to be educated, early marriage should be reduced and the parent should try to practice exclusive breast feeding so as to reduce the rate of malnutrition in children under-five years of age

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