Original Article

Analysis of Regional Variations in Influence of Household and Environmental Characteristics on Prevalence of Diarrhoea among Under-Five Children in Nigeria

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Abstract

Background: Until now, factors influencing diarrhoea in children has been studied in Nigeria without full recourse to her wide geopolitical diversities. **Aim:** This study assessed the differentials in regional prevalence of diarrhoea and the role of household and environmental characteristics in the distribution and likelihood of diarrhoea among children under-five years within each geopolitical region in Nigeria. **Subjects and Methods:** A cross-sectional study among households with under-five children. We used the data from the 2012 Nigeria National HIV/AIDS and Reproductive Health Survey (NARHS Plus II). We weighed the data and used descriptive statistics, Pearson Chi-square (x^2) and logistic regression to analyse data at 5% significance level. **Results:** Over a third, 38.0% (5062/13322) of households sourced drinking water from non-improved sources, highest in North East, 45.3% (1049/2315) and least in South West, 27.6% (521/1888) Over half, 52.7% (7021/13322) of toilets were non-improved, highest in North East, 68.6% (1588/2315) and least in South West, 35.7% (674/1888), most households practice open defecation. The overall prevalence of diarrhoea was 13.0% (1732/13322), 17.0% (294/1732) in North East and higher in other regions than 9.0% (156/1732) in the south west. The odds of diarrhoea was significantly higher among rural households in the South-South (OR=2.1, 95% CI: 1.4-3.1) but more prevalent in urban North East and South East. Also, the odds of having diarrhoea increased with wealth quintile to which household belongs was significant in all the regions except in the North East. **Conclusions:** The prevalence of diarrhoea varied widely across the regions. Also, the influence of household and environmental characteristics on the prevalence of diarrhoea differed across the geopolitical regions. This is an indication that policies on control of diarrhoea should be region-specific.

Keywords: Diarrhoea, household, improved water, sanitation, hand washing, open defecation

Introduction

Diarrhoea, a major public health problem[1] has been reported to annually account for 9% of all deaths among under-five children globally in 2015.[2] It implies that over 1,400 children die daily or about 530,000 children annually.[3] Diarrhoea is the third leading cause of death among children under-five globally.[4] The prevalence and case-fatality ratios are much higher in low-income than in middle-income and high-income countries.[5] Developing countries with poor water quality, sanitation and hygiene substantially bears more burden of the disease.[3] The greatest proportions of severe episodes of diarrhoea were reported in the South Asia (26%) and sub-Sharan Africa regions (26%).[4]

The incidence of and mortality from diarrhoea vary by age. Nearly three quarters (72%) of deaths from diarrhoea occur among children younger than 2 years. Diarrhoea incidence crests at age 6 to 11 months and then decreases with age while most mortality from diarrhoea has been found among children aged 0 to 11 months.[6] For an otherwise healthy child, a single episode of diarrhoea may not have a damaging consequence.[5] However, several episodes within a year can lead to nutritional deficits and long-term consequences especially among children in low-income and middle-income countries. Repeated episodes of diarrhoea can thus lead to cognitive deficits via stunting, but not independently as some researchers have postulated and deaths.[7,8] Unfortunately, under three years children experience an average of three episodes of diarrhoea per year in developing countries.[2]

The most common cause of severe and fatal diarrhoea worldwide

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is rotavirus (associated with 28% of severe cases and 28% of fatal cases).[5] They multiply in the human gut, exit in excreta, and transit through the environment, causing diarrhoea in new hosts. The immediate household and environmental characteristics might influence the occurrence of this killer disease.[9] For most children, the home and its immediate surroundings are the first and major environments they experience throughout their early years since young children spend most time at home.[10] Housing characteristics and other environmental conditions within a child's home have the potential to influence multiple aspects of the health and development of a child.[11]

Epidemiologic studies have shown that factors determining the occurrence of diarrhoea in children are complex and the relative contribution of each factor varies as a function of the interaction between socio-economic, environmental and behavioural variables.[12,13] It is widely recognised that exposure to diarrhoea pathogens in developing countries is as a result of factors such as quality and quantity of water, availability of toilet facilities, housing conditions, level of education, economic status of households, place of residence and general sanitary conditions (personal or domestic hygiene) of surrounding homes.[14] Nearly 90% of diarrhoea is attributed to unsafe drinking water, inadequate sanitation and poor hygiene.[15]

The literature is replete on disease model between diarrhoea and 'water, sanitation and hygiene.[12-17] However, there is consensus on the routes of faecal disease (of which diarrhoea is paramount) transmission and protective barriers [Figure 1] [17]. For instance, Choffnes *et al.* affirmed that faeces, and other infectious agents in it, can spread through fluids, fingers, flies, and the fields in which people defecate and/or grow crops and this can be transmitted and contaminate food when hands are not properly washed and keeping food in non-hygienic conditions, fingers, fluids, and flies can also contaminate food.[16] The faecal to oral pathways gives way for the transport of pathogens from person to person. The five "F" (fluids, fingers, flies, fields and floors) show 8 unique potential routes besides another multitude of options within each route.[17]

The millennium development goals (MDGs) and the recently launched sustainable development goals (SDGs) called for reduction by half, the proportion of people without sustainable access to safe drinking water.[18] This goal was adopted because clean water was seen as critical to fighting diarrhoea disease. Despite reported progress in access to potable water in most countries of the world, 663 million people do not have access to improved drinking water in 2015, nearly half of whom live in sub-Saharan Africa.[19] Reports from the 2015 World Health Organisation/United Nations Children's Fund (WHO/UNICEF) Joint monitoring programme on water and sanitation revealed that potable water remains a challenge in Nigeria with 31% of the population getting drinking water from unimproved sources. [20] The use of improved sanitation facilities is particularly low in Nigeria at 29% - even so, the disparity between urban (33%) and rural areas (25%) is evident.[21] Nigeria has witnessed the largest increase in numbers of open defecators since 1990, with 39 million people defecating in the open in 2012, compared with 23 million in 1990.[19]

Considering the complexity and interplay of factors affecting diarrhoea and also the established variability in housing types, socio-cultural practices and health behaviours across geopolitical regions in Nigeria,[20,22,23] we hypothesised that influence of these factors will vary among the regions. Taking a step further beyond previous studies, wherein the phenomenon was investigated and regional diversities in the country were not appropriately accounted for, we carried out intra-region analysis of factors influencing diarrhoea in Nigeria. Among others, this study assessed the prevalence of diarrhoea and the role of household and environmental factors and other characteristics in determining the distribution and likelihood of diarrhoea among children under-five years in Nigeria. Our objectives are to assess diarrhoea prevalence across the geopolitical regions in Nigeria

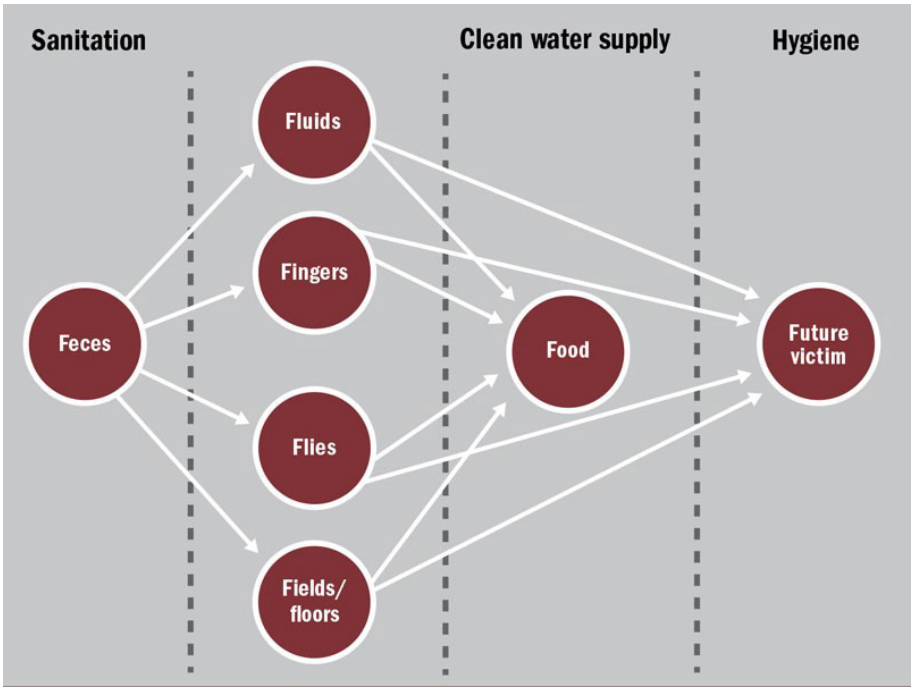

Figure 1: Pathway between disease model between diarrhoea and 'water, sanitation and hygiene [17].

and to also identify regional-specific risk factors of diarrhoea. The significance of the current study lies in its ability to identify overall and regional-specific factors influencing diarrhoea in Nigeria and provision of evidence-based recommendation to stakeholders on ways to reduce the prevalence of diarrhoea to an insignificant level.

Methods and Materials

Study setting

Administratively, Nigeria comprised 36 states and the federal capital territory (FCT). These states are subdivided into 774 constitutionally recognised local government areas (LGAs), which are further divided into wards. The country is also stratified into 6 regions geopolitical regions; North-East, North-West, North-Central, South-East, South-South, and South-West [Figure 2]. The population in each of the geopolitical regions are homogeneous and share similar socio-cultural characteristics and unique in other health-related characteristics like access to health care, environment, housing system etc. The Nigerian culture, which significantly shapes the population's way of life regardless of their socioeconomic status, is determined by the country's approximately 450 l ethnic groups and about 450 dialects.

Sources of data

In this study, we used the data from the 2012 National HIV/AIDS and reproductive health survey (NARHS Plus II),[24] a cross-sectional nationally representative survey. The survey was carried out to provide information on key HIV and AIDS, reproductive health and general household health knowledge, attitude and behavioural related issues. We carried out a retrospective analysis of household and environmental factors affecting diarrhoea among U5 children in Nigerian households. The survey, which utilised both individual and household questionnaires, adopted stratified multistage cluster sampling technique to select a nationally representative probability sample of women aged 15 to 49 years and men aged 15 to 64 years from households in rural and urban areas in all the 36 states and the FCT, Nigeria.

Sampling

The participants in NARHS Plus II were recruited through a multi-stage sampling technique. At stage 1, local governments areas (LGAs) in each state were stratified into rural and urban localities from which some urban and rural LGAs were selected. Stage 2 involved the selection of enumeration areas (EA), which are the primary sampling units (PSU) and referred to as clusters in the 2012 NARHS Plus II, within the selected LGAs. In stage 3, households within the selected clusters were listed and 32 households selected from each cluster. Overall, 35,520 households were selected but 32543 (91.6%) household heads or their proxies were successfully interviewed. The interviewers were trained in questionnaire administration and physical assessment of household features such as the type of toilet, water storage etc.

Ethical consideration

The institutional review board (IRB) of the National Institute of Medical Research, Nigeria approved the study protocol, survey instruments and materials prior to the commencement of the survey. Details of the ethical approvals have been reported earlier[24].

Data

Among the 32543 households visited, only 13,322 (40.9%) of

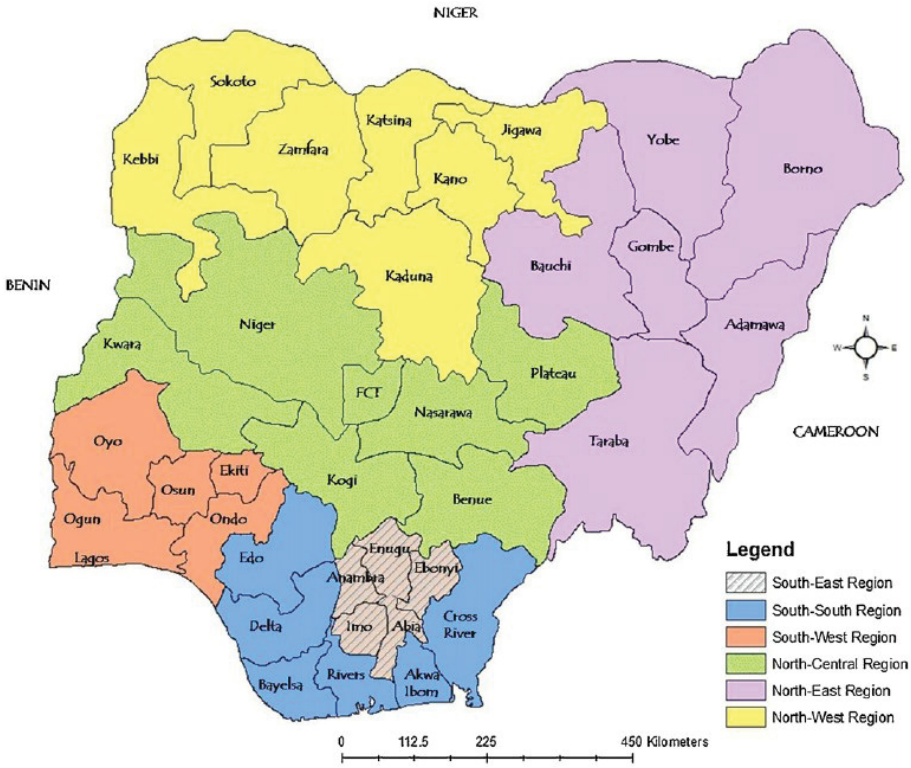

Figure 2: A map of Nigeria showing the distribution of the States, FCT and the geopolitical regions.

the households reported having under-five-year-old children. Further analysis was based on the 13,322 households.

Dependent variable

The outcome variable is the experience of diarrhoea among under-five children within two weeks preceding the date of the survey. Diarrhoea prevalence was measured as the proportion of households whose any of its under-five children experienced diarrhoea within two weeks preceding the survey.

Independent variables

The risk factors (independent variables) used in this study are motivated by findings of earlier studies[12,13,16,17,25] and were crosschecked with the disease model provided in Figure 1.[16,17] They include "geopolitical regions", "sex of household head", "wealth status", "location of residence", "source of drinking water", "type of container used for water storage", "whether the water storage was covered", "whether the water was treated before drinking", "having toilet facility", "type of toilet facility", "sharing of toilet facility". Type of household building, the floor, wall and ceiling materials were not used in the analysis because they have been used in constructing the wealth status[23,24]. We adapted the groupings of environmental factors documented in the 2013 Nigeria National Demographic Health Survey (NDHS) [20] and the 2010 WHO and UNICEF document on progress on sanitation and drinking water.[21] The "source of drinking water" was grouped into either improved or not. Improved sources are piped into dwelling/yard/plot, public tap/standpipe, tube-well or borehole, protected well and spring, rainwater and bottle water. The non-improved sources of drinking water are unprotected well and spring, tanker truck/cart with drum, surface water, sachet water and other sources.

Water storage container was grouped as either "improved" or not. A container with a narrow opening for filling (to prevent hand and flies from touching water) and dispensing devices such as spouts or taps/spigots is referred to as improved container. Proper water treatment such as "Boiling water" or "use of bleach/chlorine" or "filter" or "solar disinfection" and "filtering through cloth" were grouped as appropriate methods while "let stand and settle, use of alum and other methods" were considered as inappropriate. Toilet facilities were grouped as improved types if household 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 slap or composting toilet. Any other types of toilet were regarded as non-improved.

Statistical analyses

We used descriptive statistics to show the distribution of households with under-five children and the prevalence of diarrhoea across the independent variables. Bivariate analyses were performed to determine the significance of the association between diarrhoea and the independent variables using Pearson Chi-square (x^2) test of association. We used logistic regression to model factors predisposing children to diarrhoea. This analysis were carried out in two stages. First, the overall for Nigeria and then each geo-political region. For the overall analysis, the variables found to be significant at the bivariate level and were adjusted for in multiple logistic regression models. We fitted two multiple logistic models. The first model contained the hygienic and environmental related factors while the second model consisted of the variables in the first model in addition to a social, economic and demographic characteristic of the households.

The rationale behind the use of logistic regression model lies in its ability to determine the association between a dichotomous dependent variable and independent variables by converting the dependent variable to probability scores which assume values between zero and one as shown in equation (1).

$$P(y_i) = \frac{e^{\beta_0+\beta_1 x_{i1}+.....+\beta_k x_{ik}}}{1+e^{\beta_0+\beta_1 x_{i1}+.....+\beta_k x_{ik}}} = \frac{1}{1+e^{-(\beta_0+\beta_1 x_{i1}+.....+\beta_k x_{ik})}} \quad (1)$$

where y_i is the category of the dependent variable for the ith observation and x_{ij} is the jth independent variable $(j=1,2,...k)$ for that observation, β_j is the jth coefficient of x_{ij} and indicates its effect on the fitted model.

Hosmer and Lemeshow statistic[26] and Omnibus tests of model coefficients were used to test the goodness-of-fit of the models and whether the explained variance in the data was significantly greater than the unexplained variance at 5% significance level. Details of the procedure have been described in an earlier study.[27] The omnibus test relates to the hypotheses H_0: $\beta_2 = \beta_+.....\beta_k$ versus H_1: at least one pair $\beta_i \neq \beta j$. The data was weighted to reflect differences in population sizes of each state in Nigeria. The intra-cluster correlation was minimised by the use of effective sample size and complex survey data analysis mechanism in Stata, version 12.0 (StataCorp, Texas, USA).

Results

Across Nigeria, most sources, 62.0% (8260/13322) of drinking water to the households studied were non-improved. Only 14.2% (1892/13322) of households did not cover drinking water appropriately before drinking. Less than half, 47.3% (6301/13322) of households have improved toilet facilities and while 27.2% (3624/13322) do not have any toilet and thus result to open defecation or use of bags. These distributions varied across the regions, with higher proportions of improved facilities in the Southern regions. For instance, while 64.3% (1214/1888) of toilets in SW were of improved types, only 31.4% (727/2315) in the North East was improved. Similarly, the practice of hand washing before food preparation was more prominent in the South South, 45.0% (856/1902) and South West, 42.6% (804/1888) compared with 21.3% (493/2315) in the North East and 25.3% (668/2642) in the North Central. However, there were only minor differences in proportions of Households with improved water storage and water containers across the regions as shown in Table 1.

The overall prevalence of diarrhoea was 13.0% (1732/13322) among children in the surveyed households. The prevalence was highest, 17%.0 (294/1732) in the NE and least, 9.0% (156/1732) in the SW [Figure 3 and Table 2]. The prevalence was generally higher in households getting drinking water from non-improved

Table 1: Distribution of Household and Environmental characteristics of the Households by regions

Regions	North Central	North East	North West	South East	South South	South West	Overall
n	2642	2315	3339	1236	1902	1888	13322
Variables	%	%	%	%	%	%	%
Drinking Water Source							
Improved	60.9	54.7	61.5	67.0	59.7	72.4	62.0
Nonimproved	39.1	45.3	38.5	33.0	40.3	27.6	38.0
Container Covered							
Improved	85.0	86.8	85.9	91.3	86.9	80.6	85.8
Non-improved	15.0	13.2	14.1	8.6	13.1	19.4	14.2
Water Storage							
Improved	61.4	56.5	56.6	76.6	61.8	49.2	59.1
Non-improved	38.6	43.5	43.4	23.4	38.2	50.8	40.9
Properly Treat Water							
Yes	10.1	3.0	3.0	11.7	7.0	13.1	8.0
No	89.9	97.0	94.0	88.4	93.0	86.9	92.0
Shares Toilet?							
Have, Do not Share^	28.3	50.8	62.6	46.0	32.9	19.8	41.9
Have, Shares	26.3	22.4	23.5	27.2	42.9	51.6	31.0
Do not Have	45.4	26.8	13.9	26.9	24.2	28.6	27.2
Toilet Type							
Improved	36.8	31.4	53.4	56.5	47.5	64.3	47.3
Non-improved	63.2	68.6	46.6	43.5	52.5	35.7	52.7
Wash hand with Soap/ash							
Yes	25.3	21.3	32.6	26.5	45.0	42.6	31.9
No	74.8	78.7	67.4	73.5	54.2	57.4	68.1
Household Head Sex							
Male	91.6	96.8	97.7	82.0	82.3	81.1	90.3
Female	8.4	3.2	2.3	18.0	17.7	18.9	9.7
Residence							
Urban	30.0	18.9	21.7	13.0	23.6	73.6	29.7
Rural	70.0	81.1	78.3	87.0	76.5	26.4	70.3
Wealth Status							
Poorest	17.3	41.1	36.9	7.1	6.1	3.3	21.8
Poorer	23.2	29.7	29.0	15.9	13.4	11.0	22.0
Average	19.5	13.9	16.7	23.3	25.9	16.8	18.7
Wealthier	18.2	8.5	8.9	25.1	27.5	32.0	18.2
Wealthiest	21.9	6.8	8.6	28.7	26.2	37.0	19.3

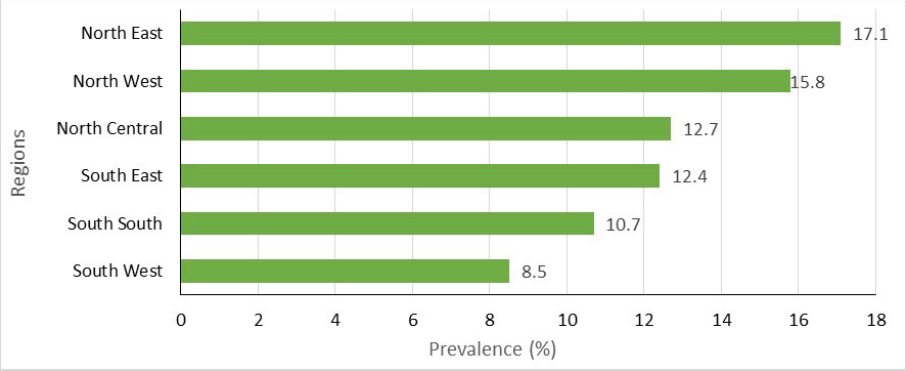

Figure 3: Burden of diarrhoea in Nigeria households within two weeks before the survey by regions.

sources, 14.7% (255/1732) than 12.4% (215/1732) sourcing water from improved sources. Similarly, diarrhoea prevalence was higher among households in poorer economic status, 16.2% (281/1732) than 9.2% (159/1732) in households with better off economic status. In all the regions except North Central, the burden of diarrhoea was higher among household using water from non-improved sources and either having none or sharing a toilet. The significant risk factor that attracted highest prevalence of diarrhoea in North Central was "not having toilet" at 13.7% (237/1732), "proper water treatment" in the North East, North West and South at 23.1% (400/1732), 22.6% (391/1732) and 15.0% (260/1732) respectively, "non-improved water sources" at 17.2% (298/1732) in the South East, and "not having toilet" at 11.3% (196/1732) in South West. Mostly, wealth status appeared to have significantly differentiated the burden of diarrhoea among the households by regions. While a prevalence of 16.4% (284/1732) was found among households in poorer wealth quintiles in the North central, the figure was

Table 2: Prevalence of Diarrhoea among under 5 children by regions and selected variables

	Proportion of Household with U5 children that had Diarrhoea							
Variables	**North Central**	**North East**	**North West**	**South East**	**South South**	**South West**	**Overall (95% CI)**	
Drinking Water Source*								
Improved	12.7	16.6	*16.0	*10.0	*8.7	8.3	12.4	11.8-13.3
Non-improved	12.6	17.8	15.7	17.2	13.7	9.2	14.7	13.7-15.6
Container Covered								
Improved	*13.1	*16.4	15.6	12.5	10.9	8.7	13.3	12.7-13.9
Non-improved	10.1	21.5	17.5	11.2	9.6	7.9	13.3	11.8-14.9
Water Storage								
Improved	*13.5	*15.3	17.4	12.0	10.3	9.4	13.6	12.8-14.3
Non-improved	11.4	19.5	13.7	13.9	11.4	7.7	13.0	12.1-13.9
Properly Treat Water								
Yes	9.3	23.1	*22.6	13.2	15.0	10.4	14.2	12.1-16.3
No	13.1	16.9	15.4	12.3	10.4	8.2	13.3	12.7-13.9
Shares Toilet ?*								
Have, Do not Share^	*10.3	*15.1	16.0	11.1	*7.8	*6.2	12.9	12.1-13.8
Have, Shares	13.4	19.1	16.0	11.6	12.0	7.9	12.9	11.8-13.9
Do not Have	13.7	19.4	15.1	15.4	12.4	11.3	14.5	13.3-15.6
Toilet Type*								
Improved	11.5	14.9	15.2	*9.8	*7.7	*7.1	11.3	10.5-12.1
Non-improved	13.4	18.1	16.6	15.9	13.3	11.1	15.1	14.3-15.9
Wash hand with* Soap/ash								
Yes	10.4	18.9	*12.7	*9.2	*8.8	7.6	11.7	10.7-12.6
No	12.1	16.6	17.4	13.6	12.3	9.2	14.1	13.4-14.9
Household Head Sex*								
Male	12.6	17.2	15.9	13.0	10.8	8.7	13.7	13.0-14.3
Female	14.0	14.9	17.3	10.6	9.9	7.7	10.9	9.1-12.5
Residence*								
Urban	11.4	17.8	15.2	14.3	*6.3	8.1	11.2	10.2-12.1
Rural	13.2	17.0	16.0	12.1	12.1	9.6	14.3	13.5-15.0
Wealth Status*								
Poorest	*11.8	17.7	*16.8	*12.6	*16.4	*19.4	16.2	11.4-13.9
Poorer	16.4	18.4	17.3	15.3	13.8	10.0	16.4	15.6-18.7
Average	14.0	13.8	14.0	16.8	10.0	10.0	13.0	14.6-17.1
Wealthier	10.3	14.9	14.0	10.0	10.9	9.0	10.9	10.6-14.2
Wealthiest	10.3	17.8	12.2	9.3	8.1	6.0	9.2	9.3-12.1
Total	12.7	17.1	15.8	12.4	10.7	8.5	13.3	7.3-9.8

*Significant at 5% Chi-square test

18.4% (319/1732) in North East, 17.3% (300/1732) in North West, 15.3% (265/1732) in South East, 13.8 (239/1732) in South South and 10.0% (173/1732) in South West as shown in Table 2.

Across the geopolitical regions, the higher the use of improved water sources, improved toilet facilities and hand washing before a meal and food preparations the lower the prevalence of diarrhoea and vice-versa. For instance, the 42.6% (804/1888) hand washing practice reported in the South West corresponded with 9.0% (156/1732) diarrhoea prevalence compared with 21.3% (493/2315) hand washing in the North East that attracted 17.0% (294/1732) diarrhoea prevalence as shown in Figure 4.

The intra-region comparison of households having children who had experienced diarrhoea within two weeks before the survey and the considered risk factors revealed differentials in their levels, degree and significance. For example, the association between diarrhoea and drinking water sources was only significant in South East and South South, proper water treatment was significantly associated with diarrhoea in the North West, while wealth status was significant to having diarrhoea in all the regions except North East and North West. Generally, households' sources of drinking water, toilet types, toilet sharing, hand washing with soap or ash, sex of household head, place and region of residence and the economic status were significantly associated with children having diarrhoea [Table 2 and Figure 5].

In Table 3, we identified the determinants of diarrhoea for each region using bivariate logistic regression models. Although the odds of having diarrhoea was higher among children who drink water from non-improved sources compared with their counterparts who drank from improved sources in all the regions, it was only significant in the South-South (p=0.03, OR=1.7, 95% CI: 1.3-2.2). While odds of having diarrhoea was lower among household that doesn't wash hands with soaps/ashes before a meal in North Central and North East, it was significantly higher in the other four regions. The likelihood of having diarrhoea was only significantly higher among rural households in the South-South (p=0.01, OR=2.1, 95%: 1.4-3.1) compared to the urban households. The reverse was the case in The North East and South East regions where diarrhoea was more prevalent in the urban settings. Also, the odds of having diarrhoea increased with wealth quintile to which household

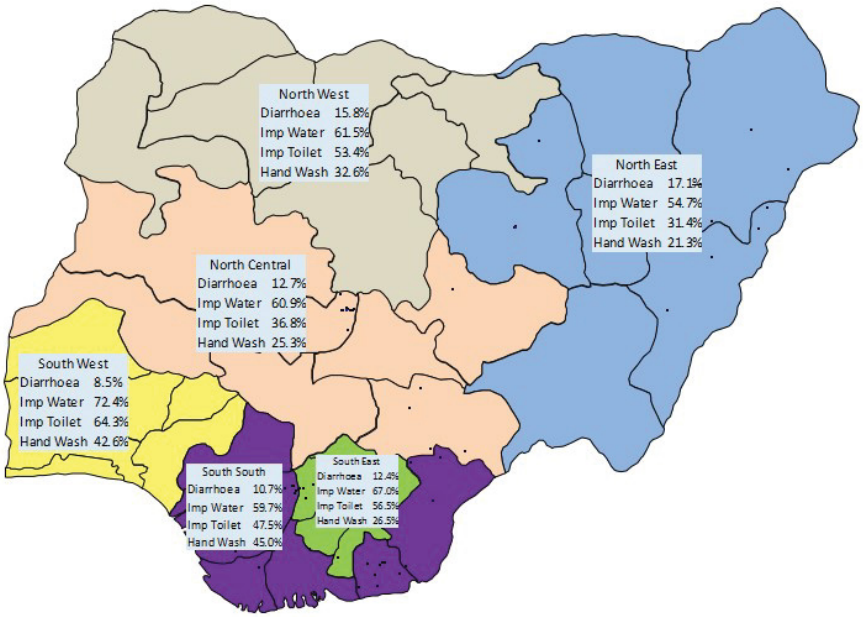

Figure 4: A map of Nigeria showing the distribution of diarrhoea among under five children and selected water, sanitation and hygienic practices.

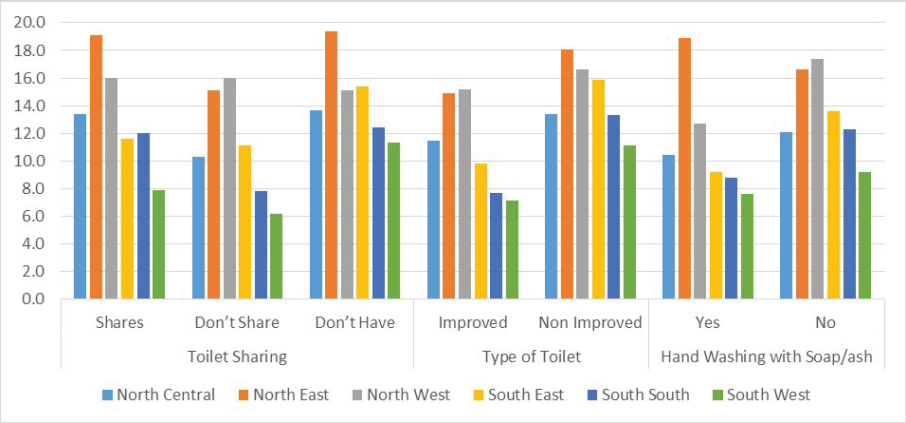

Figure 5: Prevalence of Diarrhoea in Nigeria by regions and some selected environmental characteristics.

belongs significantly in all the regions except in the North East. On sharing of toilet facilities, the odds were consistently higher among households that don't have toilets in all the region except in the North West.

Overall, children in households drinking water from non-improved sources were 20% times more likely to have experienced diarrhoea than those who drank from improved sources (p=0.02, OR=1.2, 95% CI:1.18-1.3). The likelihood of under-five children having diarrhoea was 40% more likely in households using non-improved toilets than those using improved toilets (p=0.02, OR=1.4, 95% CI: 1.36-1.5). In the same vein, children from households headed by males and living in rural areas had a higher likelihood of having diarrhoea, p=0.03, OR=1.3, 95% CI: 1.1-1.6 and p=0.02, OR=1.3, 95% CI: 1.2-1.5 respectively as shown in Table 4.

We fitted two models while controlling for effects of the significant factors in the bivariate analysis. In model I, under-five children in a household whose members do not wash hands with soap/ash had higher adjusted odds of attracting diarrhoea than those who wash hands with soap and water before a meal (aOR=1.2, 1.1-1.3, p=0.04 Model I). Similarly, the odds of getting diarrhoea was higher in households who were not using improved toilet facility (aOR=1.4; 1.3-1.6, p=0.03 Model I) than households with improved toilets. In addition to significant factors in Model I, Model II showed that under-five children from households in North East (aOR=1.9; 1.5-1.7, p=0.01, Model I) and North West (aOR= 1.8; 1.5-2.3, p=0.01, Model II) had higher odds of having diarrhoea than households from South West. Similarly, children in households from poorest wealth status were 37% more likely to have diarrhoea than households in the richest economic status (aOR=1.4; 1.1-1.7, p=0.03, Model II). The Holmer and Omnibus tests showed that Model II fitted the model better than Model I. Households' sources of drinking water, toilet types, hand washing with soap or ash, a region of residence and the economic status significantly predisposes children to have diarrhoea in Nigeria [Table 5].

Discussion

This study assessed the prevalence of diarrhoea in Nigeria, across the six regions and identified within-region risk factors of diarrhoea. We found the prevalence of diarrhoea to be high in Nigeria as one of every 8 children had experienced diarrhoea at least once within two weeks preceding the survey. This

Table 3: Bivariate logistic regression of factors predisposing Diarrhoea among under-five children in Nigeria households

	OR (95% CI)					
Variables	**North Central**	**North East**	**North West**	**South East**	**South South**	**South West**
Drinking Water Source*						
Non-Improved	1.0(0.8-1.3)	1.1(0.9-1.4)	1.0(0.8-1.2)	1.1(0.8-1.6)	1.7(1.3-2.2)	1.2(0.8-1.6)
Container Covered						
No	0.7(0.5-1.1)	1.4(1.1-1.8)	1.2(0.8-1.5)	0.9(0.5-1.7)	0.9(0.6-1.4)	0.9(0.6-1.4)
Water Storage						
Non-Improved	0.8(0.6-1.0)	1.3(1.1-1.6)	0.8(0.6-0.9)	1.2(0.8-1.8)	1.1(0.8-1.5)	0.8(0.6-1.1)
Properly Treat Water						
No	1.1(0.8-1.5)	0.8(0.6-1.1)	1.5(0.9-2.2)	0.9(0.6-1.5)	0.7(0.4-1.1)	0.8(0.5-1.2)
Toilet Type*						
Non-Improved	1.2(0.9-1.5)	1.3(0.9-1.6)	1.1(0.9-1.3)	1.7(1.2-2.4)	1.8(1.4-2.5)	1.6(1.2-2.3)
Shares Toilet?*						
Have, Do not Share^						
Have, Shares	1.3(1.0-1.9)	1.3(1.1-1.7)	1.0(0.8-1.3)	1.1(0.7-1.6)	1.6(1.1-2.3)	1.3(0.8-2.1)
Do not Have	1.4(1.1-1.8)	1.4(1.1-1.7)	0.9(0.7-1.2)	1.5(1.1-2.2)	1.7(1.1-2.4)	1.9(1.2-3.2)
Wash hands with soap/ash*						
Don't	0.8(0.6-1.1)	0.8(0.7-1.1)	1.4(1.2-1.8)	1.6(1.1-2.3)	1.4(1.1-1.9)	1.2(0.9-1.7)
Household Head Sex*						
Male	0.9(.6-1.3)	1.2(0.6-2.3)	0.9(.5-1.6	1.3(0.8-2.0)	1.1(0.7-1.6)	1.2(0.7-1.8)
Residence*						
Rural	1.2(0.9-1.5)	0.9(0.7-1.2)	1.1(0.8-1.3)	0.8(0.5-1.3)	2.1(1.4-3.1)	1.2(0.8-1.7)
Wealth Status*						
Poorest	1.2(0.8-1.7)	1.0(0.6-1.5)	1.4(0.9-2.1)	1.4(0.7-2.9)	2.2(1.2-4.0)	3.7(1.9-7.5)
Poorer	1.7(1.2-2.4)	1.0(0.7-1.6)	1.5(1.1-2.2)	1.8(1.1-2.9)	1.8(1.1-2.9)	1.8(1.1-3.0)
Average	1.4(0.9-2.0)	0.7(0.4-0.9)	1.2(0.8-1.8)	2.0(1.2-3.2)	1.3(0.8-1.9)	1.8(1.1-2.8)
Wealthier	1.0(0.7-1.5)	0.8(0.5-1.4)	1.2(0.7-1.9)	1.1(0.6-1.8)	1.4(0.9-2.1)	1.5(1.1-2.3)
Wealthiest^						

*Significant at 5% ^Reference Category OR Odd Ratio CI Confidence Interval

prevalence varied significantly across the regions, the sanitation, hygienic practices and characteristics of the households. This could be ascribed to the fact that over a third of Nigerian households do not have access to improved water sources. Both hygienic and environmental factors as well as social-economic characteristics of households significantly predisposed under-five children to have diarrhoea in Nigeria and these varied across regions. These include households' sources of drinking water, toilet types, toilet sharing, hand washing with soap or ash, sex of household head, place and region of residence and the economic status etc.

Under-five children from households in North East and North-West Nigeria were more likely to experience diarrhoea than children from South West. This might be due to the fact that households from South West Nigeria had better access to improved water and sanitation facilities[22] and as found in the current study. These findings give credence to the survey conducted in 2006 by the National Bureau of Statistics (NBS) which reported that improved water coverage ranged from 73.5% in the South West to 30.7% in the North East region in Nigeria.[28] Similar geographical variations have been reported.[29]

Children in households with non-improved sources of drinking water were more likely to suffer diarrhoea than those who drank from improved sources. This finding was corroborated by reports from rural Burundi that revealed that children from households that obtain water from protected sources were less likely to have diarrhoea as compared to those who get their water supply from unprotected sources.[30] Reports from Ethiopia, also indicated that the use of unprotected water sources was significantly associated with diarrhoea morbidity.[10,31] Across the regions, we observed variability in the odds of having diarrhoea viz-a-viz sources of drinking water. Prevalence of diarrhoea was significantly influenced by water sources in South East and South South. Unfortunately, access to improved water, though essential for human life still remains unavailable to many Nigerians. Access to water from improved sources and improved sanitation facilities is a must for the sustainable development goals to be achieved in Nigeria. This finding better buttresses the need for the provision of portable water across all regions.

In the present study, treatment of water, use of improved water storage or covering of water storage were not significantly associated with having diarrhoea among under-five year children. This is intuitive since water from a hitherto improved source might have been contaminated thereafter. A recent WHO had concluded that water from improved source is not always safe.[32] Water of initially acceptable microbial quality often becomes contaminated with pathogens during transport and storage.[33] Interventions to improve water quality at the source, along with treatment of household water and safe storage systems, have been shown to reduce diarrhoea incidence by as much as 47 percent.[25] There was no unique pattern in the likelihoods of having diarrhoea when we considered types of drinking water storage and covering of container in the regions. While the odds were lower in some household with improved types, it was higher in some regions. However, policies should

Table 4: Bivariate logistic regression of factors predisposing Diarrhoea among under-five children in Nigeria households

Variables	OR	(95% CI)	p-value
Drinking Water Source*			
Non-Improved	1.20	1.08-1.33	0.001
Container Covered			
No	1.00	0.87-1.15	0.994
Water Storage			
Non-Improved	0.95	0.86-1.05	0.309
Properly Treat Water			
No	0.92	0.77-1.10	0.381
Toilet Type*			
Non-Improved	1.39	1.26-1.54	<0.001
Shares Toilet?*			
Have, Do not Share^			
Have, Shares	1.01	0.89-1.13	0.922
Do not Have	1.15	1.01-1.31	0.038
Wash hands with soap/ash*			
Don't	1.25	1.12-1.39	<0.001
Household Head Sex*			
Male	1.30	1.08-1.56	0.005
Residence*			
Rural	1.32	1.18-1.48	<0.001
Region*			
North Central	1.56	1.28-1.90	<0.001
North East	2.22	1.82-2.69	<0.001
North West	2.02	1.68-2.43	<0.001
South East	1.52	1.20-1.92	<0.001
South South	1.29	1.04-1.60	0.022
South West			
Wealth Status*			
Poorest	1.90	1.61-2.24	<0.001
Poorer	1.93	1.63-2.28	<0.001
Average	1.47	1.23-1.75	<0.001
Wealthier	1.20	1.01-1.44	0.054
Wealthiest^			

*Significant at 5% ^Reference Category OR Odd Ratio CI Confidence Interval

be directed to the provision of portable water to regions where higher prevalence was found in a household with non-improved water storage system.

Improved household sanitation facilities have been linked to a reduction in diarrhoea incidence.[9,30,31,34] Our findings also gave credence to this fact. The likelihood of under-five children having diarrhoea was almost 40% more likely in households using non-improved toilets than those using improved toilets. Prevalence of diarrhoea was more common in households with inadequate or unimproved sanitation. On a regional basis, odds of having diarrhoea was higher in a household without toilets and those that shared toilets except in North West. This suggests that laws enforcing the provision of toilet facilities by households should be enforced in these regions.

Diarrhoea is more prevalent among households without toilet facilities in all the regions. Our finding is in consonance with reports of United Nations 2013, that countries, where open defecation is widely practised had highest under-five deaths.[19] This might not be unconnected with Nigeria situation which had the highest number of under-5 deaths in 2013 after India[35] since Nigeria has 39 million people practising open defecation.[19] Eliminating open defecation, a practice strongly associated with poverty and exclusion is critical to accelerating progress towards the MDG sanitation target.[19] Since diarrhoea diseases are of faecal origin, interventions that prevent faecal material entering the domestic environment are likely to be of greatest significance for public health and should be critical to policy formulations in all regions in Nigeria for diarrhoea to be sent to extinction.

As evidenced in our study, under-five children in a household whose members do not wash hands with soap/ash were more vulnerable to diarrhoea than those who do. Hand washing with soap after defecation, and before and after food handling can interrupt diarrhoea disease transmission path.[10,30,31] Previous study has shown that hand washing with soap can reduce the incidence of diarrhoeal disease.[1] Hand washing before meals is less prevalent in the Northern regions. Efforts should be

Table 5: Multiple logistic regression of factors predisposing Diarrhoea among under-five children in Nigeria households

	Model I		Model II	
Variables	aOR	95% CI	aOR	95% CI
Drinking Water Source*				
Non-Improved	1.13	1.02-1.25	1.10	1.03-1.20
Toilet Type*				
Non-Improved	1.41	1.25-1.59	1.20	1.05-1.37
Shares Toilet?				
Have, Do not Share^				
Have, Shares	0.98	0.87-1.11	0.84	0.74-0.96
Do not Have	1.14	1.10-1.31	1.09	1.04-1.14
Wash hands with soap* soap/ash*				
Don't	1.18	1.06-1.33	1.15	1.07-1.30
Household Head Sex				
Male			1.13	0.92-1.35
Residence				
Rural			0.91	0.79-1.05
Region*				
North Central			1.41	1.14-1.73
North East			1.86	1.49-2.32
North West			1.82	1.47-2.26
South East			1.57	1.22-2.02
South South			1.24	0.98-1.56
South West^				
Wealth Status*				
Poorest			1.37	1.11-1.70
Poorer			1.51	1.24-1.84
Average			1.26	1.04-1.53
Wealthier			1.12	0.93-1.35
Wealthiest^				

*Significant at 5%^Reference Category OR Odd Ratio aOR Adjusted Odd Ratio, CI Confidence Interval

strengthened to educate Nigeria households on the need to inculcate handwashing practices, especially in the Northern regions.

In Nigeria context, culture demands that men should be the head of household except for few situations where women may take up such responsibility. We found that children from households headed by males had a higher likelihood of having diarrhoea than those headed by females. This is in consonance with a previous report that sex of the head of the household plays a major role in determining the household choice of water source.[36] The report showed that male-headed households are less likely to choose an improved source compared with female-headed households. However, we did not find any significant difference in any of the regions. This could be ascribed to earlier argument that sex of household head may not reflect actual responsibilities or decision-making power in the household over access to drinking water and sanitation.[19] Also, female headship does not necessary implied poorer households. Husbands working in urban areas may send remittances home and as a result, a female-headed household may have higher purchasing power, which could translate to better levels of access.[19] This has thrown controversies into the understanding of the effect of sex of household head and choice of source of drinking water.

It was evidenced from our study that place of residence is a strong determinant of diarrhoea occurrence. We found children from households living in rural areas to have a higher risk of having diarrhea in most regions. This is in consonance with previous report that living in an urban area increases the probability of adopting an improved water source.[37] Also in our study, there are significant disparities between rural and urban areas in regard to sanitation. Rural areas continue to have a lower percentage of the population using improved sanitation and a higher number of people without improved facilities.[21] Nevertheless, we found diarrhoea to be more prevalent in urban North East and South East than in rural areas. This calls for serious concern. In these regions, similar efforts aimed at curbing diarrhoea in rural areas should be exercised in the urban areas.

Also, evidence from our study was that diarrhoea prevalence was higher among households in poorest and poorer economic status than those in the richest economic status. Studies have shown that wealth underpins access to improved water supply and sanitation and the ability to practise improved hygiene behaviours; hence increased the prevalence of diarrhoea in poorer households.[19,38] The UNICEF had stressed that a strong relationship exists between wealth and use of improved water sources and sanitation.[19] Also, a recent Cameroonian study reported that likelihood of using potable water sources increases consistently with increasing level of household wealth index.[38] Better-off households are more likely to consume safe and reliable water. It may be argued that the income accruable to households from the middle and poorest wealth index may be insufficient to afford clean water. This could force such households to access poor water supply especially in developing countries such as Nigeria where every household has to fend for her portable water. This situation is prevalent in all the regions

except in the North East where the likelihoods didn't differ significantly.

Conclusions and Recommendation

Diarrhoea is very prevalent in Nigeria. The likelihood of a child to contract diarrhoea differed significantly across the regions. It was also noticeable that the different factors considered in this study had varying effects on prevalence of diarrhoea across the regions. Commonest risk factors across the regions are the use of non-improved sources of drinking water, unimproved toilet facilities, sharing toilets, defecating openly, no hand washing with soap or ash and wealth quintile. This study has presented significant evidence that provision of improved water and sanitation coupled with good hygiene practices can substantially reduce diarrhoea morbidity and mortality across the regions. Based on differentials in prevalence and risk factors across the regions, regional-specific policies should be developed to tackle diarrhoea in Nigeria rather than using "generalised" approaches. Government and other stakeholders should wake up to the huge responsibility of provision of improved water to her citizenry. Empowering poorer households will reduce wealth inequalities and also play a key role in ensuring access to reliable improved water sources and sanitation facilities. Health promotion strategies on how to sustain effective hygiene practices such as handwashing and discouragement of open defecation should be instituted by relevant stakeholders and policy makers in all the regions. The current study has shown that diarrhoea remains a public health problem in Nigeria which varied by regions. This suggests that policies and programming, including resource allocation, on eradication of diarrhoea, should not be "one-cap-fits-all" but must be region-based considering the different region-based.

Strengths and Limitations

The cross-sectional design of the data collection might have introduced a recall bias. Information on the experience of diarrhoea was supplied by the household heads without any means of verification. Household heads may be unable to accurately report all diarrhoea cases especially when the child involved has died or had diarrhoea during the absence of the household heads. The strengths are worthy of mention. First, the uniqueness of this study beyond previous research is its focus on regional trends in the prevalence and factors associated with diarrhoea occurrence among under-five children in Nigeria. The study leverages on the use of National HIV/AIDS and Reproductive Health Survey (NARHS Plus II) data, a nationally representative data whose method of collection has been through a validated process.

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Competing interest

The authors declare no competing interest

Authors Contributions

AFF and OMM conceived the study, developed the research questions and designed the study. AFF analysed data and wrote the methodology and the results, contributed to writing the introduction and discussions. OMM wrote the introduction and discussion. EA partook in writing the introduction and methodology. All authors proofread the final version of the manuscript.

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