Research Journal of Agronomy
MEDWELL PUBLICATIONS SINCE 2000

Effect of Access to Potable Water and Sanitation on Health of Under-5 Children among Rural Households in Nigeria

[1]G.O. Ogunsola and [2]B.T. Omonona
[1]Department of Agricultural Economics and Extension, Faculty of Agriculture, Bowen University, Iwo, Nigeria
[2]Department of Agricultural Economics, Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria

Key words: Portable water, health, rural, under five children, DHS

Corresponding Author:
G.O. Ogunsola
Department of Agricultural Economics and Extension, Faculty of Agriculture, Bowen University, Iwo, Nigeria

Page No.: 12-20
Volume: 13, Issue 2, 2019
ISSN: 1815-9354
Research Journal of Agronomy

Abstract: This study examined the effect of access to potable water on the health of under-five children in rural Nigeria employing the Demographic and Health Survey (DHS) 2008 data. Exactly 13.571 households were analyzed using descriptive statistics and probit regression. The results showed that while the mean age of child is, more than half of the mothers had no formal education and 63.67% had access to improved water source. The probit regression results reveal that access to improved water source reduces the probability of a child being stunted, wasted, underweight and having diarrhoea. Other factors include access to improved toilet facility, sex of child, age of mother and mother's education. The age of child and household size were significant and positively related to the probability of a child being stunted, wasted, underweight and diarrhea prevalence. More definite steps to improving access to portable water should be considered. This will also aid the achievement of the sustainable development goals.

INTRODUCTION

Portable water is important for human survival and safe potable water is a basic necessity for good health but water related illnesses are the prominent health threat in the developing world. About 1.7 million deaths annually are related to drinking unsafe water and poor disposal of wastes (WHO, 2007). Safe potable water is a basic necessity for good health. Unsafe potable water can be a significant carrier of diseases such as trachoma, cholera, typhoid and schistosomiasis. Children especially under the age of five are most vulnerable to contaminated water and lack of hygienic sanitation due to their low natural immunity and high percentage of infant mortality and morbidity (Adewara and Visser, 2011). Studies in different countries have shown that the quality of water is positively significant with reductions in diarrhoea and mortality (Classen *et al*., 2007; Kremer *et al*., 2009).

Water problems affect half of humanity. About 1.1 billion people in developing countries lack access to water and 2.6 billion people lack basic sanitation (WHO/UNICEF, 2006). According to the World Bank, 88% of diseases in the developing world is caused by unsafe drinking water (Ashbolt, 2004). Diseases from microbial pollution may be the result of the contamination of drinking water by human or animal feaces containing pathogenic bacteria and viruses that may cause cholera, amoebic and bacillary dysentery and other diarrhoeal diseases; Parasites such as *Dracunculus medinensis*, in organisms living in the water (Fogden and Wood, 2009).

Today, Africa is facing the challenge of how to make up the deficiencies in creating sustainable access to potable water. Despite aid to water and sanitation targeted at regions most in need of better access to water and sanitation where Sub-Saharan Africa received about a quarter (26%) of total aid to the sector and South and Central Asia 21%, many developing countrie's improved water supply schemes are not functioning properly (Vasquez *et al*., 2009; Kleemier, 2000). As reported by Baumann (2005), 35% of all rural water systems are not functioning. Thus, sustainability of both new and existing water systems is essential and should be considered.

As part of the millennium development goals, the international community has set a goal of reducing the proportion of people without sustainable access to safe drinking water by 50% by 2015 compared to its level in 1990 (Aonymous, 2015). The target of halving the proportion of people without access to an improved drinking water source and sanitation was achieved in 2010. In 2012, 89% of the world's population had access to an improved source, up from 76% in 1990. Over 2.3 billion people gained access to an improved source of drinking water between 1990 and 2012.

Over 63 million Nigerians lacked access to improved water source while 112 million people don't have access to adequate sanitation. Over 97,000 children die every year from diarrhoea caused by unsafe water and poor sanitation. The loss of 443 million school days each year in Nigeria results from water-related illness. Close to half of all people in developing countries suffer at any given time from a health problem caused by water and sanitation deficits with millions of women spending several hours per day collecting water. Also, water infrastructure is also suffering from severe neglect. Rural areas in particular face a decline in services and in urban areas people are forced to buy water from private vendors which most cannot afford. Local governments often do not have the funds to make necessary improvements and can instead be forced to use short-term solutions which cannot be maintained by the communities who need them. (www.wateraid. org/ng/what-we-do/the-crisis/water).

At all levels (micro and macro), access to safe potable water is important as a health and development issue and improving this access can be an effective part of poverty alleviation strategies. There is a widespread assumption that safe; affordable water for potable and domestic use is available to all but the reality is that some rural areas (low-income communities) lack access to water for the most basic human needs. This lack of access to clean, safe potable water can be caused by contamination in the water or because of a lack of adequate portable water and wastewater infrastructure, such as old or nonexistent plumbing facility (WHO., 2008). Also, inadequate access to potable water may be responsible for diseases in women and children especially in rural areas who bear the primary responsibility of carrying water, often for long distances.

Furthermore, lack of access to safe potable water and sanitation results in high mortality rate, malnutrition of children especially under five children. As observed by Eneh (2005) malnutrition is responsible for high rate of stunting (33.5%), underweight (30.7%) and wasting (15.6%) among under-five children. Water is one of the most important nutrients for children to keeping them healthy and also helping them perform better. Annually, 4 billion cases of diarrhoea occur in Nigeria of which 88% is attributable to unsafe water and inadequate sanitation and hygiene. The 1.8 million people die every year from diarrhoea diseases, the vast majority children under 5 years of age. WHO. (2007) estimates that 94% of diarrhoea cases are preventable through modifications of the environment including through interventions to increase the availability of clean water and to improve sanitation and hygiene.

Although, a number of reviews exist on water and human health (Harvey and Reed, 2004). Only a few focus on public health and economics on the household level considering the demand for drinking water (Adekalu *et al*., 2002), supply (Agbelemoge and Odubanjo, 2001) and willingness to pay for potable water supplies (Casey *et al*., 2005) with little focus on children.

This study also examines the effect of portable water and sanitation at the household level on the health and nutritional status of under five children in rural Nigeria. This is important considering the fact that high infant mortality is greatly associated with contaminated water. It differs from pervious paper on diarrhea as it considers the probability of under five children being stunted, wasted and underweight. Therefore, this paper uses anthropometric measures and the incidence of diseases (diarrhoea, stunting, wasting and underweight) to examine the effect of access to portable water and sanitation on the health of under five children and aims to answer the following questions. What are the sources of portable water available to rural households? What is the effect of access to safe portable water on under-5 children's nutritional status and diarrhoea prevalence?

Literature review on access to potable water and sanitation and effects on Nigeri: Egbetokun and Omonona reported that in Nigeria, over two third of the diseases affecting the people and in particular the under-five age group can be attributed to poor water supply (lack of access to good water) and unsanitary conditions. Apart from high mortality rates caused by poor water and sanitation induced diseases, these diseases also account for high morbidity resulting in low productivity, high rate of absenteeism from work, high dropout rates from schools especially among girls and poverty. They also noticed that on the national level, less than seven out of ten Nigerians have access to safe water, over 50% of States in the Federation including the Federal Capital Territory have figures below the national average (67.40) and that all the states in the north west zone of the country have the proportion of their people with access to safe water being higher than the national average. While the reverse holds for the South-East and South-South zones, they all recorded figures below the national average. In the South West zones, only Ondo and Ekiti had figures below the national average.

According to Akpor and Muchie (2011), although, there is temporal and spatial variation in water availability between North and South in Nigeria, the country is considered to be abundantly blessed with water. Despite this abundance and existence of several government agencies responsible for the efficient water supply and distribution, current access to improved water is still low with improved supply increasing from 47% in 1990 to 58% in 2008. They recommended that there is need for enforceable water legislation, building of institutions and policies related to water resource planning, development and management, demand management and privatization of water supply and distribution sector which can result in a significant increase in proportion of people with access to improved drinking water source.

Onyenkenwa observed that dwindling municipal water supply made people to fall back on dubious water sources which are detrimental to their health. He said Methaemoglobinemia, dehydration, malnutrition and loss of parents associated with high MMR (Measles, Mumps and Rubella) and water and sanitation related low life expectancy afflict children leading to high mortality rate and morbidity in infants and under five children. Thus, he recommended that emphasis be placed on preventive health care and pro-poor health policies to ensure the quality and availability of safe water.

Adewara and Visser (2011) used 2008 DHS to construct Child height and weight Z-scores and used regression analysis to analysis the effects of different sources of drinking water and sanitation on child health outcomes in Nigeria. They found out that both child height and weight Z-scores are positive and significantly related to access to borehole and piped water and negative and significant for well water. The probabilities of a child being stunted or underweight are both significantly lower for children drinking borehole or piped water whereas well water has a positive and significant effect on these measures of child health.

MDG reported that over 2.3 billion people gained access to an improved source of drinking water between 1990 and 2012 and 2 billion people gained access to improved sanitation facility. Also, a quarter of all children under the age of 5 years were estimated to be stunted having inadequate height for their age. Thus, representing a significant decline since 1990 when 40% of young children were stunted. However, the report of 162 million young children suffering from chronic under nutrition is still alarming. Much greater effort and investment will be needed to redress inadequate water and sanitation in the coming years.

Ezeh *et al*. (2014) in their study aimed to determine whether children under 5 years old without access to improved water and sanitation facilities are at higher risk of death in Nigeria. Pooled 2003, 2008 and 2013 Nigeria Demographic and Health Survey data were used to examine the impact of water and sanitation on deaths of children aged 0-28 days, 1-11 and 12-59 months using Cox regression analysis. They observed that the risk of mortality from both unimproved water and sanitation was significantly higher by 38% (Adjusted Hazard Ratios (HR) = 1.38, 95% Confidence Interval (CI): 1.14-1.66) for post-neonatal mortality and 24% (HR = 1.24, 95% CI: 1.04-1.48) for child mortality. The risk of neonatal mortality increased by 6% (HR = 1.06, 95% CI: 0.85-1.23) but showed no significant effect. They recommended that Nigerian government needs to invest more in water and sanitation to reduce preventable child deaths.

MATERIALS AND METHODS

Study area: The study area is rural Nigeria. Nigeria the most populous nation in Africa is made up of 36 States and a Federal Capital Territory (FCT), grouped into six geopolitical zones: North West, North East, North Central, South East, South South and South West and with 774 constitutionally recognized Local Government Areas (LGAs). Nigeria lies between latitudes 4°16' and 13°53' North and longitudes 2°40' and 14°41' East with population of 140,431,790 (NPC, 2006).

Data sources and collection: The study employed the 2008 Demographic and Health Survey (DHS) a nationally representative data. Data was extracted for rural Nigeria and a total of 13571 households were considered for this study.

Methods of analysis: In the study both descriptive statistics and inferential statistical tools were employed. Descriptive statistics like tables, mean, standard deviation, percentages and frequency were used. Inferentially, the probit regression analysis is adopted to measure the degree of association between two or more variables.

Table 1: Explanatory variables

Variables	Measurements	A prior expectation
X1/Age of child	Years	-ve
X2/Sex of child	Male = 1, Female = 0	+
X3/Mother's years of education	Years	-
X4/Wealth index	Poorest = 1, Poorer = 2, Middle = 3, Richer = 4, Richest = 5	-
X5/Access to source of water	Improved = 1, Unimproved = 0	-
X6/Mother's age	Years	-
X7/Access to toilet facility	Improved = 1, Unimproved = 0	-
X8/Household size	Numbers	+
X9/Fathers years of education	Years	-
X10/Father's occupation	Agricultural services = 1; Nonagricultural services = 0	-
X11/Floor material	Improved = 1, Unimproved = 0	-
X12/Roof material	Improved = 1, Unimproved = 0	-
X13/Wall material	Improved = 1, Unimproved = 0	-
X14/Region	North Central, North East, North West, South East, South West, South Central	
X15/Duration of breast feeding	Months	-

Adewara and Visser (2011) and Babatunde *et al*. (2011)

Analytical technique

Probit model: According to Nagler, probit model constrains the estimated probabilities to be between 0 and 1 and relaxes the constraint that the effect of the independent variable is constant across different predicted values of the dependent variable. This is normally experienced with the Linear Probability Model (LPM). The probit model assumes that while we only observe the values of 0 and 1 for the variable Y, there is a latent, unobserved continuous variable Y* that determines the value of Y. We assume that P* can be specified as follows:

$$P_i^* = b_0 + b_1 x_{1i} + b_2 x_{2i} +, \ldots, + b_k x_{ki} + u_i \quad (1)$$

The probit model specified in this paper to analyse the effect of access to potable water on the health of under-five children in rural Nigeria is specified as:

$$P_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_n x_n + v \quad (2)$$

P_i which is the health of child, was measured in two forms:

- Nutritional status measured using the anthropometric measures (stunting- 1= stunted and 0 otherwise; wasting 1 = wasted and 0 otherwise; underweight 1 = underweight and 0 otherwise)
- Diarrhoea prevalence (1 = yes and 0 otherwise)

The explanatory variables are presented in Table 1.

Table 2: Socioeconomics characteristics of under five children in rural Nigeria

Variables	Frequencies	Percentage
Sex		
Male	6723	49.54
Female	6848	50.46
Child's age in months		
0-12	3324	24.49
13-24	2664	19.63
25-36	2470	18.20
37-48	2757	20.32
49-60	2356	17.36
Household head occupation		
Agricultural services	7901	58.22
Non-agricultural services	5670	41.78
Household size		
1-3	1099	8.10
4-6	7833	42.98
7-9	3886	28.63
10 and above	2753	20.29
Mothers age		
<20	774	5.70
20-39	11275	83.08
40-59	1522	11.22
Mother's education		
No education	7369	54.30
Primary	3363	24.78
Secondary	2507	18.47
Higher	332	2.45
Region		
North central	2481	18.28
North East	3206	23.78
North West	6674	28.68
South East	1485	7.34
South West	2465	12.83
South South	1638	9.25

Author's computation 2015

RESULTS AND DISCUSSION

Socioeconomic characteristics: The socioeconomic characteristics in Table 2 indicate that 49.54% of the under five children are males and 50.46% are females with most of them between 1-12 months of age (24.49%) and mean age of 27 months. The mother's age were mostly between 20-39 years (83.08%) implying that they were in their economically active years. In addition, 54.30% of the mothers had no form of formal education. Adewara and Visser (2011) posited that the investment in human capital, especially, women has great importance in the role that women play in the upbringing of a child. Majority of the households had about 4-6 members (42.98%). About 58.22% of household heads are engaged in agriculture-related activities while only 41.78% are engaged in non-agricultural occupation. This is typical of rural areas where the occupation is predominantly agriculture.

Water, sanitation and nutritional characteristics: Most of the rural dwellers have access to improved water (36.45%) and 63.55% were without access to improved water. According to UNICEF (2000) the improved water sources include water piped into dwelling, piped into yard/plot, public tap/stand pipe, borehole, protected well and protected spring while the unimproved sources are the unprotected well, unprotected spring, river, rain water, tanker truck and tart with small tank. Also, 56.82% had access to improved toilet facility while 43.18% had access to unimproved toilet facility. Improved toilet sources include; flush to piped sewer system, flush to septic tank, flush to pit latrines, ventilated pit latrine and pit latrine with slabs. Unimproved sources include; composting toilet, bucket toilet, hanging toilet and bush. In addition, most of the under five children were breast feed between 13-24 months of which 54.06% of them were non-stunted and 45.94% were stunted; 26.98% were underweight and 73.02% were not underweight; 15.51% were wasted while 84.49% were not wasted and 11.1% had diarrhea while 88.9%. Access to improved portable water and sanitation have been found out to reduce or reverse malnutrition (stunting, wasting and underweight) and diarrhoea in under five children and vice versa (Merchant *et al*., 2003; Schmidt, 2014). Lack of access to improved water is one of the major causes of ill-health in under-five children, especially stunting, underweight and wasting in under-five children (WHO., 2008; Adewara and Visser, 2011). The rampant causes of diarrhoea across the country among children have been attributed to sources of unsafe water which is as a result of lack of potable and safe drinking water imminent during the dry season.

Effect of water source on the health of the under five children

Effect of water source on the nutritional status of under five children: Examining the effect of access to portable water on the probability of a child being stunted, underweight and wasted, the regression results show that age of child is negatively related to the probability of stunting and underweight but positively related with the probability of a child being wasted, implying that other things being equal, older children are more likely to be less stunted and underweight at 1%. The marginal effect estimates reveals that this probability of a child being stunted and wasted decreases by 0.01 (stunted), 0.01 (underweight) and the probability of a child being wasted increases 0.01 (wasted) units as the age of child increases. This finding is consistent with that of Babatunde *et al*. (2011) and Adewara and Visser (2011). The sex of the child is both negative and significant at 1% implying that male under-five children are less prone to be stunted, underweight and wasted. The marginal effect estimates reveals that the probability of being stunted, underweight and wasted increases for being a male by 0.06, 0.03 and 0.01, respectively. This contradicts the findings that in sub-Saharan Africa male children under 5 years old are more likely to become stunted, underweight and wasted than their female counterpart of the same age group (Ozor *et al*., 2014).

The age of the mother is positive in relation to the probability of the child being stunted, underweight and wasted and the marginal effect estimates reveals that the probability of a child being stunted, underweight and wasted increases by 0.01, 0.01 and 0.001 for teenage (younger) mothers compared to older mothers, respectively. Mother's education is both positive and significant in determining whether a child will be stunted, underweight and wasted. The marginal effect estimates reveals that the probability of a stunted, underweight and wasted child decreases by 0.04, 0.06 and 0.03, respectively for every increase in mother's education. Educated mothers have better information on children's health care and generally earn higher incomes than mothers who are not educated. It is expected that the more educated a mother is the more likely she is to be receptive to developmental initiatives such as the childhood survival strategies have improved family nutrition and less risk of childhood malnutrition (UNICEF, 2000).

Duration of breast feeding is positive for stunting at 1% and negative for underweight (1%) and wasting, implying that young children are less likely to be underweight and wasting when fed with sufficient breast milk. The marginal effect estimates reveal that the probability of child being stunted increases by 0.02 as duration of breast feeding increases and the probability of a child being underweight and wasted decreases by 0.001 and 0.003, respectively as duration of breast feeding increases. Father occupation is negatively related to the probability of a child being stunted, underweight and wasted. The marginal effect estimate reveal that the probability of a child being stunted, underweight and wasted decreases by 0.005, 0.0007 and 0.001, respectively. Father's education is negative for stunting but positively related to the probability of a child being underweight and wasted at 1% level of significance. The marginal effect estimates reveal that the probability of a child being stunted, underweight and wasted decreases by 0.0005 and increases by 0.01 and 0.01, respectively as father's education increases.

The wealth index is positively related for stunting (1%) and underweight while negatively related to wasting. The marginal effect estimate reveals that the probability for stunting increases by 0.03 while the probability of a child being underweight and wasting decreases by 0.008 and 0.007, respectively. Thus, poorer households are more likely to have more children that are underweight and wasted than richer households, considering the poverty and hunger ravaging the rural areas.

The access to water source is both negative for stunted (1%), underweight (1%) and wasted. The marginal effect estimates reveals that the probability of a child being stunted, underweight and wasted decreases by 0.01, 0.02 and 0.01, respectively as access to water source increases, this implies that children with access to improved water source are less prone to be stunted, underweight and wasting compared with those that lack access to improved sources. This follows Babatunde *et al*. (2011) findings that access to clean water reduces the incidence of stunting among the sample children. Clean water and toilet are health variables that have been shown in the literatures to contribute to improved nutritional status of children. Also with respect to stunted, underweight and wasted, access to toilet facility is also negative and significant at 1%. This suggests that access to improved toilet facility reduces the probability of a child being stunted, underweight and wasted and the marginal effect estimates reveals that the probability decreases by 0.003, 0.01 and 0.004, respectively compared to those who use unimproved sources. This agrees with Adewara and Visser (2011) and Babatunde *et al*. (2011) that availability of improved toilet facility for human waste is essential for healthy life and adequate growth of children and lower the risk of infectious diseases and malnutrition.

The household size is positively related at 1% to stunting and wasting but negatively related to underweight. The marginal effect estimates reveals that the probability of a child being stunted and wasted increases by 0.003 and 0.001, respectively as household size increases and the probability of a child being underweight decreases by 0.04 as household size increases. Children from larger households are less prone to being stunted and wasted because of high cost of living. (Adewara and Visser, 2011).

The roof material is negative for stunting and underweight but it is positive for wasted and significant at 5%. The marginal effect estimates reveal that the probability of a child being stunted and underweight decreases by 0.01 and 0.01, respectively with the use of improved roof material as compared with those with unimproved roof material. The marginal estimate with the probability of a child being wasted increases by 0.02 with the use of improved roof material. The wall material is positively related to the probability of a child being stunted (1%), underweight (5%) and wasted. The marginal effect estimates reveal that the probability of a child being stunted, underweight and wasted increases by 0.03, 0.02 and 0.008, respectively with the use of improved wall material. The floor material is also positively related with the probability of a child being stunted, underweight and wasted increases with the use of improved floor material.

North East region is negatively related to the probability of a child being stunted, underweight (1%) and wasted (1%). The marginal effect estimate reveal that the probability of a child being stunted, underweight and wasted decreases by 0.04, 0.09 and 0.107, respectively. North West region is significant at 1% and negatively related to the probability of a child being stunted, underweight and wasted. The marginal effect estimate reveal that the probability of a child being stunted, underweight and wasted decreases by 0.03, 0.12 and 0.11, respectively. South East region is positively related to the probability of a child being stunted, underweight and wasted. The marginal effect estimate reveal that the probability of a child being stunted, underweight and wasted decreases by 0.15, 0.05 and 0.05, respectively. South West region is significant and positively related to the probability of a child being stunted and underweight but negatively related to the probability of a child being wasted. The marginal effect estimates reveal that the probability of a child being stunted and underweight increases by 0.08 and 0.04, respectively and the probability of a child being wasted decreases by 0.005. South South region is significant at 1% and positively related to the probability of a child being stunted and underweight but negatively related to the probability of a child being wasted. The marginal effect estimates reveal that the probability of a child being stunted and underweight increases by 0.05 and 0.04, respectively and the probability of a child being wasted decreases by 0.006.

Effect of access to portable water on the probability of a child having diarrhea: As observed from Table 3, the

Table 3: Distribution of household or under five children by portable water source, Sanitation and Nutritional characteristics

Variables	Frequency	Percentage
Water		
Improved portable water source	8624	63.55
Unimproved portable water source	4947	36.45
Sanitation		
Improved toilet facility	5860	43.18
Unimproved toilet facility	7711	56.82
Nutritional characteristics		
Duration of breast feeding (months)		
No breast feeding	588	4.330
1-12	1096	8.080
25-36	6719	49.51
13-24	208	1.530
37-48	2	0.020
Still breast feeding	4958	36.53
Stunted	6234	45.94
Not stunted	7337	54.06
Underweight	3661	26.98
Not underweight	9910	73.02
Wasted	2105	11466
Not wasted	15.51	84.49
Had diarrhoea	1506	11.10
No diarrhoea	12065	80.90

N = 13571

Table 4: Probit regression estimates for effect of access to portable water on health of under-five children

Independent variables	Stunting		Underweight		Wasted		Diarrhea	
	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect	Coefficient	Marginal effect
Age of child	-0.0320119***	-0.0126945***	-0.0389788***	-.0124444***	0.0617014***	0.0137311***	-.1260749***	-0.0215929***
	-0.0099694	0.00395	-0.0108583	-0.00347	-0.012622	-0.0028	(0.0143381)	(0.00243)
Sex of child	0.1404117***	0.0556812***	0.0807062***	0.0257664***	0.0457054**	0.0101713**	-0.0593355**	-0.0101624**
	-0.0219412	0.0087	-0.0238403	-0.00761	-0.0268975	-0.00599	(0.0295306)	(0.00506)
Age of mother	0.0155353**	0.0061606**	0.0217807***	0.0069537***	0.0059465	0.0013233	0.0008779***	0.0001504***
	-0.008047	0.00319	-0.0086879	-0.00277	-0.0097784	-0.00218	(0.0107126)	(0.00183)
Duration	0.0505914***	0.0200624***	-.0045081***	-.0014392***	-0.0163706	-0.0036431	-0.0029171	-0.0004996
Breast feeding	-0.008624	0.00342	-0.0094189	-0.00301	.0106039)	-0.00236	(0.0115961)	(0.00199)
Household	0.0076939	0.0030511	-0.0141832	-0.0045281	0.0056932	0.001267	0.0108117	0.0018517
Size	-0.0133244	0.00528	0.0143888	-0.00459	-0.0162665	-0.00362	(0.0176645)	(0.00303)
Toilet	-0.0096634	-0.0038318	0.0492107**	0.0157453**	0.0222797	0.0049663	0.0453184	0.007731
	-0.0258907	-0.01027	-0.0281918	-0.00904	-0.0317743	-0.00709	(0.0348997)	(0.00593)
Access to	-0.037167	-0.0147459	-0.0520598**	-0.0166976**	-0.044747	-0.0100234	-0.0110123***	-0.001928***
drinking water	-0.025124	0.00997	-0.027393	-0.00883	-0.0308004	-0.00694	(0.0013273)	(0.00023)
Father	-0.0134875	-0.0053486	-0.002325	-0.0007423	-0.007296	-0.0016237	-0.03794***	-0.006498***
Occupation	-0.0084587	-0.00335	-0.0091389	-0.00292	-0.0102861	-0.00229	(0.0111958)	(0.00192)
Fathers	-0.0013004	-0.0005157	0.0434262***	0.0138643***	0.0821038***	0.0182714***	-0.0245293	-0.0042012
Education	-0.0144724	0.00574	-0.0159641	-0.0051	-0.0183645	-0.00408	(0.0196881)	(0.00337)
Wealth index	0.0716108***	0.0283978***	0.0255463	0.008156	-0.0322153	-0.0071692	-0.0420022	-0.0071937
	-0.0192386	0.00763	-0.0215123	-0.00687	-0.0243552	0.00542)	(0.0267294)	(0.00458)
Roof material	-0.0324624	-0.0128664	-0.0350234	-0.0111461	0.0715366**	0.0160857**	0.0628025	0.0106398
	-0.0303663	-0.01203	-0.0323785	-0.01027	-0.0364733	-0.00829	(0.0400986)	(0.00672)
Wall material	0.0873859***	0.0345961***	0.0687405**	0.0218091**	0.0363151	0.0080394	-0.0526063	-0.0089286
	-0.0333289	(0.01317)	(0.37064)	-0.01168	-0.0429898	0.00947	(0.047432)	(0.00798)
Floor materia	0.007148	0.0028244	0.0937523***	0.029779***	0.0872841***	0.0192826***	0.009836	0.0016863
	0.0324132	0.01285	-0.0352324	-0.01113	-0.0404023	-0.00886	(0.0436549)	(0.00749)
Mother	0.1107654***	0.0439248***	0.1778132***	0.0567689***	0.1272491***	0.0283181***	-0.0034021	-0.0005827
Education	-0.0185976	-0.00737	-0.0213314	-0.00679	0.0244733	-0.00543	(0.0258929)	(0.00443)
Region 2	-0.0110255	-0.0043736	-0.280897***	-0.0937684***	-0.4284697***	-0.1069944***	0.620795***	0.1303816***
	(0.0372585)	-0.01478	-0.0403806	-0.01401	-0.0475283	-0.01306	(0.0531586)	(0.01309)
Region 3	-0.0844541***	-0.0335416***	-0.3751659***	-0.1254596***	-0.4609782***	-0.11349***	0.3941879***	0.0752741***
	0.0375705	-0.01494	-0.0406437	-0.01412	-0.0479143	0.01284	(0.054764)	(0.01149)
Region 4	0.3903854***	0.1490434***	0.1667558***	(0.0506146***	-0.1849129***	-0.0446728***	0.0664752	0.0118096
	0.0525261	-0.0189	-0.0621988	-0.01786	-0.068994	0.01797	(0.0772633)	(0.01422)
Region 5	0.2143967***	0.0838595***	0.1261314***	0.0389726***	-0.0215579	-0.0048391	-0.1212672***	-0.0195768***
	-0.042729	0.0164	-0.0508277	-0.01516	-0.0612351	0.01386	(0.0699369)	(0.01061)
Region 6	0.1259733***	0.0495781	0.144843***	0.0443604***	-0.0299149	-0.0067451	0.1140206	0.0207288
	(0.0460582)	-0.01795	-0.0544876	-0.01595	-0.0647498	-0.01479	(0.0704832)	(0.01356)

***1%, **5%, *10% level of significant; N = 13571; standard errors in parenthesis

sex of the child is both negative and significant at 1% and the marginal effect estimate reveals that the probability of child having diarrhea decreases by 0.02 implying that male under five children are more prone to diarrhoea than the female under five children and that males are more vulnerable to health inequalities than females (Ozor *et al*., 2014). The age of the child is positive and significant at 1% and the marginal effect estimate reveals that the probability increases by 0.0002. This suggests that as child's age increases the probability of the child having diarrhoea increases. This finding is consistent with that of Babatunde *et al*. (2011). The age of the mother is negative and significant at 1% and the marginal effect estimate reveals that the probability decreases by 0.002. This suggests that the probability of a child having diarrhoea decreases for older mothers compared to teenagers. Mother's education has a negative effect in determining whether a child has diarrhoea or not at 1% level of significance and the marginal effect estimate reveal that the probability decreases by 0.008. This suggests that education of mother decrease the probability of a child having diarrhoea. Mothers that are educated have better information on children's health care and generally earn higher incomes to give good nutrition than mothers who are not educated. This finding agrees with that of Akorede and Abiola (2013) (Table 4).

The household size is positive and significant at 1% and the marginal effect estimate reveals that the probability increases by 0.002. A child from large household size is more likely to have diarrhoea compared to a child from small household size. This finding is in line with Oloruntoba *et al*. (2014). The source of water is both negative and significant at 1% and the marginal effect estimate reveals that the probability decreases by 0.001. This implies that children with access to improved water source are less prone to have diarrhoea compared with those that lack access to improved sources. Toilet facility is also negative and significant at 1% and the marginal effect estimate reveals that the probability decreases by 0.001. This suggests that increased access to improved toilet facility reduces the probability of a child having diarrhoea. Adewara and Visser (2011) confirms this finding. The wealth index is also negative and significant at 1% and the marginal effect estimate reveals that the probability decreases by 0.002, thus, implying that poorer households are more likely to have more children that have diarrhea than the richer households considering the poverty and hunger ravaging the rural areas (Siziya *et al*., 2013).

Duration of breast feeding is negatively related to diarrhea, implying that young children are less likely to have when fed with sufficient breast milk. The marginal effect estimate reveal that the probability of child having diarrhea decreases by 0.0005 as duration of breast feeding increases father occupation is negatively related to the probability of a child having diarrhea. The marginal effect estimate reveals that the probability of a child having diarrhea decreases by 0.006. Father's education is positively related to the probability of a child having diarrhea. The marginal effect estimates reveal that the probability of a child having diarrhea decreases by 0.004 as father's education increases.

The roof material is positively related to the probability of a child having diarrhea. The marginal effect estimates reveal that the probability of a child increases with the use of improved roof material as compared with those with unimproved roof material. The marginal estimate with the probability of a child having diarrhea increases by 0.01 with the use of improved roof material. The wall material is negatively related to the probability of a child having diarrhea. The marginal effect estimates reveal that the probability of a child having diarrhea decreases by 0.008 with the use of improved wall material. The floor material is also positively related with the probability of a child having increases with the use of improved floor material. The marginal effect estimates reveal that the probability of a child having diarrhea decreases by 0.001 with the use of improved wall material.

North East region is significant at 1% and positively related to the probability of a child having diarrhea. The marginal effect estimate reveals that the probability of a child having diarrhea increases by 0.13. North West region is significant at 1% and positively related to the probability of a child having diarrhea. The marginal effect estimate reveals that the probability of a child having diarrhea increases by 0.07. South East region is positively related to the probability of a child having diarrhea. The marginal effect estimate reveals that the probability of a child having diarrhea increases by 0.07. South West region is significant at 1% and negatively related to the probability of a child having diarrhea. The marginal effect estimate reveals that the probability of a child having diarrhea decreases by 0.02. South South region is positively related to the probability of a child having diarrhea. The marginal effect estimate reveals that the probability of a child having diarrhea increases by 0.02.

CONCLUSION

Portable water is important for sustaining human health, especially under five children. Findings from this study show that access to improved source of water will prevent under five children from being stunted, underweight and wasted. Drinking from unsafe/unimproved water source can lead to diarrhoea in under five children. There is the need to provide access to safe portable water and maintenance of the already existing water source in rural areas in a way of achieving the MDG goals, now SDG goals of combating diseases, reducing child mortality and eradication of extreme poverty and hunger.

REFERENCES

Adekalu, K.O., J.A. Osunbitan and O.E. Ojo, 2002. Water sources and demand in South Western Nigeria: Implications for water development planners and scientists. Technovation, 22: 799-805.

Adewara, S.O. and M. Visser, 2011. Use of anthropometric measures to analyze how sources of water and sanitation affect children's health in Nigeria. Resources for the Future, Washington, USA.

Agbelemoge, A. and O.J. Odubanjo, 2001. Assessment of domestic water supply situation in rural communities in Ijebu-North area of Ogun State, Nigeria. J. Environ. Extension, 2: 81-87.

Akorede, Q.J. and O.M. Abiola, 2013. Assessment of nutritional status of under five children in Akure South Local Government, Ondo State, Nigeria. Int. J. Res. Rev. Applied Sci., 14: 671-681.

Akpor, O.B. and M. Muchie, 2011. Challenges in meeting the MDGs: The Nigerian drinking water supply and distribution sector. J. Environ. Sci. Technol., 4: 480-489.

Anonymous, 2015. United Nations millennium development goals-Goal 6: combat HIV/AIDS, malaria and other disease. United Nations, New York, USA.

Ashbolt, N.J., 2004. Microbial contamination of drinking water and disease outcomes in developing regions. Toxicology, 198: 229-238.

Babatunde, R.O., F.I. Olagunju, S.B. Fakayode and F.E. Sola-Ojo, 2011. Prevalence and determinants of malnutrition among under-five children of farming households in Kwara State, Nigeria. J. Agric. Sci., 3: 173-181.

Baumann, E., 2005. Common RWSN context. Skat Foundation, St. Gallen, Switzerland.

Casey, J.F., J.R. Kahn and A. Rivas, 2005. Willingness to pay for improved water service in Manaus, Amazonas, Brazil. Ecol. Econ., 58: 365-372.

Clasen, T., W.P. Schmidt, T. Rabie, I. Roberts and S. Cairncross, 2007. Interventions to improve water quality for preventing diarrhoea: Systematic review and meta-analysis. BMJ, Vol. 334, 10.1136/bmj.39118.489931.BE

Eneh, O.C., 2005. Small and Medium Enterprises in Southeast Nigeria: Problems and Solutions. WIPRO International, Enugu, Nigeria.

Ezeh, O.K., K.E. Agho, M.J. Dibley, J. Hall and A.N. Page, 2014. The impact of water and sanitation on childhood mortality in Nigeria: Evidence from demographic and health surveys, 2003-2013. Int. J. Environ. Res. Public Health, 11: 9256-9272.

Fogden, J. and G. Wood, 2009. Access to safe drinking water and its impact on global economic growth. HaloSource Inc., Bothell, Washington.

Harvey, P. and B. Reed, 2004. Rural Water Supply in Africa: Building Blocks for Handpump Sustainability. WEDC, Loughborough University, Loughborough, England,.

Kleemeier, E., 2000. The impact of participation on sustainability: An analysis of the Malawi rural piped scheme program. World Dev., 28: 929-944.

Kremer, M., J. Leino, E. Miguel and A. Zwane, 2009. Spring cleaning: Rural water impacts, valuation and institutions. NBER Working Paper, No. 5280, National Bureau of Economic Research, Cambridge, USA.

Merchant, A.T., C. Jones, A. Kiure, R. Kupka, G. Fitzmaurice, M.G. Herrera and W.W. Fawzi, 2003. Water and sanitation associated with improved child growth. Eur. J. Clin. Nutr., 57: 1562-1568.

Oloruntoba, E.O., T.B. Folarin and A.I. Ayede, 2014. Hygiene and sanitation risk factors of diarrhoeal disease among under-five children in Ibadan, Nigeria. Afr. Health Sci., 14: 1001-1011.

Ozor, M.O., O.A. Iyamu and U.C. Osifo, 2014. Prevalence of under nutrition among under five year children in Ekpoma, Edo-Nigeria. Int. J. Community Res., 3: 34-38.

Schmidt, C.W., 2014. Beyond malnutrition: The role of sanitation in stunted growth. Environ. Health Perspect., 122: A298-A303.

Siziya, S., A.S. Muula and E. Rudatsikira, 2013. Correlates of diarrhoea among children below the age of 5 years in Sudan. Afr. Health Sci., 13: 376-383.

UNICEF., 2000. Female education, the state of the world children. UNICEF, New York, USA.

Vasquez, W.F., P. Mozumder, J. Hernandez-Arce and R.P. Berrens, 2009. Willingness to pay for safe drinking water: Evidence from Parral, Mexico. J. Environ. Manage., 90: 3391-3400.

WHO., 2007. World health organization global burden of disease. World Health Organization, Geneva, Switzerland.

WHO., 2008. The global burden of disease: 2004 update. World Health Organization, Geneva, Switzerland.

WHO/UNICEF, 2006. Meeting the MDG Drinking Water and Sanitation Target: The Urban and Rural Challenge of the Decade. World Health Organization and United Nations Children's Fund, Geneva, Switzerland, ISBN-13: 9789241563253, Pages: 41.