ORIGINAL ARTICLE

AN ASSESSMENT OF THE ENVIRONMENTAL DETERMINANTS OF UNDER-FIVE MORTALITY IN KEBBI STATE, NIGERIA

| Azaki, J.B* | Mundi, R | and | Dakyes, S.P |

Department of Geography and Environmental Management | University of Abuja | Nigeria |

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Abstract

Background: Despite the formulation and implementation of child's health policies and strategic plans over the years, Nigeria is among the countries in Sub-Saharan Africa with high under-five mortality rate. **Objective**: The study investigated the environmental determinants of under-five mortality in Kebbi State, Nigeria. **Methods**: Using multi-stage sampling technique, 625 women aged 15-49 years were selected. Out of 625 structured questionnaires administered to the respondents, 603 were retrieved, giving the response rate of 96.5%. Descriptive statistics such as frequencies and percentages were employed to analyse the demographic and socioeconomic characteristics of the respondents. Cross-tabulation was used to analyse the distribution of under-five mortality experienced by women based on the environmental factors. Logistic regression analysis was applied to determine the environmental factors influencing under-five mortality in the study area. **Results**: The results of the study revealed that 35.7% of women experienced under-five mortality in Kebbi state and cross-tabulation results suggested that the highest under-five deaths occurred among women that do not treat water (66%), while the least (3.3%) among those that use electricity as cooking fuel. The results of the Logistic regression analysis revealed that at P-value <0.05, source of water, frequency of washing water container, water treatment, method of disposing waste water, type of toilet, shared toilet, frequency of washing toilet, method of disposing child's stool, type of cooling appliance, number of persons per room, use of mosquito net, refuse disposal method and type of cooking fuel were found to be the environmental factors significantly associated with under-five mortality in Kebbi state. **Conclusion**: The study therefore concluded that environmental factors are determinants of under-five mortality in the study area. It was therefore recommended that government should provide adequate infrastructure such as potable water, safe toilets, drainage system and refuse disposal facilities for public use.

Keywords: *Environmental determinants, Under-five, Mortality, Kebbi state*

1. INTRODUCTION

Over the years, global progress has been witnessed in under-five mortality rate reduction which has been attributed to the Millennium Development Goals of 2000. For instance, under-five mortality rate globally dropped from 90 deaths per 1,000 live births in 1990 to 48 deaths per 1,000 live births in 2012 [1] Similarly, under-five mortality which was estimated to be 12.6 million in 1990 reduced to 5.3 million in 2018 [2]. Childhood mortality estimates by regions of the world reveal variations with the industrialized nations recording the lowest. For instance, in 2015, Sub-Saharan Africa recorded 85% child mortality, Oceanic (51%), South Asia (33%), South East Asia (27%), North America (24%), Western Asia 23%, Latin America and the Caribbean 17% and Eastern Asia 11% [3].

Although, under-five mortality rate in sub-Saharan Africa has fallen over time from 179 deaths per 1,000 live births in 1990 to 86 in 2015, yet the region faces urgent need to accelerate progress [4] For instance, childhood mortality percentage reduction change in 2015 estimated that of Sub-Saharan Africa to be 52% which was lower than that of Eastern Asia (78%), Latin America (69%) and North America (67%) [3]. About 80% of the under-five deaths still occurred in sub-Sahara Africa and Southern Asia, with six countries accounting for half of the global deaths, namely India, Nigeria, Pakistan, The Democratic Republic of Congo, Ethiopia and China [5]. In 2018, 1 in 13 children in Sub-Saharan Africa die before their fifth birthday, which is 15 times higher than the risk a child faces in Europe, where just 1 in 196 children aged less than five die [6].

In Nigeria, progress has been made in under-five mortality reduction, but not significant enough when compared with some low-income and middle-income countries. For instance, between 1990 and 2000, Nigeria child mortality rate was estimated to be high, while countries like Bangladesh, Ethiopia, Liberia, Malawi, Nepal, United Republic of Tanzania have already lowered their rates by two-third [1]. In 1990, 2003 and 2008, Nigeria under-five mortality rates were 193, 201 and 157 deaths per 1,000 live births respectively; and the rate rose from 128 in 2013 to 132 deaths per 1,000 live births in 2018 [7]. The country's under-five mortality rate estimate in 2019 was 102 deaths per 1,000 live births, which was

*Corresponding author Author

higher than that of Liberia, Niger and Senegal that have made significant progress by cutting their under-five death rates to 60%, 62% and 66% respectively [8]. Nigeria and India in 2018 alone accounted for about a third of children's deaths in the world; placing Nigeria among countries with the highest under-five mortality [6]. Nigeria is one of the countries that implemented Millennium Development Goal (MDG) 4 that targeted under-five mortality reduction by two-thirds between 1990 and 2015. However, the country fell short of the 2015 target of 63.7 deaths per live births by 28.4%, with estimate indicating that Nigeria ought to have saved the lives of at least 400,000 children by 2015 to attain MDG 4 [9]. Despite the progress generally recorded in reducing under-five mortality rates in Nigeria over the years, it is not even among the regions. For instance, in 2017, NorthWest recorded the highest under-five mortality rate of 162 deaths per 1,000 live births, with North Central recording 103%, North East (115), South East (67), South South (59) and South West (67) [10]. Similarly, in 2018, under-five mortality rate was 187 deaths per 1,000 live births in North West Zone, which was higher than that of North Central (95), North East (134), South East (75), South South (73) and South West (62).[7] Urban and rural under-five mortality differentials have been reported in Nigeria, showing more under-fives dying in rural areas. For instance, under-five mortality in urban and rural areas in 2018 was 132 and 92 deaths per 1,000 live births respectively [7].

In response to reduce under-five mortality rates, various child health policies and strategic plans have been initiated in the country. One of such initiatives is the National Child Health Policy of 2006. The policy provides long term direction for protecting and promoting the health of children. One of the objectives of the policy was to reduce the incidence of diseases and mortality, particularly among children [11]. In 2007, to provide a framework to guide the federal, states and local governments' health planning process, National Strategic Health Development Plan was initiated. Within the framework of National Health Policy, National Reproductive Health Policy Strategy was created in 2001 to uphold Primary Health Care (PHC) as the key to health development in Nigeria. Another initiative was the National Routine Immunization Strategic Plan (NRISP), 2013-2015. The main mandate was to embark on expanded program on immunization so that childhood killer diseases could be eradicated through immunization. In 2012, Nigeria government launched Saving One Million Lives. The initiative was aimed at achieving the Millennium Development Goal of reducing child mortality by two thirds before 2015 through expanding primary health services to women and children [1]. Other initiatives targeted at reducing child mortality included Excusive Breast-feeding, Helping Babies Breathe, Kangaroo Mother Care, Making Pregnancies Safer (MPS), Baby Friendly Hospital Initiative (BFHI), Nigeria's Midwives Service Scheme, Safe Motherhood initiative, Roll Back Malaria Initiative (RBM), elimination of Iodine Deficiency Disorder (YDD), Vitamin A Deficiency Control and Integrated management of Childhood Illness (IMCI) [12].

Various studies carried out have found environmental factors to be predictors of childhood mortality. Environmental factors such as accessibility to safe water and adequate sanitation as determinants of childhood mortality in Nigeria were reported [12,14]. Similarly, studies carried out on household environment health hazards and Child Survival in Sub-Sahara Africa, using Demographic and Health Surveys (DHS) conducted between 2003 and 2008 in eight selected Sub-Sahara African countries showed that the high under-five mortality groups are at a relative disadvantage on basic household environment variables that affect hygiene; and in conclusion found Significant relationships between household environment and child survival in sub-Sahara African Countries [15]. Housing materials, household fuel use and under-five mortality was investigated in Nigeria and Ethiopia and significant relationships were established [16, 17, 18, 19]. Household environmental factors such as source of water, toilet type, child's stool disposal method and use of bed net were found in a study to be significantly related to child morbidity in Nigeria [20, 21].

Although, these previuos studies investigated the environmental determinants of child mortality, they were however carried out at national and regional levels. Therefore, there is need for an investigation to be conducted in a geographical unit of the country such as Kebbi state; so that information needed for planning and policy formulation on child mortality would be made available at that level. Besides, to the best of researchers' knowledge, the few documented studies on childhood mortality in Kebbi state such as [22, 23, 24, 25] did not address the environmental determinants of under-five mortality, the knowledge gap this study sought to bridge

2. Theoretical Framework

This study was guided by Mosley and Chen analytical framework. The model came into being in 1984 through an essay titled "An analytical framework for the study of child survival in developing countries". They argued that all social and economic factors do not operate alone, but through what they referred to as proximate determinants to influence child survival or mortality. The major assumption of the model is that in an optimal setting, over 97% of new born infants can be expected to survive through the first five years of life. Reduction in this survival probably in any society is due to the operation of social, economic, biological and environmental factors. As shown in figure 2, maternal factors that may influence child's survival are age, parity, child weight, birth interval, among others. Nutrient deficiency factors include calories intake, proteins, vitamins and minerals. Environmental factors include air pollution, food contamination, fingers

and inmate objects, among others. Health seeking behavior factors are personal preventive measures, seeking medical attention, antenatal attendance and immunization, while injury could be accidental or intentional in a child. According to Mosley and Chen, these factors cause morbidity and if proper medical attention is not given would result to child mortality.[26] The model was therefore applied in this study to investigate the influence of environmental variables (independent variables) on under-five mortality (dependent variable) in Kebbi State.

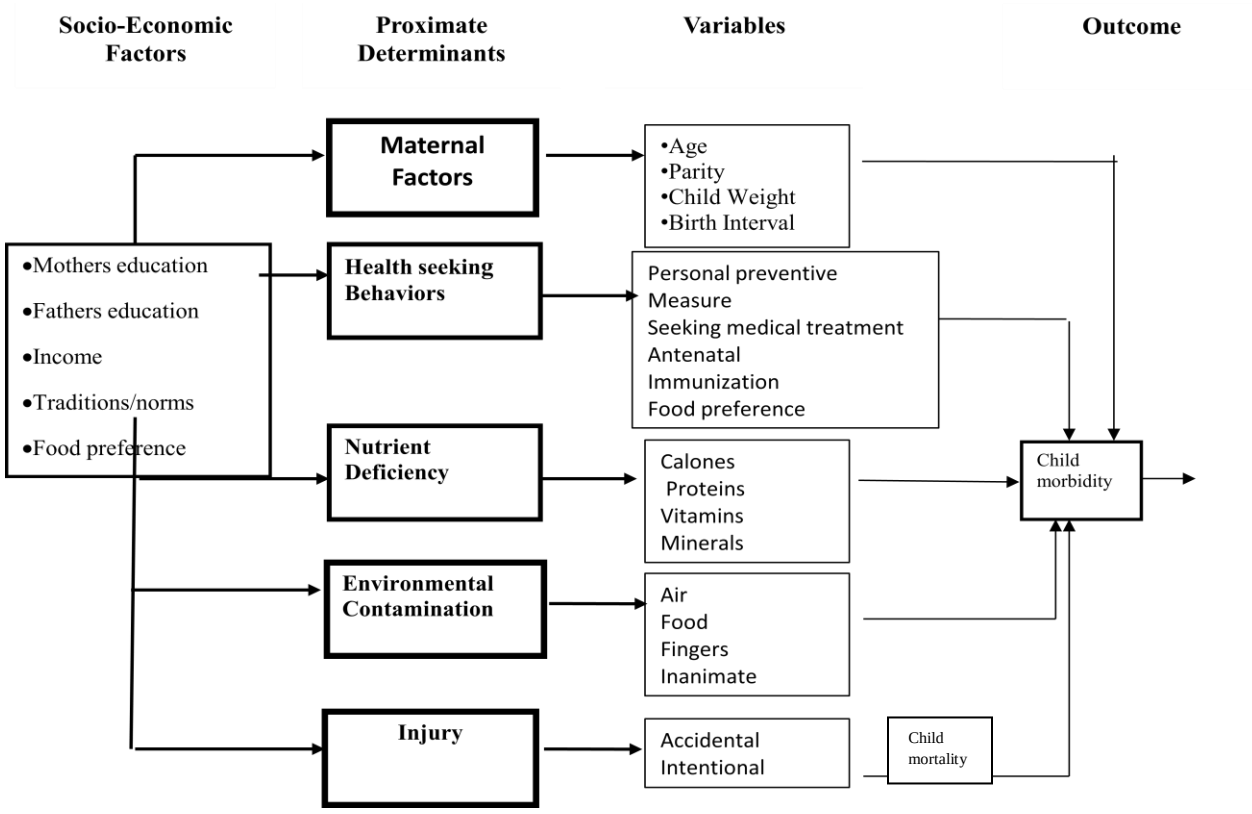

Figure 2: Analytical Framework for the Study of Child Survival. (**Source:** Adapted from Mosley and Chen, 1984).

3. MATERIALS/METHODS

3.1 Study Area

Kebbi State is located between latitude 10^0N and 13^0N and Longitude 3^0 E and 6^0 E. It lies at the extreme North West Corner of Nigeria (Fig 1). The state shares international borders with Benin Republic and Niger Republic in the North and West respectively. In Nigeria, Kebbi State shares borders with Niger State in the south and in the East with Sokoto and Zamfara States. It lies approximately at 700m above sea level, enjoying tropical continental type of climate mainly controlled by two air masses, tropical maritime and tropical continental, blowing from Atlantic and Sahara Desert. The vegetation consists of partly that of northern guinea savannah and the Sudan savannah. In the northern guinea savannah, they are characterized by trees such as locust bean tree; shear butter tree and combretum species. In the northern part of the state, the Sudan savannah consist of open wood land with scattered trees such as acacia and dump palms.

The state has a projected population of 4,440,000 in 2016 [27]. The following tribes exist in the state: Hausas (dominant in Birnin-Kebbi, Argungu and Jega); Fulanis (dominant in Bunza, Dakin Gari and Gwandu); Kambari (dominant in Yauri and Ngaski); Dakarikari (dominant in Zuru, Danko and Sakaba) and Zabarmawa (dominant in Dandi and Illo).

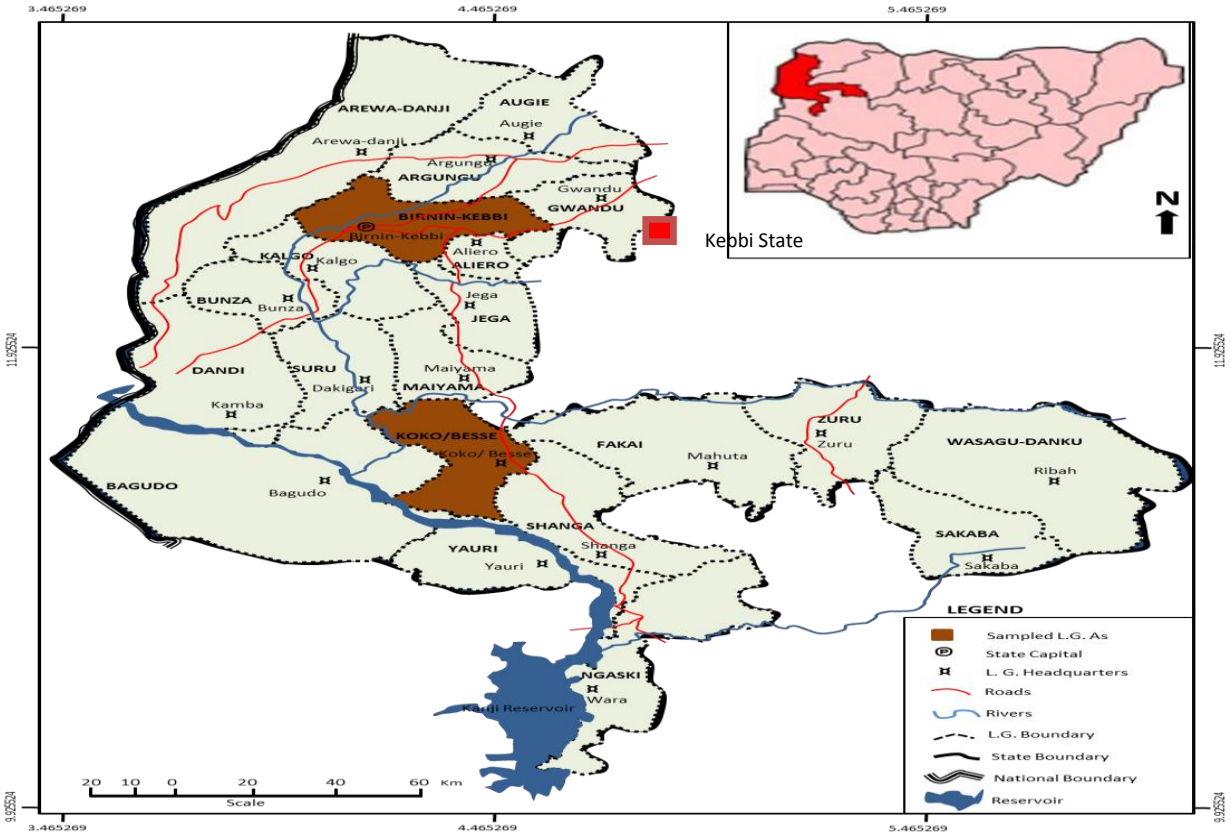

Figure1: Kebbi State showing Koko/Besse and Birnin-Kebbi Local Government Areas. (**Source**: Adapted and modified from OCHAI NIGERIA, 2016. www.unocha.org/nigeria

3.2 Sample Size Selection

The study employed the cross- sectional survey research design. The population of this study included all women aged 15-49 years. The data for the study consisted of primary and secondary sources. The primary data were sourced from structured questionnaire, while the secondary data were sourced from National Population Commission census data, Kebbi State Government publications, text books, journals and internet materials.

To select respondents for the study, multi-stage sampling technique was employed. In the first stage, two (2) Local Government Areas in the state were selected as study areas. Birnin-Kebbi LGA was purposively selected based on its uniqueness as the state capital, and also better disposed in terms of social amenities such as health facilities, educational institutions, government offices, daily markets and transportation system. To ensure that the remaining 20 LGAs were given equal chance of being included in the study, Koko-Besse LGA was selected using table of random numbers. As shown in figure 1, Birnin-Kebbi and Koko-Besse LGAs were finally selected as study areas.

In the second stage, to ensure adequate representation and spatial distribution of sampling nits, 30% of the wards were randomly selected using table of random numbers in each of the LGAs. In the third stage, using the 2006 Census Locality and Enumeration Area List, 30% selection of settlements in each of the wards using table of random numbers was carried out. To determine the sample size for the study, 3.1% Kebbi state population growth rate of 2006 census was used to estimate 141,326 total population of women aged 15-49 years in the two LGAs selected; through which the sample size of 625 was determined using Yamme's formula which is widely used by researchers and has been adjudged to be reliable in determining sample size in a cross-sectional research design survey [29, 30]. The sample size was therefore calculated as shown below.

$$n = \frac{N}{1+N(e)^2}$$

Where: n = Sample size required
N = the population size
e= Margin of error (4 %) at 95 % confidence level.

$$n = \frac{141,326}{1+141,326(0.04)^2}$$

$$= \frac{141,326}{141,327 \times 0.006}$$

$$= \frac{141,326}{226.12} = 625$$

To select respondents, systematic random sampling method, using a sampling interval (SI) of 19 was used to select 625 women from 12,117 households. Out of 625 questionnaires administered to the women, 603 were retrieved and used, giving a response rate of 96.5%. The number of selected wards, settlements, households and the sample size in each LGAs are shown in table 1.

Table1: Number of Selected Households and Sample Size in Each of the selected LGAs

L.G.A	No. of Selected wards	No. of selected settlements	No. of Households in Selected settlements	Sample Size
Birnin-Kebbi	5	21	8,243	368
Koko/Besse	4	12	3,874	257
Total	9	33	12,117	625

Source: Field Survey, 2018

3.3 Data Analysis

In the analysis of data, SPSS 23 environment was used. Descriptive statistics such as frequencies and percentages were employed to analyze the demographic and socio-economic characteristics of the respondents. Cross-tabulation, involving frequencies and percentages was used to analyse the environmental factors and under-five mortality experience. Logistic regression analysis was used to determine the environmental factors associated with under-five mortality in the study area, using < 0.05 as the p-value. Any variable that has a probability value< 0.05 was accepted as a predictor of under-five mortality, while probability value of > 0.05 was rejected.The logistic regression is a predictive analysis which is used to explain the effect of explanatory variables on the dependent variable. It is widely used by researchers because it allows one to say that the presence of a particular factor increases the probability of a given outcome by a specific percentage. In addition, using logistic regression, you can include more than one explanatory variable (dependent) and they can be dichotomous, ordinal or continuous, apart from providing a quantified value for the strength of the association. Assumptions of logistic regression are:

1. The error terms are with a mean of zero and a variance of $\pi(x)[1-\pi(x)]$
2. The conditional means of the regression equation is greater than or equal to 0 and less than or equal to 1
3. The equation model, the log odds do not show relationship among variables as in the case of linear regression. The formula used in logistic regression model is as thus:

$$P = \frac{e^{a+bx}}{1+e^{a+bx}}$$

Where:
P = the probability of an event occurring (Under-five mortality in the case of this study)
e = the base of natural logarithm (2.71828)
a and b = the coefficients of the model
X = the independent variables (environmental factors in the case of this study).

3.4 Ethical considerations

Ethical clearance was gotten from the Ethics Research Committee of Kebbi state Ministry of Health and consent of all the respondents to participate in the study was sought and granted.

4. RESULTS

4.1 Demographic and Socio-economic Characteristics of the Respondents

Table 2 presents the descriptive analysis of the demographic and socio-economic characteristics of the respondents. A total of 603 women aged 15-49 years were interviewed using structured questionnaires. Out of 603 respondents, 215 (35.7%) of them indicated to have experienced under-five deaths within 5 years preceding this survey.

Table 2: Distribution of Demographic and Socio-economic Characteristics of the Respondents. (**Source**: Field Survey, 2018).

Variable Category	Characteristics	Frequency	Percentage
Under-five mortality Experience	Yes	215	35.7
	No	388	64.3
	Total	**603**	**100.0**
Age group (Years)	15 – 20	66	10.9
	21 – 24	143	23.7
	25 – 29	62	10.3
	30 – 34	132	21.7
	35 – 39	129	21.4
	40 – 44	46	7.9
	40 – 49	25	4.1
	TOTAL	**603**	**100.0**
Marital Status	Single	25	4.1
	Married	518	85.9
	Widowed	40	6.6
	Divorced	16	2.7
	Separated	04	0.7
	TOTAL	**603**	**100.0**
Educational Attainment	No Formal Education	238	39.47
	Primary	240	39.80
	Secondary	75	12.44
	OND/NCE	10	1.66
	Degree/HND	32	5.31
	Post Graduate	08	1.32
	TOTAL	**603**	**100.0**
Ethnicity	Hausa	487	80.8
	Igbo	03	0.5
	Yoruba	40	6.6
	Kambari	14	2.3
	Fulfude	16	2.7
	Dakarkari	31	5.1
	Others	12	02
	TOTAL	**603**	**100.0**
Religion	Christianity	78	13
	Islam	524	86.8
	Traditional religion	01	0.2
	Total	**603**	**100.0**
Occupation	Civil servant	11	1.8
	Trading/Business	203	33.7
	farming	08	1.3
	Housewife	365	60.5
	Others	16	2.7
	Total	**603**	**100.0**

Table 2 further revealed that 88 % of the respondents were 15 – 39 years old, while 12% were 40 – 49 years old. Respondents (60.54%) were formally educated, with respondents that have no formal education constituting 39.46 %. The respondents that were married constituted 85.9 %, while 14.1 % were single. The respondents that were housewives constituted 60.5%, while 36.8 % of them were civil servants. The respondents that engaged in trading/business as secondary occupation were 57.38%, while the 41.42 % were farmers, civil servants and housewives.

4.2 Environmental Factors and Under-five Mortality Experience

Table 3 presents the descriptive analysis of under-five mortality experienced by women based on the environmental factors. The women that source water from river/stream recorded 28.4% under five deaths, while those that source water from tap experienced the least under-five mortality (3.7%). Under-five mortality (66 %) was recorded by the respondents that do not treat water, while 34% was experienced by the respondents that treat water. The results also revealed that women that store water in rubber drum/bucket/jary can without cover experienced 49.8% children's death, while low under-five mortality (0.5%) was experienced by respondents that use rubber drum/jerry can with cover. Under-five mortality (42.8%) was recorded by women that wash water storage container weekly, with only 5.1% recorded by those that wash daily. The respondents that dispose waste water into open field experienced 58.2% under-five mortality, while the least (5.6%) was recorded by the women that use open drainage channel to dispose theirs. Under-five mortality

(37.2 %) occurred among women that use open pit without cover as toilet, while those that use water system with cover experienced only 8.4% under-five mortality. The study further revealed that 62.3% under-five mortality was experienced by women that share toilet facility, while 37.7% mortality occurred among women that do not share toilet.

Women that wash toilet weekly experienced 36.7% under-five mortality, while 16.7% under-five mortality was experienced by women that wash toilet daily. Women that dispose child's stool at the backyard experienced the highest under- five mortality of 28.4%, while those that flush child's stool with water experienced the least under-five mortality of 8.4%. Under-five mortality (51.6%) was experienced by women that dump refuse at the backyard, against 11.6% that dump theirs in the stream/ river

Table 3: Distribution of Under-Five Mortality by Environmental Factors.

	Ever lost under-five				
	Yes		**No**		
Variables	No	%	No	%	Total(%)
Source of water					
Uncovered well	56	26	122	31.4	178(29.5)
Covered well	16	7.4	21	5.4	37(6.1)
Manual/Motorized borehole	20	9.3	03	0.8	23(3.8)
Water vendors	27	12.6	100	25.8	127(21.1)
River/stream	61	28.4	120	30.9	181(30)
Tap	08	3.7	02	0.5	10(1.7)
Others	27	12.6	20	5.2	47 (7.8)
Total	**215**	**100**	**388**	**100**	**603(100%)**
Water treatment practice					
Yes	73	34	246	63.4	319(52.9)
No	142	66	142	36.6	284(47.1)
Total	**215**	**100**	**388**	**100**	**603(100)**

	Ever lost under-five				
	Yes		**No**		
Variables	No	%	No	%	Total (%)
Type of water storage container					
Rubber drums without covers	103	47.9	128	33	235(38.9)
Clay pots	65	30.2	97	25	162(26.9)
Metal tanks	12	5.9	36	9.3	51(8.5)
Rubber drums with covers	17	1	76	19.6	98(16.3)
Rubber tanks	09	4.2	20	5.2	21(3.5)
Others	05	4.7	31	7.9	36(5.9)
Total	**215**	**100**	**388**	**100**	**603(100)**
Frequency of washing water container					
Daily	11	5.1	80	20.6	91(15.1)
Twice a week	36	16.7	24	6.2	60(9.9)
Weekly	92	42.8	147	37.9	239(39.3)
Twice a month	16	7.4	67	17.3	83(13.8)
Monthly	60	28	70	18	130(21.6)
Total	**215**	**100**	**338**	**100**	**603(100)**
Method of waste water disposal					
Open drainage channels	12	5.6	69	17.8	81(13.4)
Infiltration pits	13	06	50	12.4	63(10.4)
Open field	125	58.2	154	39.7	279(46.7)
Simple pits	29	13.5	63	16.2	92(15.3)
Others	36	16.7	52	13.4	88(14.6)
Total	**215**	**100**	**388**	**100**	**603(100)**
Type of toilet facility					
Open pit without cover	80	37.2	105	27.	185(30.7)
Open pit with cover	25	11.6	63	16.2	88(14.6)
Water system without cover	38	17.7	61	15.7	99(16.4)

Water system with cover	18	8.4	84	21.4	102(16.9)
Others	54	25.1	75	19.3	129(21.4)
Total	**215**	**100**	**388**	**100**	**603(100)**
Shared toilet facility					
Yes	134	62.3	79	20.4	213(35.3)
No	81	37.7	309	79.6	390(64.7)
Total	**215**	**100**	**388**	**100**	**603(100)**
Frequency of washing toilet					
Daily	35	16.3	81	20.9	116(19.2)
Twice a week	28	13	90	23.2	118(19.6)
Weekly	79	36.7	102	26.3	181(30)
Monthly	73	34	115	29.6	188(31.2)
Total	**215**	**100**	**388**	**100**	**603(100)**

	Ever lost under-five				
	Yes		**No**		
	No	%	No	%	Total(%)
Method of child's stool disposal					
Flush with water	18	8.4	92	23.7	110(18.2)
Pour at the backyard	61	28.4	81	20.9	142(23.5)
Cover with sand	50	23.3	90	23.2	140(23.2)
Pour in a pit latrine	40	18.6	100	25.8	140(23.2)
Others	46	21.3	25	6.4	71(11.9)
Total	**215**	**100**	**388**	**100**	**603(100)**
Method of dumping refuse					
At the backyard	111	51.6	131	33.8	242(40.1)
Stream/River	25	11.6	104	27	129(21.4)
Community refuse pit	49	22.8	124	32	173(28.7)
Other	30	14	29	7.2	59(9.8)
Total	**215**	**100**	**388**	**100**	**603(100)**
Type of living house					
Single room	77	35.8	66	17	143(23.7)
Room/Parlour	63	29.3	31	8.0	94(15.6)
Bungalow	41	19	167	43	208(34.5)
Duplex	24	11.2	99	26	123(20.4)
Story building	10	4.7	25	6.0	35(5.8)
Total	**215**	**100**	**388**	**100**	**603(100)**
Type of roofing material					
Stone coated sheets	13	06	61	15.7	74(12.3)
Thatched roofing	88	41	93	24.0	181(30)
Corrugated zinc sheets	47	21.9	86	22.2	133(22.1)
Asbestos sheets	39	18.1	87	22.4	126(20.8)
Others	28	13	61	15.7	89(14.8)
Total	**215**	**100**	**388**	**100**	**603(100)**
Type of floor					
Earth /mud	80	37.2	108	27.8	188(31.2)
Gravel	42	19.5	81	20.9	123(20.4)
Cement	48	22.3	100	25.2	148(24.8)
Tiles	25	11.6	48	12.4	73(12.1)
Others	20	9.4	51	13.1	71(11.8)
Total	**215**	**100**	**388**	**100**	**603(100)**
No of windows per room					
1	88	40.9	144	37.1	232(38.5)
2	67	31.1	138	35.6	205(33.9)
3	38	17.7	70	18	108(17.9)
None	22	10.3	36	9.3	58(9.7)
Total	**215**	**100**	**388**	**100**	**603(100)**

	Ever lost under-five				
	Yes		No		
Variables	No	%	No	%	Total (%)
Number of persons per. Room					
1-2	39	18.1	110	28.3	149(24.7)
3-4	26	12.2	81	20.9	107(17.7)
5-6	56	26	99	25.5	155(25.8)
7 above	94	43.7	98	25.2	192(31.8)
Total	**215**	**100**	**388**	**100**	**603(100)**
Type of cooling appliance					
Air Conditioner	20	9.3	103	26.5	123(20.4)
Table Fan	55	25.6	104	26.8	159(26.4)
Ceiling Fan	60	28	92	23.8	152(25.2)
None	80	37.1	89	22.9	169(28)
Total	**215**	**100**	**388**	**100**	**603(100)**
Use of mosquito net					
Yes	92	42.8	234	60.4	326(54.1)
No	123	57.2	154	39. 6	277(45.9)
Total	**215**	**100**	**388**	**100**	**603(100)**
Type of cooking fuel					
Electricity	07	3.3	51	13.1	58(9.6)
Gas	10	4.7	54	13.9	64(10.6)
Kerosene	11	5.1	57	14.7	68(11.3)
Charcoal	60	27.9	61	15.8	121(20.1)
Wood	71	33	91	23.5	162(26.9)
Animal Dugs	31	14.4	70	18	101(16.7)
Others	25	11.6	04	01	29(4.8)
Total	**215**	**100**	**388**	**100**	**603(100)**
Type of animal domesticated					
Dog	35	16.3	71	18.3	106(17.6)
Cat	20	9.3	48	12.4	68(11.3)
Cattle	46	21.4	70	18	116(19.2)
Sheep/Goat	63	29.3	90	23.2	153(25.4)
Birds	25	11.6	60	15.5	85(14.1)
None	26	12.1	49	12.6	75(12.4)
Total	**215**	**100**	**388**	**100**	**603(100)**

Source: Field Survey, 2018

The results in table 3 also show that 35.8 % under-five mortality was recorded by women that live in single room, while those that live in story building recorded the least under-five mortality of 4.7%. Women that live in thatch roofed house experienced 41% under-five mortality, while those that live in stone coated sheet house experienced the least under-five mortality of 8%. Under-five mortality (37.2%) was experienced by women that live in earth/mud floor house, while those that live in a house floored with other materials experienced the least under-five mortality of 9.4%. Under-five mortality (10.3%) was recorded by women that live in one window house, with 40.9% experienced by those that live in a house without window. The results further showed that 43.7% under-five mortality occurred among women that sleep more than 7 in a room, with 12.2% experienced by those that sleep 3-4 in a room. The results further revealed that 37.1% under-five mortality occurred among women that do not use cooling appliance, with those using air conditioner experiencing 9.3%. In respect of mosquito net utilization, 66% under-five mortality occurred among women that do not use mosquito net, while those that use mosquito net experienced 34% .The results of the study also show that 33% of under-five deaths occurred among women that use wood as cooking fuel, while those that use electricity recorded the least under five mortality of 3.3%. Women that keep sheep/goat experienced 29.3% under-five deaths, against those that domesticate cat with 9.3% under-five deaths.

4.3 Environmental Determinants of Under-five Mortality

Table 4 presents results of the logistic regression analysis of the environmental determinants of under-five mortality. The result indicates that children of mothers that use river/stream as source of water (OR .201, P-value .002), uncovered well (OR .170, P- value .004) and other sources of water (OR .163, P-value .013) were 20%, 17% and 16% respectively more exposed to the risk of dying when compared with those that get water from tap. Children of women that treat water (OR 0.45, P-value 021) were 45% less at risk of dying, compared to children that their mothers do no treat.

Type of water storage container was found to be significantly related to under-five mortality at p- value<0.05. The result predicts 38% and 1.02 times risk of under-fives dying among women that store water in metal tank (OR .387, P-value .013) and clay pot (OR 1.02, P- value 041) respectively, relative to those that use drum/bucket/jerry can with cover. Frequency of washing water storage container was found to be significantly associated with under-five mortality. Children of women that wash water container monthly (OR 1.355, P- value .048) were 1.3 times likely to die in relative to those that do that daily. Method of disposing child's stool was found to be associated with child mortality. Method of waste water disposal was found to be significantly associated with under-five mortality in this study. The result indicates that disposing waste water in an open field (OR .518, P-value .008), infiltration pit (OR .367, P- value .010) and simple pit (OR .312, p- value .021) were 52%, 37% and 31% respectively likely to experience under-five mortality, when compared with children of women that use open drainage channels to dispose water. Pouring child's stool at the backyard (OR .677, P- value .034) was 68% at risk of experiencing under-five deaths in relative to mothers that flush child's stool with water.

Table 4: Logistic Regression Analysis of the Environmental Determinants of Under-five Mortality

			95% C.I forEXP(B)		
Variables	S.E.	P-Value	OR	Lower	Upper
Source of water					
Tap	RC				
Covered well	.677	.476	.614	.164	2.349
Manual/Motorized borehole	.727	.013*	.163	.039	.679
Water vendors	.795	.386	.502	.106	2.384
River/stream	1.241	.002*	.201	.002	.222
Uncovered well	.608	.004*	.170	.052	.561
Others	.691	.368	.536	.138	2.07
Water treatment practice					
Yes	RC				
No	.121	.021*	.451	.471	12.33
Type of water storage container					
Rubber drums/bucket without cover	RC				
Clay pot	.616	.041*	1.022	.373	2.449
Metal tank	.527	.013*	.387	.530	.421
Rubber drum/bucket/ can with covers	944	.101	.421	.517	.333
Rubber tanks	.671	.327	.35	.311	.211
Others	.578	.644	.292	.294	.580
Frequency of washing water container					
Daily	RC				
Twice a week	.596	.947	1.041	.323	.349
Weekly	.598	.584	1.387	.430	.476
Twice a month	.855	.678	1.426	.267	.263
Monthly	.574	.045*	1.355	.241	7.211
Method of waste water disposal					
Open drainage channels	RC				
Infiltration pits	.229	.010*	.367	.437	.401
Open field	.554	.008*	.518	.290	.770
Simple pits	.651	.021*	.312	7.383	.702
Type of toilet					
Open pit without cover	RC				
Open pit with cover	.833	.057	4.879	.952	24.988
Water system with cover	1.138	.829	.782	.084	7.273
Water system without cover	.774	.029*	5.418	1.190	24.68
Others	.802	.021*	6.464	1.321	30.671
Shared toilet facility					
No	RC				
Yes	.325	.006*	.555	.232	.893
Frequency of washing toilet					
Daily	RC				
Twice a week	547	.121	.314	.173	2.114
Weekly	.224	.016*	.217	.161	2.419
Monthly	.165	.038*	.711	.328	2.233

Table 4: Logistic Regression Analysis of the Environmental Determinants of Under-five Mortality

Variables	S.E.	P-Value	OR	95% C.I for EXP(B) Lower	Upper
Method of child's stool disposal					
Flush with water	RC				
Pour at the backyard	.677	.034*	.630	.163	2.314
Cover with sand	.677	.476	.614	.164	2.329
Pour in a pit latrine	.565	.558	.718	.238	2.173
Method of dumping refuse					
At the backyard	RC				
Stream/River	.546	.023*	.349	.325	2.766
Community refuse pit	.624	.044*	.402	.118	1.366
Others	.432	.999	.000	.000	.233
Type of living house					
Single room					
Room/Parlour	.680	.832	.866	.228	3.281
Bungalow	.833	.057	4.879	.952	24.988
Duplex	1.681	.546	2.758	.102	74.451
Story building	1.684	.752	2.194	.084	95.997
Type of roofing material					
Stone coated sheets	RC				
Thatched roofing	.963	.000*	9.567	4.628	20.873
Corrugated zinc sheets	.863	.585	.624	.115	3.386
Asbestos sheets	.795	.836	.848	.179	4.032
Others	1.545	.277	5.363	.260	10.755
Types of floor					
Earth /mud					
Gravel	1.985	.698	.733	.248	2.144
Cement	.512	.792	.873	.320	2.384
Tiles	.691	.368	.536	.138	2.079
Others	.861	.283	.510	.312	2.484
No of windows per room					
1	RC				
2	.683	.828	1.160	.304	4.419
3	.847	.495	1.783	.339	9.380
None	1.608	.014*	1.469	.063	34.324
Number of persons per. Room					
1-2	RC				
3-4	.617	.078	3.604	1.075	12.083
5-6	.908	.032*	.298	.118	4.135
7 above	1.299	.029*	1.693	.104	16.87

Table 4: Logistic Regression Analysis of the Environmental Determinants of Under-five Mortality

Variables	S.E.	P-Value	OR	95% C.I forEXP(B) Lower	Upper
Type of cooling appliance					
Ceiling fan	RC				
Table Fan	.801	.995	1.005	.209	4.830
Air conditioner	1.784	.527	3.094	.094	10.998
None	.861	.003*	2.510	2.312	67.684
Use of mosquito net					
Yes	RC				
No	.562	.041*	.624	.713	1.344
Type of cooking fuel					
Electricity	RC				
Gas	1.427	.866	.786	.048	12.898
Kerosene	1.402	.059	2.283	1.364	33.003
Charcoal	1.161	.007*	1.334	.445	42.172
Wood	1.136	.041*	1.471	.175	15.038

Animal Dugs	2.042	.927	.829	.015	45.372
Others	1.250	.403	.352	.030	4.077
Type of animal domesticated					
Dog					
Cat	.786	.169	2.953	.632	13.792
Cattle	1.066	.306	2.975	.368	24.027
Sheep/Goat	.758	.561	1.554	.352	6.869
Birds	1.019	.168	.245	.033	1.806
None	1.945	.193	.079	.002	3.589-2- -
2 Log Likelihood 168.401					
Cox and snell square .265					
Nagelkerke R square .597					

* Significant at P- value < 0.05; **RC:** Reference Category; **OR:** Odd Rati; **SE:** Standard error.
Source: Fieldwork**,** 2018

The type of toilet facility was also significant at P – value< 0.05. Children of women that use water system without cover (OR 5.418, p-value 0.29) and other toilet facilities (OR 6.464, P – value 0.21) were 5.4 and 6.5 times respectively at risk of dying when compared with those that use open pit with cover toilet facility. The result of the analysis has also shown that under-five mothers that share toilet facility with neighborhood (OR 0.555, P-value .006) were 56% likely to experience under-five mortality, in relation to children that their mothers do not share. Children of mothers that wash toilet monthly (OR .711, P- value .038) and weekly (OR .217, P- value .016) were 71% and 23% respectively more likely to experience under-five mortality when compared with those that do that daily.

There was no significant association between the type of living house and under-five mortality. The type of floor was also not significantly related to children's death at P – value < 0.05. Roofing material was significant. Women that use thatch roofed house (OR 9.567, P – value 0.00) were 9.5 times likely to experience child's death, relative to those that live in stone coated roofing house. The number of widows per room was found to be significant. The children of respondents that live in a house without window (OR 1.469, P – value 0.14) were 1.4 times likely to experience under-five mortality when compared with those that live in a house with one window. In respect of the number of people sleeping per room, homes where 7 and more women sleep in a room (OR 1.693, P – value .029) and those women that sleep 5-6 in a room (OR .298, p- value .032) were 1.6 times and 30% respectively likely to experience under-five mortality when compared with children of women that sleep one or two in a room. Women that their children sleep under mosquito net (OR .624, P-value .041) were 62% more likely not to experience under-five mortality, relative to those that do not sleep under mosquito net.

In this study, result has further showed that the use of cooling appliance in the house was significantly associated with under-five mortality. It indicates that children of women that do not have cooling appliance (OR 2.510, P – value. 0003) were 2.5 times at risk of under-five mortality, relative to mothers that use fan. Method of dumping refuse was significantly associated with child mortality. Dumping of refuse in the community refuse pit (OR .402, P – value 0.44) and stream/river (OR .349, p-value .023) were 40% and 35% at risk of experiencing under-five mortality when compared with the children that their mothers dump refuse at the backyard. The type of cooking fuel was significantly related to under-five mortality. Children of mothers that use wood as cooking fuel (OR 1.471, P – value 0.41) and charcoal (OR 1.334, p-value .007) were 47% and 1.3 times at risk of experiencing under-five deaths, when compared with children that their mothers use electricity which is non-polluting fuel. Type of animal domesticated was not significantly associated with under-five mortality in this study.

5. DISCUSSION

The purpose of the study was to investigate the environmental determinants of under-five deaths in Kebbi state, Nigeria. The study found that 35.7% under-five mortality was experienced by women in the study area, which was higher than the ones reported by [31, 32, 33] in South West Nigeria (25.8%), South Eastern Nigeria (13.9%) and FCT, Abuja (23.5%) respectively, where primary data were also used. This is consistent with the reports of [10, 7] that found Kebbi state under-five mortality rate to be high. However, the under-five mortality rate in this study was lower than the one reported by [34] in Adamawa state, Nigeria which may be attributed to the relative peace being experienced in Kebbi state, compared to Adamawa state where activities of the "Boko Haram" are being witnessed. The result of the study further indicates that under-five mothers that use river/stream as source of water were more likely to experience under-five mortality. In support of this finding, studies conducted by [35] reported an association between use of water from poor sources such as river, stream and open well and under-five mortality in Nigeria. Similarly, [36] found the quality of drinking water to be significantly associated with under-five deaths in Ethiopia. In 2018, only 48.7% were reported to

have access to improved sources of water in Kebbi state.[7] It therefore means that majority of the population get their water from unsafe sources, thereby exposing the children to high risk of water borne diseases. Treatment of water was found to be significantly associated with under-five mortality. The relationship indicates that children of mothers that treat water before use have less risk of dying. In conformity with this finding, [37] found mothers that do not treat water before use experiencing under-five mortality in Ibadan. A study by [38] equally found a high possibility of under-fives dying of diarrheal among mothers that do not treat water in Ethiopia. When water from unsafe source is used by mothers without treatment children may contract water-borne diseases which may result to death.

The type of water storage container used was found to be significantly related to under-five mortality. This finding is not different from that of [37] where it was suggested that households that use clay pot, rubber bucket and jerry can without cover experienced more diarrhea cases among children in Ibadan. Similar finding was also reported by [39] that found children below the age of five whose mothers do not use water storage facilities that are covered were at high risk of dying due to diarrheal in Cameroun. To justify this present finding, water stored in a container without cover may be contaminated, resulting to contraction of water borne diseases among the children. Frequency of washing water storage container was found to be significant. The work of [40] also found infrequent washing of water storage container to be associated with the risk of childhood deaths in Benin. Similarly, [41] showed an association between infrequent washing of water storage container and increase in children's death in Pakistan. Method of waste water disposal was significant in this study. Similar to this finding, a study carried out in Nigeria revealed that disposal of waste water in an open field was associated with diarrheal illness among under-fives. [37] Open field disposal of waste water could expose pathogens through vectors like flies to home, resulting to water borne diseases and death among the under-fives.

The type of toilet was also found to be significantly related to under-five mortality. Previous studies such as [42, 43] found the use of unsafe toilet facility to be associated with under-five mortality in Kenya and Bangladesh respectively. Also, households in Zimbabwe that use poor toilet facility were also reported to be more likely to experience under-five deaths, in relative to their counterparts that use safe ones. [44] In the present study area, as reported by [10], only 36.1% of the population had access to improved toilet facility in 2016, with majority of the population relying on unsafe sources to defecate. The health implication is that, contact with human excreta, feaces is dangerous to health such that one gram of fresh feaces from an infected person can contain around 10^6 - 10^8 bacterial pathogens, 10^4 protozoa and 10-10^4 helminthes eggs which may be responsible for diseases spread and death among the under-fives. [45, 38] The result of the analysis has also shown that under-five mothers that share toilet facility have higher odds of under-five mortality. In conformity with this finding, [46] found women in Nigeria that share toilet to be more affected by under-five deaths than those that do not share. Also, a strong association was found between under-five mortality and women that share toilet facility in Nigeria. [18]Sharing toilet facility is one of the ways diseases can be contracted by the children. When a healthy mother shares a toilet with an infected person, the possibility of contracting disease and transmitting the same to the child may be high.

Frequency of washing toilet was found to be significant. To justify this finding, it is a common knowledge that infrequent cleaning of toilet makes it dirty, and more importantly breeds pathogens that could cause diseases. The present study has found method of disposing child's stool to be associated with under-five mortality. This finding is not different from that of [47, 48] that found women that pour child's stool in open space to have more risk of under-five deaths when compared with those that use safe methods in India and Indonesia respectively. Safe disposal of child's stool is to avoid contamination of environment, food or hand so that personal health can be protected. Method of dumping refuse was found to be significantly associated with under-five mortality in this study. Similar to this finding, it was also found in Ibadan, Nigeria, that community dumping of refuse by mothers expose them to high risk of under-five mortality [37]. There was no significant association between the type of living house and under-five mortality in this study. Similar to this finding, [21] reported that housing units was not a predictor of under-five mortality in Nigeria. Similarly, significant relationship between the type of house used by Ghanaian women and under-five mortality was not found in a study. [49] However, [38] reported an association between dwelling houses and high odds of under-five dying of diarrheal in Ethiopia. The disparity with the present finding may be that the previous study was carried out in Ethiopia nomadic community where the dwelling houses may not only be inadequate, but inconducive for habitation. Type of roofing material was found to be significant in this study. Previous study that agrees with this finding is that of [16] where it was found that use of inadequate or unsafe roofing materials by households are likely to experience higher under-five deaths in Nigeria. Under-five mortality was also found to be higher among respondents that use unhealthy type of roofing materials such as grasses, palm leaves and mould in South Western Nigeria [50].

Type of floor in the house was not significantly related to under-five mortality in this study. However, contrary to the finding of this study, [51, 46] found a significant association between the type of floor and under-five mortality in Nigeria. Unfinished floor was also found to be a predictor of under-five mortality in Nigeria [46]. The possible explanation for the disparity in the findings may be attributed to the nationally representative sample used by the previous studies, while the

current study based its study on a geographical unit of the country. The number of widows per. room was found to be significantly associated with under-five deaths. This present finding is similar to that of [52] where more under-five deaths were found to be associated with house without window. It is obvious that house without window may not provide enough ventilation for the healthy living of the mother and her child, especially during high temperature periods of the year.

In respect of the number of persons sleeping per room, it was found to be significantly associated with under-five mortality in this study. Similar to this finding, a study in Australia suggested that children living in overcrowded room are more likely to experience respiratory problems such as coughing and asthmatic wheezing, and are also 10 times more likely to die of meningitis [53]. Another study in support of the present finding demonstrated that crowding (> 4 people sharing child's bed room) was associated with 2.5 fold increase risk of disease infection in Sao Paulo [54]. According to [55], UN-Habitat recommends not more than three persons per habitable room to reduce crowding related diseases. However, in Nigeria, particularly in the Northern part, it may be difficult for people to comply with the UN-Habitat recommendation because of large families and inadequate accommodation.

It has been reported that prolonged exposure to high indoor temperature can cause heat related deadly illnesses in both adult and children [56]. In this study, result has showed that type of cooling appliance was significantly associated with under-five mortality. The possible explanation is that in a tropical country like Nigeria women without cooling appliance for use especially during hot weather periods may experience heat related illnesses such as heat exhaustion, dehydration, measles and meningitis which may increase the mortality rate of the under-fives. It was also found in this study that use of mosquito net by women was significantly associated with under-five mortality. This finding is consistent with that of [46] that reported higher odds of under-five deaths for women who do not use mosquito net in Nigeria. Similar study found malaria parasitemia which is a common killer of children to be higher among under-fives that do not sleep under mosquito net in Nigeria [57]. Mosquito net is a globally recommended safe method of malaria prevention and its use is being promoted by both WHO and UNICEF through distribution and advocacy programmes.

The type of cooking fuel was found to be significant in this study. This finding is not different from that of [58] where it was suggested that more children died of respiratory infections among mothers that use wood, animal dung and straw for cooking in Ethiopia. Similar result was reported by [43] showing that women in Tanzania that use wood as cooking fuel were more likely to experience under-five deaths than their counterparts that do not use wood. Wood as solid fuel for cooking is commonly used in Nigeria, particularly in the rural communities because it is considered to be available and cheaper than gas and kerosene. However, the smoke released as carbon monoxide may affect the health of mothers and their children. Further analysis of the results did not find any association between the type of animal domesticated and under-five deaths in this study. Similar result was reported by [37] suggesting that domestication of animals was not significantly related to under-five mortality in Nigeria. The explanation for this finding may be that, except in nomadic communities, many households in northern Nigeria keep animals in a free range which minimizes their contact with members of the households, thereby reducing contraction of animal related diseases.

6. CONCLUSION

The purpose of this study was to investigate the environmental determinants of under-five mortality in Kebbi state, Nigeria. Despite the efforts of the government to reduce under-five deaths, the study found that it is still high in Kebbi state. Source of water, frequency of washing water container, water treatment practice, type of water storage container, waste water disposal method, type of toilet, shared toilet, frequency of washing toilet, child's stool disposal method, type of roofing material, number of persons sleeping per. room, use of mosquito net, type of cooling appliance, refuse disposal method and type of cooking fuel were found to be significantly associated with under-five mortality in Kebbi state. The study concluded that environmental factors are determinants of under-five mortality in the study area. It was therefore recommended that to reduce under-five mortality rate, government should provide adequate infrastructure such as potable sources of water, sanitary facilities, water drainage system and safe refuse disposal system for public use.

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