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Predictive Model and Risk Factors of Under-five Mortality in Nigeria: A Study Based on 2018 Nigeria Demographic and Health Survey

D. A. Agunbiade[1], O. Fatoki[2] and N. F. Adeleye[3,*]

[1] Department of Mathematical Sciences, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria
e-mail: bayoagunbiade@gmail.com

[2] Department of Statistics, Ogun State Institute of Technology, Igbesa, Ogun State, Nigeria
e-mail: fatoki_olayode@yahoo.com

[3] Department of Statistics, Ogun State Institute of Technology, Igbesa, Ogun State, Nigeria
e-mail: leyinton@gmail.com

Abstract

The death of children under-five years is one of the critical issues in public health and the need for improving child survival continues to be a matter of urgent concern. In this study, we develop a predictive model in order to examine the risk factors of under-five mortality in Nigeria. The study utilized data from 2018 Nigeria Demographic and Health survey. The demographic and mortality data of 127,545 children were extracted and univariate and multivariate logistic regression models were employed. The results revealed that under-five mortality was 143 deaths per 1,000 live births in Nigeria. The likelihood of death was higher among males compared to females children (OR = 1.893, P<0.05). First and second birth order have a lower chances of decreasing odds of under-five children (OR = 0.737, P<0.05) and (OR = 1.888, P<0.05).The under-five mortality was higher among children born to mothers who belong to other religions compared to Christians. Islam (OR = 1.689, P<0.05) and traditionalist (OR = 2.705, P<0.05) respectively. Public servant (OR = 1.881, P<0.05) and unmarried mother (OR = 1.896, P<0.05) were increased the odds of dying chances of under-five mortality in Nigeria. Children of mothers without education experienced more death compared to mothers who attended post-secondary education (OR = 3.372, P<0.05). Sex of child, birth order, religion, marital status, maternal occupation and maternal education were significant factors associated with under-five mortality in Nigeria. Thus, planning and implementing

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*Corresponding author

relevant strategies that focus on those identified risks factors of under-five mortality is required for improvement of child survival in Nigeria.

1. Introduction

Under-five mortality refers to the deaths of children aged between 0-59 months of life. Under-five mortality remains a huge challenge in Nigeria despite concerted efforts made by all sector (Adebowale *et al*., 2017). According to Black *et al*. (2016), the death of children under-five years is one of the critical issues in public health and improving child survival continues to be a matter of urgent concern globally. Remarkable progress in the reduction of mortality among children under the age of five has been made globally. In 1990, an estimated 12.6 million deaths occurred among under the age of five children and it declined to 5.2 million in 2019. Sub-Saharan Africa, including Nigeria and South Asia which are home to only 52 percent of the under-five population, account for more than 80 percent of the 5.2 million of under-five mortality (WHO, 2020). The global under-five mortality rate has dropped by 59 percent, from 93 deaths per 1,000 live births in 1990 to 39 deaths per 1,000 live births in 2018. This is equivalent to 1 million children dying before reaching the age of five in 1990, compared to 1 in 20 in 2018 (UN IGME, 2020).

There are widespread regional disparities in children's chances of survival with WHO African region carrying the highest burden of under-five mortality in the world. Sub-Saharan African including Nigeria continues to be the region with the highest risk of dying before the age five in the world with 78 deaths per 1000 live births in 2018. This means that 1 child in 13 dying his or her before their fifth birthday, which is 16 times higher than the average ratio of 1 child in 199 in high-income countries.

In Nigeria, according to the recent 2018 Nigeria Demographic and Health Survey (2018 NDHS) report, the under-five mortality rate was 132 deaths per 1,000 live births, which means 1 in 8 children in Nigeria dies before reaching age five. Despite small improvements in child mortality rates over the past decade, Nigeria still has high rate of under-five deaths. Therefore, more efforts need to be made and appropriate interventions also needed to be implemented to meet the Sustainable Development Goals (SDGs) that targeted to reduced under-five mortality rate to at least as low as 25 deaths per 1,000 live births by 2030. This study aimed to predict risk factors of under-five mortality in Nigeria.

2. Literature Review

Under-five mortality is a key indicator of child health as well as the economic status of any country. According to UNICEF (2020), 85% of child deaths occur during the first five years of life. Furthermore, it is estimated that 52 million children under-five years will die during the period 2019 and 2030. Being an indicator, under-five mortality has been extensively studied globally. This section presents some studies on under-five mortality conducted within Nigeria as well as in other country highlighting the risk factors of children deaths.

Ahinkorah *et al*. (2022), carried out a study on socio-economic determinants and proximate causes of under-five death in Guinea. Logistic regression analyses and descriptive analysis were done on the 2018 GDHS in order to identify the determinants for under-five death. Guinea had a mortality rate of 111 per 1,000 live births for children under five. The risk of death was higher for children born to mothers from other religions than it is for Christians.

Gizachew (2021), their study aimed to determine the factors that contribute to under-five mortality in Southern Nations, Nationalities and people's regions (SNNPR), Ethiopia. The study sought to identify the determinant factors associated with under-5 mortality. For the 2016 EDHS, a multivariate logistic regression model was used. The results showed that under-five mortality in Ethiopia was associated with factors such as sex, birth order, child size, place of delivery and birth type.

Ezeh *et al*. (2021), research from 22,455 singleton live babies (2013-2018). Their study intended to identify factors associated with under-five deaths in Northern geographical areas. Data from Nigeria Demographic and Health Survey (2013-2018) were used to analyze the data using logistic regression and generalized linear latent and mixed models. The highest under-five death rate was recorded in the northwest (179 deaths for 1000 live births), according to the findings. Based on the adjusted model, it was found that geographic zone, poor household, paternal occupation and perceived children's bodies at birth, Caesarean deliveries, and education of mother and father were all strongly associated with an increase in under-five mortality.

Azuike *et al*. (2019), used secondary data from the 2013 Nigeria Demographic and Health Survey were analysed using both a multivariate and univariate logistic regression model. According to the findings, several factors contribute to the high rate of under-five mortality in Nigeria's southern-east geopolitical area. Anambra State children had lower

chances of dying under five than those living in other states. However, the odds of dying under five were reduced by factors such as maternal education, maternal age below 35 years, rich wealth index, and female gender.

Abate (2018), examined factors that determine under-five mortality in Adigrat Town. The goal of this study was to identify the most significant causes of child deaths. Data were collected through primary data sources. These data were obtained by interviewing women aged between 15 and 49. The results using the poison regression model revealed a link between under-five years of mortality, the father's education and family income, the mother's age at first childbirth, the health status of the mother and breastfeeding status.

Sohail and Neupane (2018), considered prevalence factors and determinants associated with South Asia's under-five mortality. The Demographic health survey data between 1999-2014 in five South Asian nations (Bangladesh India Maldives Nepal and Pakistan) was analyzed. It was discovered that under-five mortality rates were affected by the factors of age, education, occupation, and marital status.

Bako *et al*. (2016), research on analysis of the rates of under-five deaths in Kaduna State of Nigeria. To determine the relative mortality of each factor, 415 questionnaires were collected. The data was analysed using logistic regression. The results showed that under-five mortality was significantly related to six factors. These included distance to the nearest health facility, age at first marital, current marital situation, level of education, mother's age and length of breastfeeding.

3. Materials and Methods

3.1. Source of data

The source of data for this study was 2018 Nigeria Demographic and Health Survey which were downloaded from www.measuredhs.com.

3.2. Sampling

The sample was selected using a stratified, two stage cluster design. Samples of 40,427 women of reproductive age were interviewed. Births that have occurred in the last five years prior to the date of the interview were extracted for the analysis.

3.3. Data collection

The questionnaire was used to collect information from the women which include background characteristics, birth history and time of the interview.

3.4. Binary logistic regression model

Overtime, medical researchers have conventionally used the logistic regression simply because of the dichotomous nature of the study outcome variable.

Logistic regression is a class of generalized linear model and types of regression model used when the outcome variable is qualitative and have binary indicators. In this study, the outcome event is under-five mortality. That is, proportion of a cohort of children born in the last five years who had died before their fifth birthday.

The relationship between the independent variables and under-five mortality can be represented by a logistic regression model of the form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n \tag{3.1}$$

where Y is the response variable (under-five mortality) with a status 1, if the child die before reaching five year and 0, if otherwise.

The expected value of Y is the probability that $Y = 1$ which makes the range of y to be limited between 0 and 1. Logit link function is therefore used to transform the output of a linear regression and present it in form of probability. Therefore, Y is expressed as logit(p) where p is the probability of dying before the age of five. The logit transformation is written as the log odd:

$$\text{logit}(p) = \log\left[\frac{p}{1-p}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_n X_n. \tag{3.2}$$

The model in equation (3.2) above shows the odds of under-five mortality.

Here,

p is the probability of dying before the age of five.

β_0 is constant which measures under-five mortality when all the independent variables are held constant.

$\beta_1, \beta_2, \beta_3, \ldots, \beta_n$ are unknown parameters of the model estimated by maximum likelihood techniques.

$X_1, X_2, X_3, \ldots, X_n$ represent the independent variables.

The model in equation (3.2) is widely used for analyzing data involving binary response and independent variables.

4. Results and Discussion

Univariate analysis

The results from Table 4.1 below revealed that out of all the 127,545 children delivered by 41,821 mothers, 18,220 (14.3%) were reported deaths before celebrating their fifth birthday. This survey retrospectively covered from the year 2013 to 2018.

Above half (51.3%) of the under-five children were males. A little above one-quarter (27.8%) of the mothers of under-five children occupied the fifth birth and above in their families. Almost all the women of under-five children (95.0%) had been in union either at the time of data collection or previously. The commonest age group among mothers was those greater than 35 years (70.7%). More than half of under-five mothers (59.5%) were practiced Islamic religion. Most part of the mothers (42.3%) were engaged as a traders. Nearly half of the mothers of under-five children (49.9%) had no formal education. Only (32.0%) of the mothers had at least 1 birth in the last five years.

Table 4.1: Frequency and percentage distribution of some selected demographic variables of under-five mortality from 2018 Nigeria DHS data.

Covariates	Categories	Frequency	Percent
Child is Alive	Dead	18220	14.3
	Alive	109325	85.7
Sex of Child	Male	65464	51.3
	Female	62081	48.7
Birth Order Number	First Birth	29992	23.5
	Second Birth	25343	19.9
	Third Birth	20584	16.1
	Fourth Birth	16157	12.7
	Fifth Birth +	35469	27.8
Religion	Christianity	50451	39.6
	Islam	75942	59.5
	Traditionalist	677	.5
	Others	475	.4
Maternal Age	15 – 19	551	.4

	20 – 24	3102	2.4
	25 – 29	7462	5.9
	30 – 34	9163	7.2
	35 – 39	90152	70.7
	40 – 44	8317	6.5
	45 – 49	8798	6.9
Marital Status	Not Married	6408	5.0
	Married	121137	95.0
Maternal Occupation	Unemployed	4049	3.2
	Farmer	24999	19.6
	Trading	53995	42.3
	Artisan	27843	21.8
	Public Servant	10052	7.9
	Civil Servant	6607	5.2
Maternal Education	No education	63699	49.9
	Primary	25311	19.8
	Secondary	30756	24.1
	Tertiary	7779	6.1
Age of the Child	Under 1	25596	20.1
	1 - Under 2	24236	19.0
	2 - Under 3	23336	18.3
	3 - Under 4	23560	18.5
	4 - Under 5	30817	24.2
Births in the Last Five Years	No Birth	38999	30.6
	1 Birth	40811	32.0
	2 Births	39278	30.8
	3 Births	7700	6.0
	4 Births +	757	.6
Total		127,545	100.0

Source: Authors' Computation, 2022

Table 4.2 divulged the results of the logistic regression model which revealed that sex of a child, birth order, religion, marital status, maternal education and maternal occupation were statistically significant risk factors of under-five children mortality at 5 percent of significance.

The odds of under-five children death among males was 1.893 (OR = 1.893, P<0.05) times more likely to die before celebrating fifth birthday than females. Children with first birth order of (OR = 0.747, P<0.05) and children with second birth order (OR = 0.888, P<0.05) were associated with decreased odds of under-five death compared to those from families with fifth birth order. Children of under-five mothers that practiced Islamic religion was 1.689 (OR = 1.689, P<0.05) and traditionalist (OR = 2.705, P<0.05) were experienced more deaths before reaching the age of five compared to those who practiced Christianity. Mothers of under-five children who were not married was 1.896 (OR = 1.896, P<0.05) were associated with increased odds of under-five mortality compared to those married mothers. Mothers of under-five children whose occupation were public servant was 1.881 (OR = 1.881, P<0.05) were more likely to die before completing fifth birthday. Children of under-five mothers who had no formal education was 3.372 (OR = 3.372, P<0.05) were more likely to die before reaching the age of five compared to those who had attained post secondary education.

Table 4.2: Parameter estimates of the logistic regression model that has a predictive influence on under-five mortality of some selected demographic variables from 2018 NDHS data.

Covariates	Coefficient	Odd Ratio (OR)	P – value
Sex of child			
(Female)		**1.000**	
Male	-0.113	1.893	0.000
Birth Order			
First Birth Order	0.291	0.747	0.000
Second Birth Order	0.119	0.888	0.000
Third Birth Order	-0.001	0.999	0.963
Fourth Birth Order	-0.007	0.993	0.802
(Fifth Birth Order)		**1.000**	
Religion			
(Christianity)		**1.000**	

Islam	0.372	1.689	0.000
Traditionalist	-0.350	2.705	0.003
Others	1.454	4.279	0.765
Maternal Age			
15-19	-0.154	0.857	0.336
20-24	-0.427	0.652	0.961
25-29	-0.408	0.665	0.714
30-34	-0.500	0.607	0.823
35-39	-0.616	0.540	0.576
40-44	-1.016	0.362	0.062
(45-49)		**1.000**	
Marital Status			
(Married)		**1.000**	
Not Married	0.101	1.896	0.032
Maternal Occupation			
Unemployed	0.032	1.033	0.658
Farmer	-0.073	1.076	0.119
Trading	-0.075	0.927	0.083
Artisan	-0.039	0.961	0.386
Public Servant	-0.127	1.881	0.019
(Civil Servant)		**1.000**	
Maternal education			
No education	0.989	3.372	0.000
Primary	-0.808	1.668	0.572
Secondary	-0.404	0.446	0.061
(Tertiary)		**1.000**	
Constant	1.632		

Test	**Chi-square**	**DF**	**P-value**
Omnibus Test Model Co-efficient	216.354	31	0.000
Hosmer and Lemeshow Test	124.612	8	0.652
-2loglikelihood value	82997.658		

Source: Authors' Computation, 2022 variable ( ) reference category

Model can be formulated as:

$$Y = f\ (A) \tag{4.1}$$

Y = Under-five mortality and A represents some selected demographic variables.

The fitted logit models is: Log (odds of under-five mortality) = 1.632 + 0.113M + 0.291FBO – 0.119SBO – 0.372IM – 0.350TDT + 0.101NM – 0.127PS + 0.989NE

Where,

M = male, FBO = First Birth Order, SBO = Second Birth Order, IM = Islam, TDT = Traditionalist, NM = Not married, PS = Public Servant and NE = No education.

4.1. Evaluation of the full model

Results from Table 4.2 showed that the chi-square value and their corresponding P-value are 216.354 and 0.000 for the entire omnibus test. This suggests that the entire test is statistically significant at 5 percent. The value of -2loglikelihood is fairly large (82997.6). This indicates that the fitted model is of moderate predictive power.

Goodness-of-fit test

The goodness of fit of the model was examined by using Hosmer-Lemeshow goodness of fit test.

Hypothesis test

H_0 : The model is a good fit versus

H_1 : The model is not a good fit.

Since the P-value 0.652 > 0.05, we do not reject the null hypothesis and we conclude that the model is a good fit and consistent with the data.

Table 4.3: Result of Hosmer and Lemeshow test.

Test	Chi-square	DF	P- Value
Hosmer and Lemershow	124.612	8	0.652

Source: Authors' Computation, 2022

4.2. Discussion

The total of 127,545 under-five children included in this study, 18,220 (14.3%) of them were reported dead before the age of five years.

51.3% of the children were males and the remaining 48.7% of them were females. The majority (27.8%) of the children had birth order above five, 23.5% of them had first birth order. About 19.9% of them had second birth order, 16.1% of them had third birth order and the remaining 12.7 % of them had fourth birth order. More than half of children (59.5%) were practicing Islam, 39.6% of the children were Christian, 0.5% were children of traditionalist and the remaining 0.4% of those children were from others. Majority (95.0%) of the children were from married mothers while the remaining 5.0% of them were children of mothers who were not married. About half (49.9%) of the children of mothers had no formal education, 19.8% of the mothers of children had primary education, 24.1% of the children had secondary education while the remaining 6.1% of the children had tertiary education.

The results of the multivariate logistic regression analysis disclosed that male children were at higher risk of under-five death compared to female children. This is in line with previous studies by (Yaya *et al*., 2018). The reason for this might be that male children are biologically weaker than that of female counter parts due to a fundamental genetic advantage.

Children of lower birth order experienced less death than those children of higher birth order. This is consistent with the previous study by (Woldeamanuel, 2019; Kayode *et al*., 2012).The possible explanation for this might be that as birth order increases care given to child by mother's decreases with respect of having more children.

The study showed that mothers without education increased the odds of under-five mortality. This result agrees with nationally representative study in Nigeria (Maniruzzaman, 2018; Adeolu *et al*., 2016). This may be because educated mothers are more likely to seek health care attention from pregnancy period to post delivery. Also educated mothers are more likely to understand the importance of immunizations and ensure that her child is vaccinated appropriately.

There was a strong association between religion and under-five mortality in Nigeria. Children born into Christian family had a lower risk of under-five death than those whose mothers practiced Islam and traditional religions. This was compatible with previous studies conducted by (Cau *et al*., 2013; Wood, 2007).

5. Conclusion

The purpose of this paper was to develop a predictive model and identifying the risk factors of under-five mortality in Nigeria. The study utilized data from 2018 Nigeria

Demographic and Health Survey. The response variable in this study was under-five mortality and the predictors' variables were selected from demographic variables. Univariate and Multivariate logistic regression model were employed in order to examine the risk factors. The results revealed that sex of child, birth order, religion, marital status, maternal education and maternal occupation were statistically significant risk factors of under-five mortality in Nigeria.

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