

Environmental Factors as Predictors of Childhood Mortality Experience in Nigeria

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Abstract

Child Mortality (CM) remains a problem in Nigeria. Despite the high prevalence of under-five mortality in Nigeria, the role of environmental factors as predictors of U5 mortality has not been adequately explored. We explored factors influencing CM in Nigeria against the backdrop of limited research on the survival chances of under-five children (UFC). This cross-sectional study used the 2013 Nigerian Demographic and Health Survey. The *survey* was a nationally representative sample of females of reproductive age (15-49 years). A total n=31,828 births were reported among the 38,522 participants within five years preceding the survey among which 2879 died. We censored children who were alive at the day of survey. Data were analysed using descriptive statistics, Chi-square and Cox-Proportional hazard models ($\alpha=.05$). Mean age of the women was 29.5 ± 7.0 years and 65% were living in the rural areas, 9.0% of UFC died before attaining age five. The hazard of child mortality was 28% higher among children who had no access to safe water (aHR=1.277, 95% CI:1.174-1.390) and 31% higher for no access to improved toilet facilities (aHR=1.312, 95% CI: 1.205-1.429). Children of mothers with no education were about 33%times likely to die before age 5 than children whose mothers had secondary education (aHR=1.327, 95% CI:1.065-1.653). The richer the household from which a child comes, the lower the likelihood of death before age 5. The hazard of child mortality was significantly higher among those who lived in houses made of unimproved roofs and walls, used unimproved cooking fuel, used mosquito nets regularly and shared toilet facilities. Childhood mortality is still high in Nigeria and children from poor homes in rural areas, with limited access to improved sanitation, housing materials and safe water were the most affected. Child health programming should focus on infrastructural development as a tool of improving the living conditions of under-five children in Nigeria.

Résumé

La mortalité infantile (MI) reste un problème au Nigéria. Malgré la forte prévalence de la mortalité de moins de cinq ans au Nigéria, le rôle des facteurs concernant l'environnement en tant que facteurs prédictifs de la mortalité chez les enfants de moins de 5 ans (EMC) n'a pas été suffisamment étudié. Nous avons étudié les facteurs influençant MI au Nigéria dans le contexte de la recherche limitée sur les chances de survie des enfants de moins de cinq ans (EMC). Cette étude transversale

a utilisé l'enquête démographique et de santé nigériane de 2013. L'enquête était un échantillon national représentatif de femmes en âge de procréer (15-49 ans). Au total, n = 31 828 naissances ont été signalées parmi les 38 522 participants au cours des cinq années précédant l'enquête, parmi lesquels 2879 sont décédés. Nous avons censuré les enfants vivants le jour de l'enquête. Les données ont été analysées en utilisant des statistiques descriptives, des modèles de risque Chi-carré et Cox-Proportionnel ($\alpha = 0,05$). L'âge moyen des femmes était de $29,5 \pm 7,0$ ans et 65% vivaient dans des zones rurales, 9,0% de l'EMC étaient décédées avant l'âge de cinq ans. Le danger des enfants de la mortalité était de 28% plus élevé chez les enfants qui n'avaient pas accès à l'eau potable (AHR = 1,277, IC à 95%: 1174-1390) et 31% de plus sans un meilleur accès aux installations sanitaires (AHR = 1,312, IC à 95% : 1.205-1.429). Les enfants de mères qui ne sont pas lettrées étaient environ 33% susceptibles de mourir avant l'âge de 5 ans que les enfants dont les mères avaient une éducation secondaire (aHR = 1,327, IC à 95%: 1,065-1,653). Le risque de mortalité infantile était significativement plus élevé chez ceux qui vivaient dans des maisons construites avec des toits et des murs non améliorés, qui utilisaient des combustibles de cuisson non améliorés, utilisaient régulièrement des moustiquaires et des toilettes communes. La mortalité infantile est encore élevée au Nigéria et les enfants des foyers pauvres des zones rurales ayant un accès limité à des installations sanitaires améliorées, des matériaux de logement et de l'eau salubre sont les plus touchés. Le program en matière de santé infantile devrait être axée sur le développement des infrastructures en tant qu'outil d'amélioration des conditions de vie des enfants de moins de cinq ans au Nigéria.

Introduction

Child Mortality (CM) remains a problem in the developing countries. Despite high rate of under-five mortality in Nigeria, child health and living conditions are often neglected as a result of lackadaisical stance of the government to the health of its citizens. Child survival in any nation can be affected by serious environmental problems that arise in the people's environment. Factors such as contaminated water, inadequate sanitation, smoky cooking fuels and infestation by insects can contribute to childhood mortality. Children, however, constitute one of the groups that are more vulnerable to health hazards that emanate from all these environmental factors. According to UNICEF (2010), approximately 8.1 million children under the age of five in the world died annually in 2009. Out of the reported child mortality in the world, not less than three million of them occur due to environmental related diseases (WHO, 2007). This has led both

national governments and international organizations to commit efforts towards combating high child mortality in countries with high level of mortality.

Child mortality has reduced worldwide for the past three decades due to various efforts put in place. However, despite these efforts toward improving child health, the decline in child mortality in sub-Saharan Africa has been slower. According to United Nations (2011) and WHO (2014), out of the twenty countries with the highest child mortality in the world, nineteen of them are in sub-Saharan Africa, while Nigeria is identified as one of the high child mortality countries world-wide (UNICEF, 2011). In Nigeria, child mortality only declined from 199 per 1000 live births in 1990 to 128 per thousand live births in 2013 (NPC [Nigeria] and ICF Macro, 2014). Considering the regional distribution of child mortality in the country, the rate varies from 90 per 1000 live-births in the South-West to 185 per 1000 live-births in the North-West (NPC [Nigeria]

and ICF Macro, 2014).

Compared with countries with high mortality, child mortality is higher in Nigeria. The two-third reduction in child mortality between 1990 and 2015 advocated by the Millennium Development Goals (MDGs) was unachievable. Therefore, in order to meet the Sustainable Development Goal of reducing child mortality, much is needed to be done, and this will include investigating the various factors that are militating against child survival in the country.

This paper, therefore, determined how mortality of children under the age of five in Nigeria is related to the household environmental characteristics such as place of delivery, source of drinking water, sanitation facility, as well as access to good housing materials, and other socio-demographic characteristics of the children so that drastic steps that will enhance child survival can be undertaken. According to available relevant literatures, several factors have been identified with high child mortality in Nigeria and other parts of the world. For instance, in a study by Titilayo and his colleagues, factors such as maternal, demographic, and socioeconomic factors were found to be important determinants of childhood mortality in developing countries (Titilayo *et al.*, 2009). Several researchers have also linked childhood mortality with health conditions of the parents, most especially of the mother (Houle, Clark, Kahn, Tollman & Yamin, 2015; Katherine & Carolyn, 2017).

Household environmental factors such as the building construction materials, sources of water and types of toilet facilities, as well as cooking facilities have also been identified as risks factors of child mortality. A study in Nigeria by Adedini (2015) identified maternal factors and household environment conditions as some of the factors affecting childhood mortality. Another study by United Nations (2011) identified unsafe water, sanitation and hygiene, indoor smoke from solid fuels among the 10 leading causes of deaths in high-mortality developing countries. An estimate by World Bank also has it that environmental risk factors are responsible for about one-fifth of the total burden of disease in low income countries (World Bank, 2001). In a similar study, WHO

(2014) reported that about 60% of the infections killing children under the age of five are related to environmental conditions, most especially inadequate sanitation and contaminated water. Also, of relevance to health status of children is the hygiene practices of their mothers.

Although literatures have extensively linked social and economic conditions with children health status, poor data availability has limited investigation of the effects of environmental factors at the household level in most parts of the world (WHO, 2016).

Potential environmental health risks have been categorized into two: the traditional hazard related to poverty and lack of development, such as waste disposal, vector borne diseases, inadequate sanitation, air pollution (indoor) and lack of safe water while the second emanated from the modern day hazards including rural air pollution and exposure to agro industrial chemical and wastes, caused by development that lacks environmental safeguards (WHO, 2016). We considered the first category in this study. To unravel the factors militating against the survival chances of under-five children in Nigeria, we explored effect of maternal environmental conditions on child mortality against the backdrop of limited research in this regard.

Materials and Methods

Study Area

The study was conducted in Nigeria, the most populous country in Africa. Nigeria has a young population and the life expectancy is low and lower than the figure for sub-Saharan Africa (WHO, 2014). Nigeria has a total population of 140,431,790, of which 17.1% of the total population constitutes children below the age of five during the last 2006 census with annual population growth rate of 3.2% (PRB, 2013). In Nigeria, the current total fertility rate is 5.5 (NPC [Nigeria] & ICF International, 2014), a reduction from the figure obtained in 1990. Under-five mortality in the country is put at 128 deaths per 1000 live births. Although one can say that Nigeria is still at the first stage of

demographic transition, the country is predominantly rural and the literacy level is low.

Sample and Sampling

This study is an analytic and used quantitative secondary data from the Nigeria Demographic and Health Survey (NDHS) that was undertaken in 2013. The data was a nationally representative sample in 904 clusters (372 clusters in the urban and 532 clusters in the rural areas). The data set contains information on all women aged 15 to 49 years from 40,680 households. Of the occupied households, 38,522 were successfully interviewed and a total weighted sample of 31,828 births were reported within five years preceding the survey among the women. The NDHS provides information on fertility, mortality, health issues, socio-economic and environmental conditions of the respondents. The 2013 NDHS particularly asked a number of questions about the household environmental conditions, including: the source of drinking water, type of sanitation facility, type of flooring, walls, and roof, and number of rooms in the dwelling etc.

Description of study variables

The outcome variable in this study was under-five mortality while the key explanatory variables were environmental factors. The outcome variable is dichotomous (1 if child is alive and 0 if child is dead). The explanatory variables examined in this study, therefore, include children's age, mothers' age at birth of the children, educational attainment, religion of mothers, place of residence (rural or urban), employment status, family type, region of residence, wealth quintile, birthweight, place of delivery, as well as environmental factors such as wall materials (Unimproved: No wall, Cane/Palm/Trunks/ Dirt, Bamboo/Stone with Mud, others and Improved Cement, stone with lime/cement, cement blocks and bricks); floor materials (Improved: cement, ceramic tiles, vinyl asphalt strips, parquet and polished wood; unimproved: earth, sand, dung, rudimentary, wood planks, palm, bamboo, and others) and roof materials (Improved: Cement and roofing shingles and Unimproved: no roof, thatch/palm

leaf, sod, rudimentary, rustic mat, palm/bamboo, wood planks, cardboard, wood, and others) as used in Adebawale (2017) and NPC & ICF(2014). Other sources of drinking water include (Improved: piped into dwelling/yard/plot, public tap/standpipe, tube-well or borehole, protected well and spring, rain water, and bottle water, while others are unimproved. Toilet types (Improved: "flush/pour flush to piped sewer system", "flush/pour flush to septic tank", "flush/pour flush to pit latrine", "ventilated improved pit (VIP) latrine", "pit latrine with slab or compost toilet" while other types of toilet facilities were categorized as non-improved) and disposal of stools (Improved: Toilet while unimproved consists of Garbage, Buried and Not Disposed) and other hygiene practices; cooking fuel (unclean/biomass, clean fuel). The groupings of the environmental characteristics were as described in the 2013 NDHS (NPC & ICF, 2014) and the 2010 WHO and UNICEF document on progress on sanitation and drinking water, as used in Morakinyo and Fagbamigbe (2017).

Data analyses

This study used univariate, bivariate and multivariate data analyses. Frequency was used to describe the data and at bivariate level of analysis, Chi-square model was used to examine the association between childhood mortality experience for the index under five children and the independent variables. First, we performed bivariate Cox regression. All significant factors at $p=0.25$ were candidates for the multivariate analysis. At the multivariate level, Cox regression model was performed to establish the influence of environmental factors on the risk of child mortality, amidst other variables like age, educational level, religion, place of residence etc. In the Cox regression, the number of months a child has lived was used as response to the time variable while the living status of the children was censored "1" for alive and "0" for dead.

In the multivariate analysis, two models were evaluated. Model I (unsaturated model) consists of only the environmental factors and U5 mortality while Model II (the saturated model)

has the environmental factors in addition to socio-demographic covariates so as to see if the observed relationship between the environmental factors and U5 mortality remained significant or not in the presence of these confounders.

The data was weighted using appropriate weighting mechanism described in NPC & ICF (2014) so as to correct any imbalance that arose from either under-sampling or over-sampling. STATA statistical package, Version 20.0 was used for data analysis and significance set at 5%.

Results

Child Mortality by Children's Backgrounds Characteristics

The distribution of child mortality by background characteristics is shown in Table 1. The distribution of births in the study area revealed that, out of the 31,828 of the children born by the respondents in five years preceding the survey, about 2,879 of the children died before attaining the age of five. Therefore, the overall child mortality was 9.0%. Among the children that died, 40.8% died during infancy, 33.8% between 28 days and one year, while 25.4% of them died between one year and before attaining five years of age. Male children (9.6%) were found to have excess mortality over female children (8.4%). The distribution of child mortality among different age groups of mothers further revealed that women of reproductive age in their middle age (15-24 years) reported lower child mortality of 8.4%, when compared with women in their early and later ages of their reproductive life which reported 9.6% and 9.8% respectively. Child mortality decreased from 10.9% among women with no education to 4.9% among women with higher education in the study area. According to the working status of the mothers, child mortality was a little bit higher

among mothers that are not currently working (8.9%) when compared with mothers that are currently working (9.4%) as shown in Table 1.

The distribution of respondents according to their place of residence revealed that women living in urban areas had lower child mortality (6.5%) than women residing in rural areas (10.4%). The distribution of child mortality by family type revealed that women from monogamous family recorded the lowest childhood mortality when compared with their counterparts in single parent and polygamous families which reported childhood mortality of 10.1% and 10.6% respectively.

Among different tribes in the country, women from Yoruba tribe had lowest child mortality (6.5%), while child mortality was higher among Hausa/Fulani women (10.9%). Those from Igbo/Ibibio reported 8.2%, while 7.8% of women from other tribes reported child mortality. Among different religious groups in the country, those practicing Islam reported highest mortality (10.0%), followed by the Traditionalists (9.4%), while child mortality among Christians constitutes 7.5%.

Child mortality among the respondents decreased as their wealth increased from 11.5% among the poorest women to 5.0% among the richest. Respondents' wealth index was found to significantly affect child mortality. In addition, the distribution of child mortality by number of births in the last five years revealed that child mortality increases along with the number of births; from 7.6% among women with one or two births to 17.9% among women with three or four births and to 33.8% among women with five or more births. Similarly, child mortality also increased with the number of children ever born from 7.4% among women with one or two births to 10.9% among women with five or more births.

Table 1: Distribution of Child Mortality by Background Characteristics

Categories	Proportion of U5 deaths n(%)	Total number of Children	X ² p-value
Age of Mothers			
15-24	755 (9.63)	7,834	*0.002
25-34	1,331 (8.39)	15,866	
35—49	793 (9.75)	8,128	
Mother's Educational level			
None	1,712 (10.93)	15,656	*<0.001
Primary	564 (9.20)	6,127	
Secondary	514 (6.26)	8,211	
Higher	90 (4.88)	1,834	
Husband's Educational level			
None	1360 (11.03)	12,334	*<0.001
Primary	559 (9.50)	5,884	
Secondary	669 (7.40)	9,035	
Higher	214 (5.68)	3,767	
Working Status			
Not Working	924 (9.40)	9,823	0.218
Currently Working	1,947 (8.90)	21,864	
Family Type			
Single-Parent	135 (10.1)	1,337	*<0.001
Monogamous	1,680 (8.22)	20,426	
Polygamous	1,044 (10.6)	9,851	
Place of Residence			
Rural	723 (6.50)	21006	*<0.001
Urban	2,156 (10.41)	10822	
Ethnicity			
Yoruba	228 (6.47)	3,527	*<0.001
Hausa/Fulani	1,507 (10.9)	13,826	
Igbo/Ibibio	293 (8.17)	3,589	
Others	850 (7.81)	10,887	
Religion			
Christians	868 (7.45)	11,650	*<0.001
Islam	1964 (9.98)	19,679	
Traditionalists	28 (9.39)	300	
Wealth Index			
Poorest	859 (11.46)	7,496	*<0.001
Poorer	872 (11.85)	7,355	
Middle	468 (7.79)	6,001	
Richer	413 (7.30)	5,656	
Richest	267 (5.02)	5,320	
Number of Births in the Last Five Years			
1 or 2 Births	2,070 (7.57)	27356	*<0.001
3 or 4 Births	792 (17.91)	4,423	
5 births+	16 (33.79)	49	
Children Ever Born			
1 or 2 Births	678 (7.4)	9,164	*<0.001
3 or 4 Births	900 (8.16)	9,800	
5 births+	1,401 (10.89)	12864	
Sex of Child			
Male	1,548 (9.64)	15946	*0.001
Female	1331 (8.44)	15882	
Total	2879(9.04)	31828	

*Significant at 5%

Child Mortality and Environmental Characteristics

The distribution of childhood mortality by environmental characteristics is presented in Table 2. Distribution of child mortality by various sources of water indicated that those drinking from improved sources had 8.16% child mortality which was significantly higher than among those who drank from unimproved sources (10.4%). Children who usually sleep under mosquito nets had lower child mortality (8.4%) when compared with those that did not use it (9.4%).

On the use of toilet facilities, those women that used improved toilets had lower child mortality (7.9%) when compared with those that used unimproved toilets (10.4%). In addition, those disposing their stool through toilet had

higher child mortality than those disposing through other means. Also, respondents that shared toilet facilities with other people reported higher child mortality (9.8%) than those that do not share toilet facilities (7.0%). Further analysis revealed that toilet facilities and the way stools are disposed significantly affected child mortality in the country.

Housing materials are another factor that can affect human survival. In this study, child mortality among those that lived in houses made of improved wall and floor materials were 7.0% and 8.3% respectively compared with 11.0% and 11.1% among those that used unimproved wall and reef materials respectively. Both roof and wall materials were found to have significant effects on child mortality among women in the study area.

Table 2: Distribution of Child Mortality by Health Related and Environmental Characteristics

Characteristics	Proportion Dead n(%)	Total Number of Children	X ² p-value
Source of Water			
<i>Improved</i>	1561 (8.16)	19130	*<0.001
<i>Unimproved</i>	1898 (10.35)	12415	
Mosquito Nets			
Used Regularly	916 (8.38)	11924	*0.008
Not Used Regularly	1963 (9.40)	20883	
Toilet Facilities Type			
<i>Improved</i>	1249 (7.85)	15911	*<0.001
<i>Unimproved</i>	1601 (10.35)	15665	
Toilet Facilities Shared			
Shared	522 (7.02)	7436	*<0.001
Not shared	1460 (9.76)	14959	
Stool Disposal			
<i>Improved</i>	1170 (6.26)	18690	*0.003
<i>Unimproved</i>	654 (6.21)	10531	
Wall Materials			
<i>Improved</i>	1079 (6.98)	15458	*0.001
<i>Unimproved</i>	1762 (10.98)	16047	
Roof Materials			
<i>Improved</i>	1898 (8.26)	15458	*<0.001
<i>Unimproved</i>	950 (11.07)	8582	
Cooking Fuel			
<i>Improved</i>	1762 (10.98)	16047	*<0.001
<i>Unimproved</i>	1079 (6.98)	15458	
<i>Total</i>	2879 (9.04)	31828	

*Significant at 5%

Source: Gbadebo, *et al.*, (2018)

Factors influencing Child Mortality

At bivariate level, the Cox regression showed significant lower hazard of child mortality among children whose mothers are, aged 35-49, teenagers

or young adults, monogamous family, urban dwellers, in richer wealth quintiles, with fewer number of children ever born and the child being a female. With regard to the environmental

Table 3: Adjusted determinants of child mortality

Characteristics	Model I aHR (95% CI)	p-value	Model II aHR(95% CI)	p-value
Mosquito Nets				
Not Used Regularly	RC		RC	
Used Regularly	1.132 (1.035 - 1.239)	*0.007	1.030 (0.917 -1.156)	0.618
Wall Materials				
Unimproved	RC		RC	
Improved	0.630 (0.576 - 0.688)	*<0.001	1.991 (0.846 - 1.162)	0.915
Roof Materials				
Unimproved	RC		RC	
Improved	0.739 (0.677 - 0.807)	*<0.001	1.005 (0.872 - 1.157)	0.948
Source of Water				
Unimproved	1.277 (1.174 - 1.390)	*<0.001	0.991 (0.882 - 1.114)	0.882
Improved	RC		RC	
Cooking Fuel				
Unimproved	1.784 (1.548 - 2.057)	*<0.001	0.827 (0.629 - 1.088)	0.175
Improved	RC		RC	
Toilet Facilities Shared				
Shared	RC		RC	
Not Shared	0.715 (0.636 - 0.803)	*<0.001	0.919 (0.805 - 1.050)	0.214
Toilet Facilities Type				
Unimproved	1.312 (1.205 - 1.429)	*<0.001	1.088 (0.970 - 1.220)	0.151
Improved	RC		RC	
Age of Mothers				
25-34			RC	-
15-24			1.437 (1.229-1.680)	*<0.001
35-49			0.912 (0.796-1.046)	0.190
Mother's Educational Level				
Secondary			RC	-
None			1.327 (1.065-1.653)	*0.012
Primary			1.185 (0.964 -1.457)	0.107
Higher			1.007 (0.723-1.403)	0.967
Family Type				
Polygamous			RC	
Single-Parent			1.176 (0.897 – 1.541)	0.240
Monogamous			0.897 (0.797 – 1.011)	0.074
Place of Residence				
Urban			RC	
Rural			1.215 (1.041 -1.419)	*0.014
Religion				
Traditionalists			RC	
Christianity			1.841(0 .729 – 4.653)	0.197
Islam			1.692 (0.674 -4.245)	0.262
Wealth Index				
Poorer			RC	
Poorest			0.926 (0.780 -1.071)	0.300
Middle			0.718 (0.598 -0.862)	*<0.001
Richer			0.734 (0.581- 0.926)	*0.010
Richest			0.556 (0.393 -0.788)	*0.001
Number of Children Ever Born				
1 or 2 Births			RC	
3 or 4 Births			1.008 (0.855 - 1.187)	0.928
5 births+			1.448 (1.198 - 1.751)	*< 0.001
Sex of Child				
Male			RC	
Female			0.893 (0.804- 0.992)	*0.034

RC: Reference Category aHR adjusted Hazard Ratio *Significant at 5%

Source: Gbadebo *et al.*, (2018)

characteristics, hazard of child mortality were significantly higher among those who drank from unimproved sources of water, used unimproved toilets, lived in houses made of unimproved roofs and walls, used mosquito nets regularly and shared toilet facilities. These are not shown in the Tables.

Table 3 presents the adjusted effects of the socio-demographic and environmental factors on child mortality. In Model I, the hazard of child mortality was lower among children from houses with improved wall and roof materials, who had access to safe water, improved cooking fuel, improved toilet facilities and who did not share toilet facilities and those who did not use mosquito nets regularly. For instance, the hazard of child mortality was 37% times lower among children from houses with improved wall materials compared to those from unimproved wall materials (aHR=0.630, 95% CI: 0.576-0.688). Also, the hazard of child mortality was 28% higher among children who had no access to safe water (aHR=1.277, 95% CI:1.174-1.390) and no access to improved toilet facilities (aHR=1.312, 95% CI: 1.205-1.429).

However, the outcome of the multiple Cox regression for Model II showed that only the mothers' age, mothers' educational attainment, wealth index, residence, number of children ever born, and sex of children were the only significant characteristics at the presence of other confounders. None of the environmental, sanitation and housing factors considered was significant. Female children were found to be 11% times less likely to die compared with their male counterparts (aHR=0.893, 95% CI: 0.804-0.992). Children of mothers aged 15-24 had 44% higher hazard of mortality before age five than those whose mothers were aged 25-34 years (aHR=1.437, 95% CI:1.229-1.680).

Children of mothers with no education were about 33% times likely to die before age 5 than children whose mothers had secondary education (aHR=1.327, 95% CI:1.065-1.653). Children from rural areas were 20% times more likely to die before attaining age 5 than children from urban areas (aHR=1.215, 95% CI:1.041-1.419). The richer the household from which a child comes, the lower the likelihood of death before age 5. In

particular, children from households in the richest wealth quintile were about 45% less likely to make their fifth birthday compared to those from poorest wealth quintile (aHR=0.556, 95%

Discussion

This study examined the position of environmental factors and other socio-demographic factors as predictors of childhood mortality in Nigeria. In this study, childhood mortality was found to be associated with mothers' age, education, employment status, sex of child, family type and location of residence. Health and environmental factors such as toilet facility, source of drinking water, mosquito net usage, house roof and wall materials, cooking fuel were also associated with child mortality.

The effect of sources of water is significant to child mortality in the study area with children who had access to water from improved sources such as taps, pipes and boreholes having higher likelihood of surviving beyond five years. Similarly, a child brought up in more hygienic condition (having good toilet facility and efficient refuse and excreta disposal) tend to survive child mortality than those who do not. In both rural and urban areas, access to clean water and improved sanitation are some of the most important factors in human health. Over one billion people living in developing world live without potable water, while some three million lack basic sanitation (UNICEF, 2011, WHO, 2016). The indirect link between poor water system and sanitation and mortality makes relationship between the two to be unclear, Adebowale, *et al.*, (2017), however stated that safe water is not sufficient in itself to reduce child mortality unless sanitation and hygienic practices are equally good. Therefore, child health programming should focus on improving access to potable water and good sanitation.

Environmental health factors play important role in child survival even when controlling for socio-economic variation (Adedini, 2015). Although difficult to decipher in empirical analyses, Rainham and McDowell (2005) found survival like all population health outcomes, are clearly linked to the environment. It may be difficult to ascertain the direct effect of

environmental factors on health partly due to innumerable contamination routes and over shadow of environmental factors by social and environmental factors after they have been controlled for. Therefore, due to the inherent difficulty in measuring the effects of the environmental factors, well-defined and robust environmental health indicators are not widely available (Franz & Roy, 2006).

Child mortality decreased as the level of education attained by mothers' education increased. This finding is consistent with the report of study carried out by Adedini *et al* (2011). Parent's education significantly affects child mortality, this in agreement with report of Measure DHS (1997) that there was strong evidence concerning the positive impact of mother's education on child's health and survival. It is clear that there is generally a drop in infant and child mortality when the level of mother's education increases. There are strong inverse relationship between mother's education and child mortality. Child mortality reduced with higher education of respondents' partner, but mother's education has a greater influence on child survival in Bangladesh than that of father's education (Adedini *et al*, 2015; WHO, 2016).

A working parent will be able to provide for both material and health needs of his/her children; this will contribute to the higher chance of the child surviving as identified in Ronsmans *et al.* (2010), that mother-working status exerts a significant negative influence on child mortality. Despite the fact that a negative relationship was found between the working status of mothers and child mortality in this study, the effect was not statistically significant. Also, the family type that a woman belongs to also significantly influenced child mortality in the study area.

The usual place of residence of respondents can also influence her health and that of her children. A significant relationship existed between place of residence and child mortality. Children in rural areas had more likelihood of not attaining age five. This was also in consonance with the findings in Measure DHS 1997. This study found that place of delivery has

beneficial effect on child mortality. The risk of child mortality was lower for the children who were born at home and hospital compared to the children born elsewhere.

Although not significant in the saturated model (Model II), the environmental and sanitation factors considered in the current study was significant in the unsaturated model. Good sanitation, improved sources of water as well as improved housing nonetheless contributes to child survival. The insignificance of these factors in the presence of other confounders in the saturated model was most likely due to the influence of wealth index and educational attainment in the model. Generally, children from economically better off households (with wealth index as a proxy) had higher chances of survival than other children. Also, educational attainment has been established in several studies as a weapon of empowerment and wealth creation. Access to improved water sources, improved sanitation system, improved housing materials and health system in general, is contingent on household wealth status as documented by Fagbamigbe *et al.*, (2015). Therefore, the significance of the environmental factors in the full model masked by wealth and educational status.

Conclusion

Childhood mortality is still high in Nigeria and children from poor homes in rural areas, with limited access to improved sanitation, improved housing materials, improved sources of safe water and cooking fuel were the most affected. Child health programming should focus on infrastructural development as a tool of improving the living conditions of under five children in Nigeria.

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Compliance with ethical standards

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Conflict of Interest

The authors declare that they have no conflict of interest

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pp 23-34

