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Cox-regression analysis of under-five child mortality in Nigeria's North-West region

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Abstract

Although under-five mortality in Nigeria has decreased, some regions, such as the North-West, continue to have a high death rate. As a result, efforts to reduce the rate must continue by identifying the primary cause of under-five death. The primary goal of this study is to determine the key variables influencing the survival of children under the age of five in Nigeria's North-West region using the 2018 Demographic and Health Survey data. The Cox Proportional Hazard Regression was used in this study to evaluate the influence of mother's education, age of first delivery, previous birth interval, birth type, gender of the under-five child, and paramedics' assistance during labor. All factors had a significant influence on the survival rate of children under the age of five. Females under the age of five had a lower hazard (risk) of dying than men. When compared to single-birth offspring, twins experienced a threefold increase in the risk of mortality. Furthermore, a greater mother's education is associated with a reduced risk.

Keywords: Survival analysis, mortality rate, cox proportional hazard, hazard ratio, under-five mortality

Introduction

Around the last few decades, countries all over the world have attempted to minimize child mortality. Child mortality is a key indication of a child's health. The under-five mortality rate is the number of deaths among children aged one to five years per 1000 live births in a given year. This mortality rate may be used to indicate the degree of health issues among children under the age of five, the availability of basic health care, and the success of primary health care (Danzhen You, Lucia Hug, Simon Ejdemyr, Jan Beise and World, 2015) [3].

In Nigeria, baby and under-five mortality rates have remained stable over the last five years, with 74 and 117 deaths per 1,000 live births, respectively. At these rates of mortality, one out of every 13 Nigerian children born dies before reaching the age of one, and one out of every eight does not live to the age of five. Infant and under-five mortality rates have also steadily dropped over the last 25 years, from 126 and 213 in 1990, respectively (UNICEF Report, 2015) [11].

Infant and under-five mortality rates are strongly linked to important socioeconomic and geographic factors. Both rates fall as the family wealth index and the mother's degree of education rise, and both rates are greater in rural regions and the North-West geopolitical zone. A kid from the poorest 20% of families is twice as likely as a child from the wealthiest 20% of households to die before their first birthday or before their fifth birthday (UNICEF Report, 2014) [9].

The primary goal of this research is to identify the major factors that impact or influence the survival of children under the age of five in Nigeria's North-West area.

Materials and Methods

Data collection and study variables

This study made use of data from the 2018 Nigeria Demographic and Health Survey (NDHS). The response variable is the death risk of children under the age of five, as assessed by the time it takes for a child to reach the age of five from birth to death. The survival period is given in months and spans from 0 to 60 months.

The explanatory factors include the mother's education, the mother's first birth age, the previous birth interval, the birth type, the gender of the under-five child, and whether paramedics assist labour.

Method of data analysis

The impact of these variables was investigated using the Cox Proportional Hazard Regression.

The Cox proportional hazard model is a survival model that measures the relationship between one or more covariates with time. The risk of the event per time unit changes over time at baseline levels of covariates was denoted by $h_0(t)$. The hazard function was represented by $h(t)$.

The Cox proportional hazard model used in this study has the following form:

$$h_i(t, X) = h_0(t) \exp(\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_p X_p)$$

$$h_i(t, X, \beta) = h_0(t) \exp \sum_{i=1}^p \beta X_i$$

Where,

$h_i(t, X)$ is the risk of death for child i at time t

$h_0(t)$ is the baseline hazard function; $X = (x_1, x_2, x_3, \dots, x_p)$, are the selected variables

β is the vector of unknown coefficients of the explanatory variables x_i .

Results and Discussion

Descriptive Analysis

Table 1 shows that 254 (10%) of babies died before reaching the age of five. The percentage of infants who died before the age of five from families where the mother has a low education (up to elementary school) is greater (12.3%) than in other educational backgrounds. The risk of under-five mortality appears to be related to the mother's age at the time of the first delivery. Furthermore, 22.6% of the infants whose mother's age at first birth was greater than 35 years old died. Likewise, children born in multiples (twins, triplets, etc.) are approximately three times more likely to die than single-birth newborns. Additionally, a male newborn has a greater chance of dying before the age of five than a female infant.

Table 1: Sample characteristics

Variables	Died (n=254)	Alive (n=2295)	Total (n=2549)
	n (%)	n (%)	n (%)
Mother's education status			
Low	158 (12.3%)	1126 (87.7%)	1284 (100%)
Middle	80 (8.2%)	901 (91.8%)	981 (100%)
High	16 (5.6%)	268 (94.4%)	284 (100%)
Mother's age at the first delivery			
20-35 years old	150 (9.6%)	1416 (90.4%)	1566 (100%)
<20 or >35 years old	97 (10.2%)	855 (89.8%)	952 (100%)
≥ 35 years old	7 (22.6%)	24 (77.4%)	31 (100%)
Previous birth interval			
<24 months	117 (11.9%)	863 (88.1%)	980 (100%)
≥24 months	137 (8.7%)	1432 (91.3%)	1569 (100%)
Birth Type			
Single	239 (9.6%)	2258 (90.4%)	2497 (100%)
Multiple	15 (28.8%)	37 (71.2%)	52 (100%)
Gender			
Male	164 (12.2%)	1185 (87.8%)	1349 (100%)
Female	90 (7.5%)	1110 (92.5%)	1200 (100%)
Paramedics at Labour			
Non-Medic	89 (11.2%)	704 (88.8%)	793 (100%)
Medic	165 (9.4%)	1591 (90.6%)	1756 (100%)

Survival Analysis

Kaplan Meier: The survival function of children under the age of five is depicted in Figure 1 for six Nigerian regions. Survival rates are greater in the south-east, south-south, and

south-west areas than in the north-central, northeast, and north-west regions. The northwest has the lowest overall survival rate among the six areas, which leads to the major goal of this research.

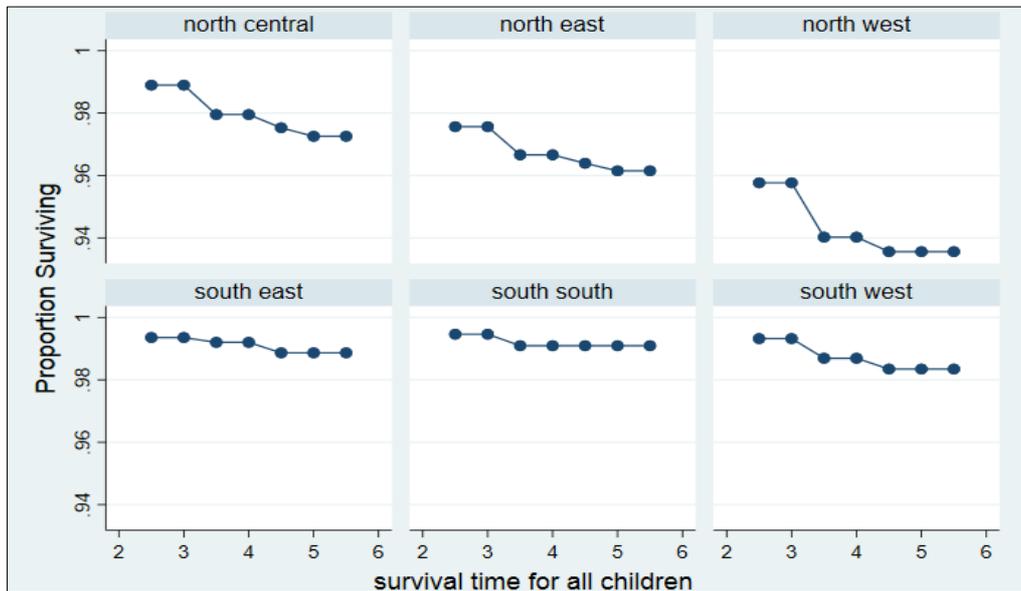


Fig 1: Kaplan Meier curve for under-five survival in North-West Nigeria based on region.

The Kaplan Meier curve in Figure 2 indicates that the curve rapidly declines from the start of the first year until the 23rd month, then progressively lowers in the following months. A

rapid drop indicates an increase in child mortality, whereas a gradual drop indicates a decrease.

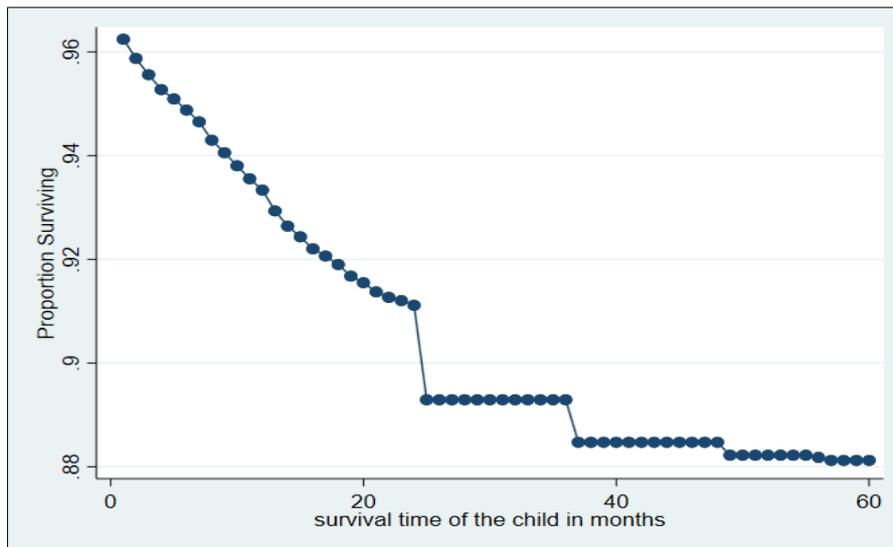


Fig 2: Overall Under-five child survival status in North-West Nigeria.

Table 2: Parameter estimation for Cox Regression Survival Model

Variable	β (Se)	Wald	p-value	Hazard Ratio
Mother's education status				
Low*	-	-	-	-
Middle	-0.481 (0.141)	11.643	0.001	0.618
High	-0.897 (0.273)	10.792	0.001	0.408
Mother's age of first delivery				
20-35 years old*	-	-	-	-
< 20 years old	-0.027 (0.134)	0.041	0.840	0.973
≥ 35 years old	0.986 (0.391)	6.356	0.012	2.681
Previous birth interval				
< 24 months*	-	-	-	-
≥ 24 months	-0.345 (0.131)	6.936	0.008	0.708
Birth type				
Single*	-	-	-	-
Multiple	1.151 (0.271)	18.011	0.0001	3.161
Gender				
Male*	-	-	-	-
Female	-0.510 (.131)	15.079	0.001	0.601
Paramedics at labour	-0.080 (0.136)	0.347	0.556	.923

Cox Regression Model

We utilize Cox regression to forecast the time based on a model. In North-West Nigeria, we examine the risk variables linked with the death of children under the age of five. According to the results of the Cox regression model in Table 2, all factors except paramedic labour were statistically significant.

Higher-educated mothers are less likely to have infant fatalities. (Ettarh and Kimani, 2012), (Mwangi Muriithi, 2015)^[4, 7] and others have done similar studies (Aheto, 2019)^[2]. These mothers are more likely to want to learn about health care.

The hazard ratio based on the age of birth delivery reveals that women with a first delivery age of more above 35 years have a 2.681-fold increased chance of not surviving when compared to the optimum mother's ages of first delivery (20 – 35 years old).

Meanwhile, if a mother has a longer birth interval with a previous birth, the likelihood of her children dying will be lower (Kayode, Adekanmbi and Uthman, 2012)^[5]. The tight birth gap between the first and second child might cause issues with both mental and physical health. To reduce the risk of infant and mother death, the World Health Organization (WHO) advised a two-to-three-year gap between births.

When compared to single births, twin newborns have a 3.161 percent higher probability of dying. In their research, (Monden and Smits, 2017)^[6] also indicate that twin births are more likely to result in death than single child deliveries.

The gender hazard ratio implies that females have a longer survival time than males. The findings of this study are also consistent with the findings of (Ruggieri *et al.*, 2016) and (Afeez *et al.*, 2018)^[8, 11]. In terms of the immune system and genetic variables, female toddlers are more likely to survive than male toddlers. Female children under the age of five are more resistant to illness.

Conclusion

All variables related primarily on the survival rate of under-five children. Female under-five children had a reduced hazard (risk) of mortality compared to the male. Twin under-five children experienced four times higher danger of mortality as compared to single born children. Higher mother's education seems to have a reduced hazard. Hence, an educated mother is more likely than an ignorant one to know how to take excellent care of her child, which is why it's important to consider her education.

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