Original Research Article

What Explains The High Rate of Infant Mortality in Rural Nigeria: Biodemographic or Socioeconomic Factors?

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ABSTRACT

Background: Children in the rural Nigeria are faced with higher mortality than their urban counterparts. And a number of factors are responsible for this. This study was aimed at determining which of bio-demographic or socio-economic factors contribute more to high rate of infant mortality in rural Nigeria.

Methods: Data from the 2013 Nigerian Demographic and Health Survey were re-analysed using multivariate Weibull proportional hazard model to determine the effect of bio-demographic and socio-economic factors on infant mortality in rural Nigeria.

Results: After controlling for other factors, child's sex, maternal age at child birth, birth interval, maternal age at first birth, type of toilet facilities, place of residence and maternal education are factors associated with infant mortality in rural Nigeria. Hazard of infant mortality was lowest among female children (HR = 0.83, CI= 0.75-0.93). Infant whose mother's age at child birth were 35 yr or more have higher risk of death (HR=1.40, CI=1.13- 1.74). Hazard of death was 64% (CI= 0.54- 0.76) higher at infancy among birth interval of 20-35 and 46% (CI= 0.38, 0.56) higher at infancy among birth interval more than 35 months. The risk of death was significantly highest in North-east (HR=1.26, CI=1.05-1.51) and North-west (HR=1.40, CI=1.16-1.67). The use of improved toilet facility (HR=0.83, CI=0.74, 0.94) lower risk of infant death. Also, infants whose mothers had secondary or higher education had lower risk of infant death (HR= 0.91, CI= 0.75-1.10).

Conclusions: Both bio-demographic and socioeconomic factors contribute significantly to infant mortality. Hence, in reducing infant mortality in rural Nigeria attention should be directed towards bio-demographic and socioeconomic factors.

Keywords: infant mortality, under-five mortality, determinants, Rural Nigeria.

INTRODUCTION

Childhood mortality is one of the measures of a country's health conditions and the level of its socioeconomic development. Consequently, its increase or decrease is an indicative of a growth or decline in general living standards. Globally, data indicated that seven million under-five children died annually (UNICEF, 2012) and Sub-Saharan African region is a major contributor to this statistics (UNICEF, 2014).

Children in the rural areas are faced with higher mortality than their urban counterparts, (Cai, 2006 and Wang, 2003. This rural disadvantage in child mortality was due to household-level factors, (Wang, 2003). Van de Poel, et al (2009) observed that controlling for differences in household socioeconomic status reduces the median rural-urban risk ratio in infant mortality in a

set of developing countries by 59%. After adjusting for a range of bio-demographic and socioeconomic factors, the urban advantage in child mortality remains significant in about one-third of the countries.

In Nigeria, the 2013 NDHS also showed a huge differential in infant mortality between rural and urban areas. It was evidence from the report that infant mortality in rural areas was 86 per 1000 live birth as against 60 per 1000 live birth in urban areas. And this is even more pronounced in under-five mortality, with 100 deaths per 1000 live births in urban areas as against 167 deaths per 1000 live births in rural areas. Furthermore, the trend in neonatal mortality in Nigeria showed that there has been consistent rural-urban differential in neonatal mortality in the last twenty years in Nigeria, in which urban residence have reduced risk of neonatal death compare to their rural counterparts, c

Because of the challenge infant mortality pose to public health in Nigeria and all developing countries, many studies have utilized various methods to identified factors associated with high infant mortality rates in Nigeria, (Antai 2010; Odimegwu, 2002; Adedini, et al 2015; Abimbola and others 2012; Abimbola, 2015). But none of these studies used parametric approach to examine this association. Therefore, this study utilized parametric method to determine which of bio-demographic or socio-economic factors contribute more to high rate of infant mortality in rural Nigeria.

MATERIALS AND METHODS

This study involved secondary analysis of nationally representative data from the 2013 Nigerian Demographic and Health Survey. The sampling frame used for the 2013 NDHS was the 2006 National Population and Housing Census of the Federal Republic of Nigeria. The survey covered all the 36 states and the Federal Capital Territory, Abuja. The primary sampling unit (PSU), referred to as a cluster, was defined on the basis of Enumeration Areas (EAs) from the 2006 census frame. Information on deaths and births of children aged less than five years was obtained from 23403 eligible rural women, aged 15–49 years who were either permanent residents in the selected households or visitors that slept in the selected households on the night preceding the survey. From these women, a total (weighted) of 20702 live-born infants were obtained. The analyses were restricted to live births and most recent births during the five years preceding the surveys to limit mothers' potential for differential recall of events, as deliveries had occurred at different points in time prior to the interview. For detailed sampling procedures of 2013 NDHS contact, (NPC and ICF 2014).

Variables used in the study: The outcome variable in this study is infant mortality, which is death between age 1 and 11 months. While the study variables are biodemographic and socioeconomic factors. These factors were based on the Mosley and Chen framework and existing literatures on infant mortality in developing countries. The socioeconomic factors considered are maternal education, socioeconomic status, type of toilet facility, source of water, marital status, religion, region of residence while the bio-demographic factors are child's sex, type of marriage, Maternal age at birth of child, preceding birth interval, child year of birth and age of respondent at first birth.

Statistical model: Cox regression technique developed by Cox in 1972 is a useful technique for analysis of survival data and it takes care of censoring problem in mortality data and this is its major advantage. In this technique, the outcome variable is the risk of death in infancy measured as the duration of survival since birth in months. The difference between various survival models is based on the distribution that the timing function is assumed to follow (Cleves et al. 2004). In this study we used Weibull model because it is suitable for hazards that are either monotonically decreasing or increasing (Blossfeld and Rowher 2002).

And it is an established knowledge that mortality in human population is usually high in the first year of life; then it declines in other ages of childhood and throughout most of the teenage years, then increasing slowly in adult ages to old age, (Rasugu, 2007). The Weibull proportional hazards model is of the form:

$$h_i\left(\frac{t}{x_i}\right) = \lambda \exp(\beta' x_i) p t^{p-1} \qquad (1)$$

Where: $h_i\left(\frac{t}{x_i}\right)$ = the hazard of death for child i at time t; p = shape parameter estimated from the data, β =the vector of unknown coefficients of the explanatory variables x_i

The hazard ratio between two different values of x is given by

$$\frac{h(t/x_1)}{h(t/x_2)} = exp\{\beta_1(x_1 - x_2)\} \qquad (2)$$

Data Analysis: The analytical tools used in this study are Descriptive statistics and Weibull hazard regression model.

Descriptive statistics include the use of frequencies and percentage while Weibull hazard regression model was used to identified the factors that have significant effect on infant mortality in rural Nigeria.

In all there are two models, classified as follows:

Model 1: This model contains the selected bio-demographic variables and infant mortality

Model 2: This model contains the combination of socioeconomic and bio-demographic and infant mortality. The hazard ratios, confidence intervals and p-value < 0.05 were used to measure the effect of Bio-demographic and Socioeconomic variables on infant mortality. All statistical analyses were done using Stata statistical package (version 12).

RESULTS

Table 1: Distribution according selected factors associated with infant mortality

Variables	Frequency	Percentage
Bio-demographic factors		
Sex of the child		
Male	10431	50.4
Female	10271	49.6
Type of marriage		
Monogamous	11635	56.2
Polygamous	9067	43.8
Maternal age at child birth		
<20 years	3719	18.0
20-35 years	13887	67.1
>35 years	2427	11.7
Birth interval		
First birth	3776	18.2
<24 months	3963	19.1
24-35 months	6775	32.7
>35 months	6188	29.9
Maternal age at first birth		
< 20years	11097	53.6
20-35years	7172	34.6
>35years	48	0.2
Child year of birth		
2012-2013	5347	25.8
2010-2011	7225	34.9
2008-2009	5746	27.8
Socio-economic variables		
Maternal education		
No education	13144	63.5
Primary education	3763	18.2
Secondary and higher education	3795	18.3
Socioeconomic status		
Poor	8972	43.3
Middle	3555	17.2
Rich	5790	28.0
Marital status		
Never married	2796	13.5
Ever married	17906	86.5
Religion		
Catholic	1814	8.8
Other Christian	6199	29.9
Islam	10026	48.4

Continued Table 1….		
Others	199	1.0
Source of drinking water		
Unimproved	11215	54.2
Improved	9487	45.8
Type of toilet facilities		
Unimproved	13050	63.0
Improved	7652	37.0
Region		
North West	9125	44.1
North East	4213	20.4
North Central	3368	16.3
South East	860	4.2
South South	1908	9.2
South West	1228	5.9

In table 2, the risk of infant mortality is higher in the Northern than the southern region of rural Nigeria. Also, the results revealed that female children had lower risk of death (HR = 0.83, CI = 0.75, 0.93) than male children. Infants whose parents marriage type are polygamous were associated with higher risk of death (HR = 1.04, CI = 0.92, 1.16) than children of monogamous type of marriage. With reference to maternal age at child birth, increase in age was associated with increased risk of death- 20-35 years (HR = 1.06, CI = 0.89, 1.25), and greater than 35 years (HR = 1.40, CI = 1.13, 1.74). Similarly, increase in maternal age at first birth is also associated with increased risk of infant death: 20-35 years (HR = 1.02, CI = 0.91, 1.14) and greater than 35years (HR = 2.46, CI = 1.22, 4.96). While increased birth interval reduces the risk of infant death: less than 24 months (HR = 1.05, CI = 0.88, 1.25); 24-35 months (HR = 0.64, CI = 0.64, CI = 0.54, 0.76) and greater than 35 months (HR = 0.46, CI = 0.38, 0.56). Furthermore, infants whose mothers had secondary and higher education had lower risk of infant death (HR= 0.91, CI= 0.75-1.10) while those whose mothers had primary education higher risk of death (HR =1.04, CI= 0.89, 1.21) than children whose mother had no education. Also, infants of middle socioeconomic status (HR=0.97, CI=0.84, 1.13) and rich socioeconomic status (HR=0.94, CI= 0.81, 1.08) all had reduced risk of infant death. Other risk factors are access to improved sources of drinking water (HR=1.03, CI=0.92, 1.15); infant of married parents had higher risk of

(HR = 1.16, CI = 0.79, 1.69) and use of improved toilet facilities had lower risk of infant death (HR=0.83, CI=0.74, 0.94).

Table 2: Hazard ratios of infant mortality associated with biodemographic and socioeconomic factors

Variables	Model I HR (95% CI)	Model II HR (95% CI)
Sex of the child		
Male	1.00	1.00
Female	0.84 (0.75, 0.93) *	0.83 (0.75, 0.93) *
Type of marriage		
Monogamous	1.00	1.00
Polygamous	1.20 (0.90, 1.12)	1.04 (0.92, 1.16)
Maternal age at child birth		
<20 years	1.00	1.00
20-35 years	1.01 (0.86, 1.19)	1.06, (0.89, 1.25)
>35 years	1.37 (1.11, 1.69) *	1.40 (1.13, 1.74) *
Birth interval		
First birth	1.00	1.00
<24 months	1.12 (0.95, 1.32)	1.05 (0.88, 1.25)
24-35 months	0.68 (0.57, 0.80) *	0.64 (0.54, 0.76) *
>35 months	0.49 (0.40, 0.59) *	0.46 (0.38, 0.56) *
Maternal age at first birth		
< 20years	1.00	1.00
20-35years	1.03 (0.92, 1.14)	1.02 (0.91,1.14)
>35years	2.43 (1.21, 4.89) *	2.46 (1.22, 4.96)*
Child year of birth		
2012-2013	1.00	1.00
2010-2011	1.12 (0.98, 1.28)	1.12 (0.98, 1.28)
2008-2009	1.10 (0.96, 1.26)	1.09 (0.95, 1.25)
Maternal education		
None		1.00
Primary		1.04 (0.89, 1.21)
Secondary and higher		0.91 (0.75, 1.10)*
Socioeconomic status		
Poor		1.00
Middle		0.97 (0.84, 1.13)
Rich		0.94 (0.81, 1.08)
Marital status		
Never married		1.00
Married		1.16 (0.79, 1.69)
Religion		
Catholic		1.00
Other Christian		1.26 (1.03, 1.51)
Islam		1.07 (0.86, 1.34)
Others		1.11 (0.65, 1.92)
Source of water		
Unimproved		1.00
Improved		1.03 (0.92, 1.15)
Type of toilet facilities		
Unimproved		1.00
Improved		0.83 (0.74, 0.94) *
Region		
North Central		1.00
North East		1.26 (1.05, 1.51) *
North West		1.40 (1.16, 1.67) *
South East		1.25 (0.93, 1.67)

P<0.05 (statistically significant)

DISCUSSION AND CONCLUSION

The findings from this study identified biodemographic factors, such as child's sex, maternal age at child birth, birth interval, maternal age at first birth and socioeconomic factors such as, type of toilet facilities, place of residence and maternal education as factors associated with infant mortality in rural Nigeria. Most of these covariates or factors remained significantly associated with infant mortality even after controlling for the effects of other important factors.

Considering sex of child, results shows a statistical significant relationship between child's sex and infant mortality, in rural Nigeria. Female children had reduced risks of dying at infancy compared to male children. This may be attributed to Cultural beliefs, that female children are more important to the family development than male counterpart. Since the study is rural base where great proportion of the respondents had little or no formal education female children are regarded as a source of wealth in terms of bride price at marriage. Consequently parents show considerable care to females children than male siblings. This is consistent with similar studies both national and international. (Abimbola O. et al, 2012; Justine, et al 2015; Damodar S. et al 2015).

Our also study found that maternal age at child birth was significantly associated with infant mortality. Children of older age, more than 35years was at higher risk of dying compare to children of younger age. This finding is in consistent with Damodar et al, (2015) that the risk of infant death was highest among births to mothers aged 30years and more compare with children of mothers aged 20-29. Biological factors (Osital, and others, 2015) may be likely explanation for this. Similar findings have been identified in the previous studies, (Uthman, 2008); Heiko and others 2004); among others.

Further, as previously found in Nigeria (Uthman, 2008), (Akinyemi et al, 2013), (Adedini. et al. 2015) and elsewhere

(Whitworth & Stephenson, 2002) this study established that birth interval was an important factor to infant mortality in rural Nigeria. Children with a longer birth interval had lower risks of death than children with a shorter birth interval of 24 months or longer. According to Whitworth & Stephenson, (2002), this could be due to the depletion in maternal syndrome as a result of having births that is too close, and due to competition for household resources often characterize with short birth intervals.

The study also identified that access to improved toilet facilities as significant factor to the risk of infant mortality in rural Nigeria. It was found that the risks of infant mortality were significantly lower if children are raised in households that had access to improve toilet facilities. This is in agreement with Akinyemi, (2013). Since access to improved toilet facilities is directly related to socio-economic status, it implies that socioeconomic status is also a factor affecting infant mortality, Osita and others (2015).

The study also established a significant association between region and infant mortality. As has been previously established (Antai, 2011) and (Adedini and others, 2015), this study observed that region where children were born or raised has a great influence on the risks of death at infancy as children residence in the northern region was at higher risk of infant mortality compared with children residence in southern region. The North-east and North-west has the highest risk of infant mortality while has the lowest risk of death at infancy. This also was consistent with Abimbola, and others (2012) which show that North-west region had the highest under-five mortality rate of 200.9 deaths per 1000 births, followed by North-east region with 195.8 deaths per 1000 births. The reasons for these disparities in infant across regions in rural Nigeria are diverse. For instance, North-east and North-west regions are regions where children were mostly of higher order birth - i.e. fifth order or higher, mothers were mostly uneducated, mainly

unemployed and in poor households, and were mostly teenagers at the time of their first birth (Adedini, et al., 2015).

Children whose mother had secondary or higher education had lower risk of death at childhood than children of mother with no education in rural Nigeria. This agree with the work of the following researchers, (Osita, 2015; Akinyemi et al, 2013; Antai, 2011; Uthman, 2008; Whitworth & Stephenson, 2002. An explanation for this could be that mothers with higher education could alter her approach to such practices as poor health-seeking behaviour, and frequency of births. Since education is directly related to wealth index, it implies that high educated mothers would have the resources to take care of the health and social needs of their children, which in turn increase chance of child survival. (Whitworth and Stephenson, 2002).

In conclusion, the study found that both bio-demographic and socioeconomic variables are important determinants to infant mortality in rural Nigeria. Male children had higher infant mortality risk than female children. Infant mortality is increased for children of short birth interval.

Increase in maternal age at child birth increase the risk of infant mortality. Children of literate mothers had lower risk of infant mortality. Other factors identified that significantly associated with infant mortality in rural Nigeria are mother region of residence and unimproved toilet facilities.

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REFERENCES
- UNICEF. 2012. Report on child deaths
- UNICEF. 2014. Report on child deaths.
- Cai, L. C. 2006. Rural-Urban Differentials of Premature Mortality Burden in South-West China *International Journal for Equity in Health.* 5: 13
- Wang, L. 2003. Determinants of child mortality in LDCs: Empirical findings from demographic and health surveys. *Journal of Health Policy* 65: 277-299.
- Van-de, P. E., O'Donnell, O. and Van, D. E. 2009. What explains the rural-urban gap in infant mortality: household or community characteristics? *Demography.* 46.4: 827-850.
- Akinyemi, J. O., Bamgboye, E. A. and Ayeni, O. 2015.Trends in neonatal mortality in Nigeria and effects of bio-demographic and maternal characteristics. *BMC Pediatrics.* 15: 36.
- Antai, D. and Moradi, T. 2010. Urban Area Disadvantage and Under-5 Mortality in Nigeria: The Effect of Rapid Urbanization. *Environ Health Perspect*, 118: 6.
- Odimegwu, C. O. 2002. Determinants of Breast-Feeding Status in Eastern Nigeria. *Journal of African Population Studies.* 17.1: 69-82.
- Adedini S. A., Clifford, O., Eunice, N. S. I., Dorothy, N. O. and Latifat, I. 2015. Regional variations in infant and child mortality in nigeria : A multi-level analysis. *Journal Biosoc. Sci.* 47: 165-187.
- Abimbola, O., Adepoju, A. O. and Falusi, A. O. 2012. Determinants of Child Mortality in Rural Nigeria. *World Rural Observations.* 4.2: 38-45.
- Abimbola O. A. (2015). Differential Pattern in Child Mortality Rate in Rural Nigeria. *Annua Research& Review in Biology* 7.5: 309-317.
- National Population Commission & ICF Macro. (2014). Nigeria Demographic and Health Survey 2013 Report Abuja, Nigeria.
- Cleves, M. A., Gould, W. W., & Gutierrez, R. G. 2004. *An introduction to survival analysis using Stata*. College Station, TX: Stata Corporation
- Blossfeld, H.-P., & Rowher, G. (2002). Techniques of event history modelling: New approaches to causal analysis. London, England: Lawrence Erlbaum Associate.
- Rasugu, D. W. 2007. Determinants of infant and child mortality in Kenya: an

analysis controlling for frailty effects. *Population Research and Policy Review*, 26.3: 299-321.

- Justine, B. N., Henry, G. M, and Thomas N. O. A. 2015. Understanding the determinants of under five child mortality in Uganda including the estimation of unobserved household and community effects using both frequentist and Bayesian survival analysis approaches. *BMC Public Health.* 15:1003.
- Damodar, S., Saritha, N., Lucky, S., Gulati, B. K. and Arvind, P. 2015. Levels, trends & predictors of infant & child mortality among Scheduled Tribes in rural India. *Indian J Med Res*. 141: 709-719.
- Osita K. Ezeh, Kingsley E. Agho, Michael J. D., John J.H. and Andrew Nicolas. 2015. Risk factors for postneonatal, infant, child and under-5 mortality in Nigeria: a pooled cross-sectional analysis. *BMC OPEN* 5:e006779. doi:10.1136/bmjopen-2014-006779.
- Uthman, O. A. 2008. Environmental Factors, Neighbourhood Deprivation, and Under-Five Mortality In Nigeria: An Exploratory Spatial Data Analysis Internet. *Journal of Pediatrics and Neonatology*. 9.1: 1-10.
- Heiko, B., Olaf, M., Albrecht, J., Adjima, G., Gisela, K. and Bocar, K. 2004. Risk factors of infant and child mortality in rural Burkina Faso. *Bulletin of the World Health organization*. 82: 265-273.
- Akinyemi, J. O., Bamgboye, E. A. and Ayeni O. 2013. New trends in under-five mortality determinants and their effects on child survival in Nigeria : A review of childhood mortality data from 1990-2008; *African Population Studies*. 27.1: 25-42.
- Whitworth, A. and Stephenson, R. 2002. Birth spacing, sibling rivalry and child mortality in India. *Social Science & Medicine* 55: 2107-2119.
- Antai, D. 2011. Regional inequalities in under-5 mortality in Nigeria: a population-based analysis of individual- and community-level determinants. *Population Health Metrics* 9.6: 1-27.

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