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On the socioeconomic determinants of households' access to safe drinking water: some evidence from Nigeria

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Abstract

Background/Objectives: This study investigated the socioeconomic determinants of households' access to safe drinking water alongside the factors responsible for urban-rural inequality in access to safe drinking water in Nigeria.
Methods/Statistical Analysis: Data from 2013 Demographic and Health Survey (DHS) was used. The study adopted both ordinary least squared (OLS) and probit regression models to estimate the determinants of access to safe drinking water (SDW). The technique of Blinder-Oaxaca Decomposition has also been adopted to assess the urban-rural inequality in having access to SDW.
Findings: The results show that age linear, marital status, household size, awareness, Northern region, female and access to electricity have positive effects on the likelihood to access safe drinking water (SDW). However, age nonlinear, poor, rural locality and time taken to fetch water have negative impacts on the probability to adopt a particular source of SDW. Also, the same factors except female are responsible for the urban-rural inequality in access to SDW.
Improvements/Applications: The study recommended that there should be old age social security for old people, private water selling business, massive electrification, awareness campaign, incentive system, and rural development, to access SDW.

Key Words:safe drinking water, probit model, Blinder-Oaxaca, JEL Classification: Q25, J11, C35

1. Introduction

Improved water is fundamental to socioeconomic and environmental activities; because improved water is necessary for health, urbanization, food, natural and equality purposes[1]. In view of these roles and others, access to safe drinking water has been enlisted as a target 10 of MDG 7, one of the targets of SDG 6and has been declared as a fundamental human right by the UN since July 28, 2010[2][3][4]. Also, March 22 is being designated as a 'World Water Day' and is being celebrated every year since 1993 [1]. Thus, the importance of safe water cannot be over-emphasised for it even accelerates the rate of economic growth and development through improved welfare, better health and quality education. It is maintained by [5] that water is a central part of national and local economies and it is *sine qua non* to creating and maintaining jobs across all sectors of the economy.

Conversely, unsafe water poses a lot of serious challenges to the people, especially children and women, and even to economy at large. It is observed by[6]that hundreds of a million people, majority being children, suffer from chronic diarrheal diseases and long term parasitic plague transmitted via unsafe water and contaminated food. Moreover, [7]pointed out that thousands of women are compelled to spend most of their time covering long distance to fetch water. The water-borne diseases result in high illness costs, reducing potential productive population and decreasing productive work time; which all together dwindle the speed of economic growth and development. As such, lack of access to safe drinking water can impede the process of attaining sustainable development goals.

A cursory look at the global access to safe drinking water suggests that the world has met the target 10 of MDG 7 of 88% access since 2010 with 2.3 billion people gained access to safe water between 1990 and 2012 [8]. That is, 89% of the global population had access to safe drinking water in 2012. This is indeed a great achievement!

Although access to improved drinking water is a fundamental human right, yet it is not universal as 748 million people (in 2012) still have no access to safe drinking water and 90% of them live in the rural areas [8]. Additionally,

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there would be 547 million people without access to improved drinking water in 2015 if the present trend is maintained. By implication, despite the fact that the world is celebrating five years early of meeting the afore-said target; there are still many countries in the world which are not on track to meet the target. Majority of these countries, as posited by [8], are in Oceania and sub-Saharan Africa. The report indicated that two out of five people without access to safe drinking water live in Africa and it is only 64% (325 million) of sub-Saharan African population that have access to safe drinking water.

Being a sub-Saharan African country with also 64% of her population having access to safe drinking water sources, Nigeria has not met the target within the deadline. This is so even with the fact that Nigeria is endowed with natural resources especially sources of water like rivers, springs, lakes and so forth; which could be easily refined and supplied to the populace.

It is against this backdrop that this study sets out to investigate the socioeconomic determinants of households' access to safe drinking water sources and urban-rural inequality in having the access in Nigeria. The recent trend and achievement so far recorded in the country will be examined. This is timely as the world just celebrated the 'World Water Day' and expiration of MDGs. It is relevant as the world just conceived and implemented Sustainable Development Goals.

The paper is structured into six sections. The remaining parts are: section two coverage of safe drinking water in Nigeria. Section three is the methodology of the study whereas section four presents and discusses the results. Finally, section five gives concluding remarks and recommendations.

2. Coverage of Safe Drinking Water in Nigeria

The tables in the section give us snapshot of the situation of access to safe drinking water in Nigeria over the period 1990-2012. They also show how far Nigeria has gone in improving the access to safe drinking water and how impressive the progress has been as compared with other country in region, SSA and Globe. Table 1 shows the trends of the two sources of improved water over the last two decades. It is clear that the other improved water sources have been the major contributor to the safe drinking sources in Nigeria since 1990 till date and have been on the increase.

Table 1. The Major Sources of Improved Water in Nigeria

Year	Piped Water on Premises	Other Improved Water	Total
1990	14	32	46
2000	10	45	55
2006	4	43	47
2010	4	54	58
2012	4	60	64

Sources: WHO/UNICEF (2008-2014)

For example, the other improved was 32% in 1990 as against 14% piped water on premises and the former rose to 45%, 54% and 64% in 2000, 2010 and 2012 respectively. But the latter rather deteriorated to 10%, 4% and 4% in 2000, 2010 and 2012 respectively. These other improved sources include public taps or stand pipes, tube wells or boreholes, protected dug wells, protected springs and rain water collections. While the developed world records greater gains in access to piped water on premises; the developing world records higher successes in access to other improved water. However, the overall access to safe drinking water has been poor since 1990s till date, thereby putting Nigeria off the track to meet with the MDG target. For instance, the population with access to safe drinking water though has increased between 1990 and 2012 but marginally by just 0.82% on average annually. This is quite below expectation.

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Table 2. Rural-Urban Disparity in Access to Safe Drinking Water in Nigeria

Year	Urban	Rural
1990	79	30
2000	77	36
2006	65	30
2010	74	43
2012	79	49

Sources: WHO/UNICEF (2008-2014)

Table 2 shows the disparity in having access to safe drinking water between rural and urban areas. It is shown that there has been a wide gap between them in favour of urban area since 1990 till 2012. The gap has been around 30% to 49%, which implies that the urban residents have more access to safe drinking water than their rural counterparts.

Figure 1. Rural-Urban Disparity

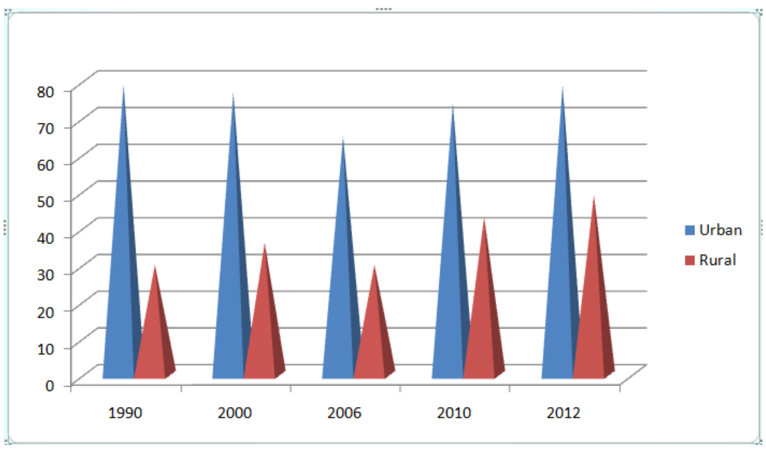

Figure 1 gives graphical presentation of table 2 and it reveals the high inequality between the two areas. Although the urban access to safe drinking water stagnates around 65% to 79% and the rural access improves between 1990 and 2012; yet the gap remains wide. This is so because the progress in the rural access to safe drinking water has not been impressive as it just increased by 19% between 1990 and 2012. Thus, a lot needs to be done to bridge the gap.

Table 3. Comparative Analysis of Access to Safe Drinking Water Regionally and Globally

Year	Nigeria	South Africa	Sub-Saharan Africa	World	MDGs
1990	46	81	48	76	88
2000	55	87	55	83	88
2006	47	93	58	87	88
2010	58	91	61	89	88
2012	64	95	64	89	88

Sources: WHO/UNICEF (2008-2014)

Table 3 indicates the progress made by Nigeria between 1990 and 2012 in relation to South Africa, Sub-Saharan African (SSA), Global averages and MDG's target. The table suggests that Nigeria has not made any significant progress when compared with South Africa and World but it has been oscillating around the SSA's average. Ironically, although Nigeria is the largest economy in Africa yet it is trailing far behind its second largest rival (South Africa) by wide margins of 35% to 46% since 1990 till date. Also, Nigeria has been lagging behind the Global average with a margin of 25% to 40% between same periods. As a result, it is highly unlikely for Nigeria to meet the MDG's target as it is not making the desired progress of 1.91% on annual average but at 0.82%. As a consequence, there have been gaps of 24% to 42% between them.

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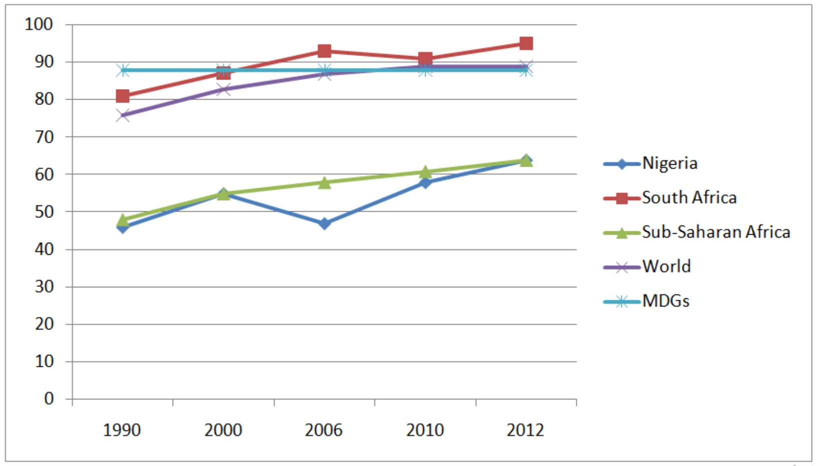
Figure 2 also compares graphically Nigeria with South Africa, SSA, World and MDG in terms of having access to safe drinking water for the period 1990-2012. The figure shows how Nigeria has been dropping behind South Africa, World and MDG. While South Africa has exceeded the MDG's target highly and the World also has gone beyond the MDG's target slightly; Nigeria and SSA were not even on track to meet the target.

Figure 2. Cross-Country Comparative Analysis of Acces to SDW



2.2. Meaning and Determinants of Access to Safe Drinking Water

This section reviewed existing conceptual, theoretical and empirical studies on safe drinking water. About 70 per cent of the earth's surface is occupied by water (hence, the name blue planet) and most of the water is seawater. Fresh water, from which drinkable water is mostly drawn, is only 2.5 per cent of the 1.4 billion cubic kilometres of water occupying the earth. Also, it is only less than 1 per cent of the fresh water that is drinkable without previous treatment. Therefore, it is only small amount that is available for drinking, cooking and for other domestic uses, whereas the remaining is locked up as ice, glacier and ground water. Salt water can be drinkable after desalination [9], [10], and [11]. Since not all water is drinkable, then the questions to be asked are: what is drinking water? What is safe drinking water (SDW)? What are the characteristics of SDW? What is access to SDW?

According to [12], drinking water is one for ingestion, basic personal and domestic hygiene and cooking. It exempts water for clothes washing. It is observed by[13] that drinking water is water used for domestic purposes, drinking, cooking and personal hygiene excluding clothe washing. Safe drinking water is water with microbial, chemical and physical features that meet WHO guidelines or national standards. Also, [14]posited that SDW should be: "sufficient, safe[1], acceptable[2], physically accessible[3] and affordable[4]". By *sufficiency*, [14]mean the amount required for SDW should be at least 20 litres per capita per day (this is also the WHO and UNDP standard). However, 20 litres may not meet some of the basic needs like laundry and bathe on-site, but 50 litres per capita per day is the quantity that can meet most of the basic consumption and hygiene requirement.

In [8]divided drinking water sources into two major categories: improved[5] and unimproved sources. The improved water sources include piped water in a dwelling, plot or yard, and other improved sources (public taps, or standpipes, tube wells or boreholes, protected dug wells, protected springs and rainwater collections). *Unimproved Water sources* include unprotected dug well, unprotected spring, cart with small tank/drum, tanker truck and surface water (river, dam, lake, pond, stream, canal, irrigation channels) and bottled water. Access to SDW is defined by [15],

[1]Safety means the water should be free from micro-organisms, chemicals and other things that are harmful to human health.
[2] Acceptability implies that the water should be of standard colour, odour and taste for each personal and domestic purpose.
[3] Physical accessibility signifies that the water can be reached within or in the close-by vicinity of the user. For e.g., [13]recommends that the distance should be less than 1 kilometre.
[4]Affordability suggests that that the direct and indirect costs and charges of obtaining the water should not be too expensive for the common man.
[5]Improved water sources are sources of water, by way of their construction or through certain interventions, are shielded from external contamination, especially faecal matter.

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as the proportion of population having a safe drinking water[6]. Thus, this paper views access to safe drinking water as being able to obtain water that is clean, safe, sufficient, close-by, acceptable, sustainable and affordable.

In [16]defined poverty as lack of basic needs of life like shelter, food, clothing and water. As such, access to safe drinking water is a good indicator of poverty, and on the basis of this, two theories of poverty will be briefly reviewed and related to access to SDW. In [17] came up with the individual attribute theory of poverty, which states that the poor are architect of their problem due to laziness, lack of skills, inherent disabilities and wrong choice. This implies that poor lacks access to SDW, because of their laziness, lack of education and refusal of accessing SDW. This problem can be best solved through community development by way assistance and safety net.

In [17]postulated that the structural theory of poverty is a progressive social theory. Theory blames economic, political and social systems as being responsible for poverty. This is owing to the structural barriers that hinder the poor from having access to socioeconomic services like jobs, education, water, housing, health care, safety and political representation. Equality in opportunities is the last resort of getting out of this structural poverty.

This subsection reviews some empirical studies across the globe, especially the developing world where the problem is more pronounced.

In [18]examined the inequities in access to safe drinking water in 11 Latin American and Caribbean countries using their respective Livings Standards Measurement Survey Study data for the period 1995-1999. Non-parametric measures were used in the analysis. Their results suggest that there is an association between income, economic conditions and location, and access to safe drinking water. Also, it is the difference in income level that is responsible for urban-rural inequality in access to safe drinking water. In another panel study of 135 countries across the globe, [19] established that poverty has negative impact on households' access to safe drinking water. It is also established that gender relations mediate social relations of water in terms of time taken to fetch water. They arrived at these findings using pooled regression model and UNDP Human Development Report.

Similarly, [20]also analysed the determinants of water and sanitation access in Yemen using the country's DHS dataset for the period 2003 and binary logit model. The results show that wealth has a strong and significant positive impact on the probability of having access to improved water and sanitation facilities by 3% and 30% respectively. Pubic per capita spending in health and population also increases the likelihood of accessing the improved water and sanitation by about 1% and 4% respectively. Lastly, electricity raises the possibility of having access to them by respectively 12% and 18%. The probabilities indicate the variables are stronger in determining access to improved sanitation than safe water.

Furthermore, [21]examined the socioeconomic determinants of sources of drinking water in Ghana using logistic regression technique. Their findings show that incomes, access to clean toilet facility, access to electricity, are the major predictors of households' access to SDW. They also found out that urban residents have more access to SDW than rural residents. Likewise, [22]examined the availability of safe water and decent sanitation services in South Africa by gender of head of household using South Africa General Household Survey and descriptive statistics. The study established that there is a link between socioeconomic status and availability of water and sanitation. It also found out that no any major difference in the wealth of household and availability of safe water and sanitation facilities by gender of household head.

Also, [23] assessed the factors determining public demand for safe drinking water in Penshawar district of Pakistan using 315 households' data (consisting of 2,455). Non-parametric measures were applied to the analysis. Their results reveal that income and awareness are the major determinants of demand for SDW. [24]observed that it is the age of the household members, marital status, and the sector where the household member works, the type of employment, the number of working hours, access to informal means of financial credit, and income level were the main determinants of households' access to SDW. They arrived at these findings using Nigeria's Households Survey data collected by World Bank and National Bureau of Statistics (NBS) and logistic regression technique.

In [25] investigated the impact of households' awareness on their choice of improved water sources in Cameroon using the country's Third Multiple Indicator Cluster Survey (MICS3) data. The results of their estimated bivariate probit model suggest that more awareness, educated headed-household and households owning TV are more likely

[6]Source that is less than 1 km away from the place where it is used and having the option of securing at least 20 litres per capita per day on a regular basis.

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to adopt improved water sources. In [26] examined accessibility and coverage of drinking water and water security aspect in Kerala, India using secondary data. The findings showed a state with a lot of rivers and lakes is prone to drought due to reckless sand mining and quarrying mushrooming over the years. Given this couple with decline in availability of rain, surface and underground waters as well as distance; Kerala has witnessed a decline in per capita water availability over years.

Lastly, [27]established that proportion of households with access to improved water sources and sanitation facilities reached 90% and 77% as at 2011 in Vietnam respectively but only 74% of them had access to improved water sources and sanitation facilities combined. The regression results revealed that geographical locations, living areas (urban), wealth index, ethnicity and educational level of household head are the major determinants of households' access to improved water sources and basic sanitation facilities combined.

From the studies reviewed above, it is clear that little attention has been paid to the urban-rural inequality in access to SDW and few large-scale studies exist in Nigeria. This study fills the gap.

3. Data and Methods

2013 Demographic and Health Survey (DHS) dataset collected by[28] National Population Commission and ICF International is the main source of data for this study. In the light of the relevant theories and empirical studies reviewed, the variables used in specifying the empirical model below are derived from them. First, the structural form of the model can be stated in equation (1) below:

$$sdw_i = f(socioeco_i) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Equation (1) shows that the households' access to safe drinking water is influenced by the above socioeconomic variables. The equation can be re-written in regression line form as follows:

$$sdw_i = \propto_i + \delta_n socioeco_i + \mu_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Where $socioeco_i$ is a vector of socioeconomic characteristics of household$i(i = 1, 2,3, \dots\dots, n)$

Table 4. Definition of Variables

Variables	Definitions
socioeco	Socioeconomic Characteristics of Head of Household
sdw	Safe Drinking Water Sources
age	Age of Head of Household
gen	Gender of Head of Household (Male=0 and Female=1)
rg	Region of Head of Household (North=1 and South=0)
loc	Locality of Head of Household (Rural=1 and Urban=0)
hhz	Household Size
ms	Marital status of Head of Household (Married=1 and Single=0)
awr	Awareness: if Household-head has Radio=1 and otherwise=0
wlt	Wealth Index (Poor=1 and Non-poor=0)
$\boldsymbol{\mu_i}$	Error term capturing other determinants not included in the model.

Source: Authors' Construction using DHS by NBS, (2013)

Table 4 presents the definitions of variables included in the regression models. Given the discrete nature of the variables, probit regression model can be used to estimate the equation (2) since the assumptions of OLS technique break down. However, to ensure consistency and reliability of the results, OLS, and probit models would be estimated. Thereafter, the findings of probit model would be selected because it is better than those of OLS[29], and [30]. As such, equation (2) can be re-specified as follows:

$$Log\left[\frac{\Pr(sdw) \geq 0}{1 - \Pr(sdw) \geq 0}\right] = \propto_i + \delta_n socioeco_{i_i} + \mu_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. (3)$$

Where:$P\,r(sdw) = Probabilityof Householdhaving accesstosafedrinkingwater$

$$1 - Pr(sdw) = Probabilityof Household having no access to safe drinking water.$$

In order to explain rural-urban difference of having access to safe toilets, the model of Blinder-Oaxaca decomposition is used [31]and [32]. The model is specified as below, given the two groups Urban (U) and Rural (R) areas so that $g = (U, R)$.

$$Y_i = X_{ig}\beta_g + \varepsilon_{ig} \dots\dots\dots (4)$$

This mean equation (4) can be disaggregated to derive equation (5) below:

$$\bar{Y}_U - \bar{Y}_R = \Delta^{OLS} = (\bar{X}_U - \bar{X}_R)\hat{\beta}_U + \bar{X}_R(\hat{\beta}_U - \hat{\beta}_R) \dots\dots\dots (5)$$

Thus the generalized can be specified in equation (6) below.

$$\bar{Y}_U - \bar{Y}_R = (\bar{X}_U - \bar{X}_R)\beta^* + \bar{X}_U(\beta_U - \beta^*) + \bar{X}_R(\beta^* - \beta_R) \dots\dots\dots (6)$$

$\beta^*$is defined as a weighted average of the coefficient vectors β_U and β_R:

$\beta^* = \Omega(\mathrm{I} - \Omega)\beta_R$ where Ω is a weighted matrix and I is an identity matrix. Equation (6) can be further extended into equation (7) below.

$$\bar{Y}_U - \bar{Y}_R = (\bar{X}_U - \bar{X}_R)\hat{\beta}_R + \bar{X}_R(\beta_U - \beta_R) + (\bar{X}_U - \bar{X}_R)(\beta_U - \beta_R) = E + C + I \dots\dots\dots (7)$$

The first part Eexplains the group differences in the predictors (the endowment effect). The second part Ccaptures the contribution of differences in the coefficients inclusive of the intercept differences. The last part $I$is an interaction term accounting for the possible multicollinearity in the differences in endowments and coefficients between the two areas.

Note that the negative coefficient of Blinder-Oaxaca decomposition tells us that such a variable is narrowing the gap but positive value implies widening of the gap for the group under consideration. This is so because the Z-scores are multiplied by -1.

4. Results and Discussion

Tables 5 and 6 contain the frequency of households' access to safe drinking water and summary or descriptive statistics on some of the variables respectively. Table 5 indicates the proportion of people having access to different sources of drinking water.

According to the 2013 DHS dataset, 42.92% (about 16,505) of the households surveyed lack access to safe drinking water, thereby resorting to using unprotected well, unprotected spring, river, dam or bottled water. This suggests that it is only 57.08% (21,954) of the observation that have access to improved sources of drinking water: piped into dwelling (2.02%), public taps/standpipes (7.47%), tube well/borehole (35.07%), protected well (11.03%), protected spring (0.53%) and rain water (0.98%). Majority of the households with access to SDW use tube well/borehole and protected well

Table 5. Frequency Table of Access to Drinking Water (Based on 2013 DHS Dataset)

/No.	Sources of Drinking Water	Frequency	Percent
1	Piped into Dwelling	775	2.02
2	Public Taps/Standpipes	2873	7.47
3	Tube Well/Borehole	13,491	35.07
4	Protected Well	4,233	11.03
5	Protected Spring	204	0.53
6	Rain Water	378	0.98
7	Unimproved sources	16,505	42.92
8	Total	38459	100

Source: Authors' Computation

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Table 6. Other Socioeconomic Features of Households in the Dataset

Variables	Observation	Mean	Std. Dev.	Min	Max
Age in years	38446	45.39598	16.1991	10	95
Household Size	38522	4.643944	3.108378	1	35
Time (in minute)	38040	19.3531	28.96389	0	420

Source: Authors' Computation

Table 6 reveals that total observations for age, household size and time are 38,446, 38,522 and 38,040 respectively.

Table 7. Estimatesfrom Binary Response Models of Access to Safe Drinking Water

	Binary Probit Regression Model		***OLS***
VARIABLES	*Coefficient*	*Marginal effect*	*Coefficient*
Age	*0.0115****	*0.00454****	*0.00425****
	(0.00276)	*(0.00109)*	*(0.000994)*
Age-squared	*-7.23e-05****	*-2.86e-05****	*-2.72e-05****
	(2.71e-05)	*(1.07e-05)*	*(9.78e-06)*
Education level	*-0.0296****	*-0.0117****	*-0.0102****
	(0.00639)	*(0.00253)*	*(0.00227)*
Electricity	*0.180****	*0.0710****	*0.0678****
	(0.0225)	*(0.00890)*	*(0.00748)*
Female	*0.130****	*0.0512****	*0.0471****
	(0.0219)	*(0.00852)*	*(0.00788)*
Marital status	*0.0486***	*0.0192***	*0.0181***
	(0.0223)	*(0.00885)*	*(0.00810)*
Log time	*-0.130****	*-0.0515****	*-0.0492****
	(0.00715)	*(0.00282)*	*(0.00258)*
Household size (log)	*0.0264***	*0.0104***	*0.00867**
	(0.0127)	*(0.00503)*	*(0.00460)*
North	*0.190****	*0.0750****	*0.0672****
	(0.0209)	*(0.00823)*	*(0.00747)*
Poor	*-0.531****	*-0.209****	*-0.195****
	(0.0229)	*(0.00883)*	*(0.00813)*
Rural	*-0.268****	*-0.105****	*-0.0985****
	(0.0186)	*(0.00721)*	*(0.00671)*
Radio	*0.0225*	*0.00890*	*0.00842*
	(0.0163)	*(0.00645)*	*(0.00573)*
Hausa	*0.446****	*0.170****	*0.163****
	(0.0224)	*(0.00808)*	*(0.00789)*
Yoruba	*0.0852****	*0.0336****	*0.0341****
	(0.0251)	*(0.00981)*	*(0.00901)*
Igbo	*0.147****	*0.0576****	*0.0558****
	(0.0256)	*(0.00992)*	*(0.00934)*
Constant	*0.0990*		*0.542****
	(0.0699)		*(0.0253)*
Observations	*30,705*	*30,705*	*30,705*
R-squared	*0.0805*		*0.107*

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*Source: Authors' computation*

The age of household's head ranges from 10 to 95 years with mean age of 45.40 years and standard deviation of 16.20 years. The household size ranges from 1 to 35 embers with the mean size of 5 members and standard deviation of 3 members. Finally, the minimum time taken to fetch water is 0 minute but the maximum is 420 minutes (7 hours).This means the mean time is 19.35 minutes with the standard deviation of 28.96 minutes.

Table 7 contains estimates from OLS and binary probit regression models on determinants of access to safe drinking water in Nigeria in 2013. In the table, it is shown that age in years, age squared, education level, rural

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locality, wealth index (poor), electricity, female, time, North, and ethnic groups are significant at 1% level of significance in all the models.

Also, household size is significant at 5% in binary Probit Model but at 10% in OLS Model. Marital status is however significant at 5% in the two models. The inclusion of age in years and age squared in the models is to capture both the linear and non-linear effects of the age. The significant positive coefficient of age (i.e. age linear) shows that as the age of household's head adds by a year, the probability of such a household to have access to safe drinking water improves. The significant negative coefficient of age squared (age non-linear) tells us that at a certain age level, the probability of household having access to safe drinking water falls down, as his/her age rises by a year.

Table 8. Marginal Effects of Binary Probit Models of three Major Sources of SDW

	(1)	(2)	(3)
VARIABLES	Pipe	Borehole	Well
Age	-0.000258	0.00586***	-0.000597
	(0.000553)	(0.00105)	(0.000528)
Age-squared	3.54e-06	-4.77e-05***	8.95e-06*
	(5.41e-06)	(1.03e-05)	(5.14e-06)
Education level	0.00244**	-0.00848***	-0.00407***
	(0.00120)	(0.00247)	(0.00132)
Electricity	0.0178***	0.0489***	-0.0109**
	(0.00220)	(0.00615)	(0.00423)
Female	0.0140***	0.0316***	-0.00222
	(0.00453)	(0.00832)	(0.00421)
Marital status	-0.00147	0.00732	0.0117***
	(0.00434)	(0.00836)	(0.00415)
Log time	-0.0115***	-0.0395***	-0.00778***
	(0.00136)	(0.00265)	(0.00141)
Household size (log)	0.00652***	-0.00342	0.00320
	(0.00248)	(0.00478)	(0.00245)
North	-0.000854	0.0398***	0.0304***
	(0.00424)	(0.00786)	(0.00401)
Poor	-0.0413***	-0.163***	-0.00576
	(0.00371)	(0.00758)	(0.00444)
Rural	-0.0244***	-0.0635***	-0.0124***
	(0.00372)	(0.00701)	(0.00361)
Radio	-0.00265	-0.000773	0.00383
	(0.00279)	(0.00549)	(0.00278)
Hausa	0.0628***	0.104***	0.0234***
	(0.00574)	(0.00867)	(0.00469)
Yoruba	0.0312***	-0.0988***	0.101***
	(0.00543)	(0.00881)	(0.00714)
Igbo	-0.0338***	0.109***	-0.0112**
	(0.00422)	(0.00987)	(0.00507)
Observations	30,762	30,762	30,762

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*Source: Authors' computation*

Thus, this means the age of household-head has positive effect on the access to safe drinking water up to a certain limit beyond which it has negative effect. It is perhaps due to fewer opportunities to access safe drinking water at an older age.

The models also show that education level has a negative effect on the likelihood to access SDW, which suggests that the probability of accessing SDW decreases as the level increases. But the probability improves if the household has access to electricity. Moreover, being female and married household also improves the probability of accessing SDW respectively. As the time taken to fetch water rises by 1%, the likelihood of household accessing SDW falls down whereas the likelihood improves as the size of the household increases by 1%.

Again, Northern household is more likely to access SDW than his/her Southern counterpart but being rural household reduces the probability of accessing SDW than being urban household. Finally, poor household head is unlikely to access SDW than non-poor household. Hausa, Igbo and Yoruba households are more probable to access SDW than other minority ethnic groups.

In terms of marginal effect, it is shown that the household's probability to utilize improved water rises by 0.45% as the age advances by a year while the probability reduces by 1.17% if the education level rises. Having access to electricity and being female lead to 7.10% and 5.12% rise in the probability of household's access to SDW respectively. Also, as the time taken to fetch water rises by 1%, the likelihood of household utilizing SDW decreases by 5.15% but the probability upsurges by 1.92% if the household is married.

Being from the North improves the chances of using SDW by 7.50% whilst the chances fall by 10.50% if the household is from rural area. When the size of the household rises by 1%, the likelihood to adopt SDW also goes up by 1.04% but the likelihood reduces by 20.90% if the household is poor. Being Hausa, Yoruba and Igbo bring about 17.0%, 5.76% and 3.36% increases in the chances to use SDW than minorities.

The models in table 8 show the marginal effects of determinants of access to piped water, borehole and protected well respectively. It is indicated that education level has 0.24%, -0.85% and -0.41% marginal effects on the probability to use piped, borehole and protected well water respectively. Age has 0.59% marginal effect on access to borehole water. Electricity has 1.78%, 4.89% and -1.09% probabilities to utilize piped, borehole and protected well water respectively. Being female causes 1.40% and 3.16% probabilities to access piped and borehole water respectively. Being married leads to 1.17% more likely to use well water but increase in the household size results 0.65% chances to adopt piped water. Time has -1.15%, 3.98% and 3.04% marginal effects on access to piped, borehole and protected well water respectively. North has marginal effects of 3.98% and 3.04% on access to piped, borehole and protected well water respectively. North has marginal effects of 3.98% and 3.04% on access to piped, borehole and protected well water respectively.

Being poor results in -4.13%, -16.3% and -0.58%, likelihoods to apply piped, borehole and well water respectively. Rural area has also 2.44%, 6.35% and 1.24% less chances to use piped, borehole and protected well water respectively. Hausa has 6.28%, 10.4% and 2.34% more possibilities to access piped, borehole and protected well water respectively. Igbo has -3.38%, 10.9% and -1.12% probabilities to utilize piped, borehole and protected well water respectively. Lastly, Yoruba has 3.12%, -9.88% and 10.10% chances to adopt piped, borehole and protected well water respectively.

Table 9 contains the results of Blinder-Oaxaca decomposition on rural-urban inequality in access to SDW among households. Column (1) reveals that the mean prediction of urban households to access SDW is 2.724 while that of rural households is 1.869, resulting in difference of 0.855. This implies that rural households are 0.855 less likely to use SDW than their urban counterparts. The gap is brought about by the three major factors: overall endowment, the overall coefficient and overall interaction effects. The total endowment effects contributed significantly to the inequality by 0.579 or 67.72%. This means that certain natural qualities of rural households must improve by 67.72% for them to have equal likelihood to access SDW as their urban counterparts.

The total coefficient effects contributed significantly to the gap by 0.736 or 86.08%. This suggests that certain socioeconomic features of rural households should rise by 86.08% for them to have the same probability to access SDW as their urban counterparts. Finally, the total interaction effects contributed significantly to the difference by -0.460 or -53.80%. The combined effects of endowment and coefficient have to be cut down by 38.23%. These effects are all significant at 1% level of significance. The columns 2, 3 and 4 present the individual contributions of the variables through the overall effects.

For example, education level contributes to the endowment, coefficient and interaction gaps by 0.0024, -0.0087 and 0.0523 while age contributes significantly only to endowment gap by 0.00959. Being female causes 0.0098 rise in the endowment gap but access to electricity contributes significantly to the endowment, coefficient and interaction gaps by 0.198, -0.126 and 0.170 respectively. Time contributes significantly to the endowment, coefficient and interaction inequalities by 0.0776, 1.082 and -0.762 respectively whilst being poor widens only endowment difference by 0.288 significantly. Household size also contributes to the respective endowment, coefficient and interaction inequalities by 0.0111, 0.356 and 0.0425 whereas North contributes to the respective endowment,

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coefficient and interaction differences by -0.0306, 0.239 and -0.109. Hausa causes 0.0731, 0.135 fall and 0.0579 rise in the endowment, coefficient and interaction inequalities respectively.

Table 9. Blinder-Oaxaca Decomposition of Rural-Urban Inequality in Access to SDW

	(1)	*(2)*	*(3)*	*(4)*
VARIABLES	***Overall***	***Endowment***	***Coefficient***	***Interaction***
Age		*0.00959***	*-0.384*	*-0.00413*
		(0.00447)	*(0.378)*	*(0.00436)*
Ages-squared		*-0.00542*	*0.302*	*0.00417*
		(0.00361)	*(0.188)*	*(0.00361)*
Education level		*0.00192*	*-0.0987****	*-0.0523****
		(0.00636)	*(0.0203)*	*(0.0109)*
Electricity		*0.198****	*-0.126****	*-0.170****
		(0.0126)	*(0.0170)*	*(0.0231)*
Female		*0.00983****	*0.0140*	*0.00631*
		(0.00345)	*(0.0110)*	*(0.00498)*
Marital status		*-0.00255*	*0.0348*	*-0.00362*
		(0.00355)	*(0.0514)*	*(0.00535)*
Log time		*0.0776****	*1.082****	*-0.0762****
		(0.00591)	*(0.0585)*	*(0.00658)*
Household size (log)		*0.0111****	*0.356****	*-0.0425****
		(0.00387)	*(0.0508)*	*(0.00647)*
North		*-0.0306****	*0.239****	*-0.109****
		(0.0113)	*(0.0398)*	*(0.0183)*
Poor		*0.288****	*-0.0362*	*0.0295*
		(0.0157)	*(0.0398)*	*(0.0325)*
Radio		*0.00457*	*-0.0200*	*-0.00495*
		(0.00391)	*(0.0270)*	*(0.00668)*
Hausa		*-0.0731****	*-0.135****	*0.0579****
		(0.00488)	*(0.0167)*	*(0.00756)*
Yoruba		*0.0509****	*-0.0151***	*-0.0486***
		(0.0143)	*(0.00588)*	*(0.0189)*
Igbo		*0.0391****	*-0.0274****	*-0.0457****
		(0.00900)	*(0.00776)*	*(0.0129)*
Group (Urban)	*2.724****			
	(0.0178)			
Group (Rural)	*1.869****			
	(0.0147)			
Difference	*0.855****			
	(0.0231)			
Endowments	*0.579****			
	(0.0201)			
Coefficients	*0.736****			
	(0.0388)			
Interaction	*-0.460****			
	(0.0373)			
Constant			*-0.450***	
			(0.205)	
Observations	*30,705*	*30,705*	*30,705*	*30,705*

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 *Source: Authors' computation*

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It is indicated that Yoruba contributes to the endowment, coefficient and interaction gaps by 0.0509, -0.0151 and -0.0486 respectively. Lastly, Igbo has 0.0391, -0.0274 and -0.0457 shares to the endowment, coefficient and interaction differences respectively but constant widen the coefficient gap by 0.450. It is worth mentioning again that negative value implies that the gap is narrowing whilst positive value means the gap is widening.

The models above have all suggested that poverty is one of major determinants of access to safe drinking water in Nigeria. This is self-convincing findings considering the rate at which poverty is increasing in the country and households have to purchase water every day since public provision is very insufficient even in the major cities. Rural areas are highly impoverished due terrible poverty and they are remote thereby making it impossible even for water sellers to supply water to them. Power outage is an order of the day in Nigeria while piped-borne water and boreholes require stable power supply. All the major cultures are found to be encouraging the use of safe drinking water, particularly Hausa. This may not be unconnected with the fact that most Hausa areas in the country are not riverine but more of a desert, thereby forcing them to obtain safe drinking water. Level of education is found to have negative influence on the access to SDW as a whole but it has positive effect on access to piped-borne water. This could be educated households are well knowledgeable of the water-borne diseases and, as a result; they prefer well treated water sources, like piped-borne water, to any other source of water. Also, some of the significant determinants of access to borehole water carry negative values reflecting lower chances of having access to borehole. This could be due to the fact that borehole requires huge investment and technical process to install it or buy it.

However, it is not treated like piped-borne water. Differences due to characteristics(coefficient effects) are shown to be the major contributor to the rural-urban inequality. Time taken to fetch water is also the major contributor to the coefficient gap. And this is very clear in Nigeria as rural dwellers cover several kilometers just to get water as opposed their urban counterparts who have been provided with piped-borne at their

5. Conclusion

This study has arrived at important stylized facts as regards the factors determining households' access to safe drinking water as well as those responsible for urban-rural disparity in access to improved sources of drinking water in Nigeria. First, the study has discovered that the significant socioeconomic determinants of households' access to safe of drinking water in Nigeria are age, marital status, gender, and household size, level of awareness, locality, region, time, wealth index, and access to electricity. Age linear, gender, marital status, households, level of awareness, region and access to electricity have positive effects on the likelihood of households to adopt safe drinking water sources; whereas age nonlinear, time, poor wealth index and locality have negative influences on the probability.

Second, the study has also found out that there exists an inequality in access to SDW between urban and rural areas. And the factors responsible for that are differences in age, marital status, household size, level of awareness, locality, region, time, wealth index and access to electricity, in terms of endowment, coefficient and interaction effects. While, the endowment and coefficient effects widen the gap between them; the interaction effects narrow the inequality.

To this effect, any economic and health intervention should target the above-mentioned variables to improve the households' access to safe drinking water as well as bridge the rural-urban gap in access to safe drinking water in Nigeria. In other words, policy interventions should not only focus on socioeconomic factors of improving access to safe drinking water but also on the rural-urban disparity.

It is against this backdrop that the following policy measures have been recommended by the authors. Firstly, there should be social security scheme targeting aging population to empower them to have access to safe drinking water. This is so recommended given the negative effect of age squared. Secondly, private individuals have an opportunity of water selling business by just constructing public tap or boreholes and selling the water. Also, there should be public-private partnership in providing public taps every few meter away from dwellings. This could help reduce time spent fetching water. Thirdly, there should be also public-private partnership to empower the poor to enable them have the wherewithal to adopt one source of safe drinking water or the other. Fourthly, massive electrification of communities is another way of improving population with access to improved sources of drinking

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water. Fifthly, government should also intensify its awareness campaign through media by explaining the health consequences of unimproved sources of drinking water.

Sixthly, youthful, married, female, northern household head of household and household with large members should be encouraged to continue to access SDW through some incentive system. Lastly, concerted and sincere efforts should be directed towards rural development so that the gap between the urban and rural dwellers in access to safe drinking water will be bridged.

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