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Socioeconomic and Demographic Predictors of Potable Water and Sanitation Access in Ghana

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Abstract Lack of access to potable water and good sanitation is still one of the most challenging public health concerns of the twenty-first century despite steady progress over recent decades. Almost a billion people globally lack access to safe water; over two billion live without adequate sanitation facilities. The challenge is even more daunting for Sub-Saharan Africa where coverage levels for both potable water and sanitation remain critically low. The urgent need to address the issue calls for adequate understanding of the socio-economic dimensions. Using the 2008 Ghana Demographic and Health Survey, we investigated the socio-economic and demographic factors associated with access to potable water and improved sanitation facilities. Our generalized linear models reveal that income, education, household size, and region are significant predictors of improved water and sanitation access. Our discussion and conclusion sections highlight the implications of the study results for water policy formulation and implementation in Ghana, and broadly for other developing countries.

Keywords Ghana · Water · Sanitation · Hygiene · Health · Millennium development goals

1 Introduction

One of the major problems facing developing countries in the twenty-first century is the lack of access to potable water and sanitation facilities. Currently, nearly a billion people

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globally lack access to potable water while about two billion live without improved sanitation facilities (Cosgrove and Rijsberman 2014; Sivakumar 2011). While notable progress has been made on potable water access since 1990, with well over two billion people having gained access to improved drinking water sources—a progress that must be celebrated as a success, there are still profound gaps between demand and supply. The latest World Health Organization updates on drinking water and sanitation estimate that there are still more than 700 million people across the globe without access to better-quality water sources; and nearly half of this population are in Sub-Saharan Africa (WHO 2014). The situation is even worse for improved sanitation facilities where globally, nearly 2.5 million people live without good sanitation facilities; and some one billion people practice open defecation (WHO 2014).

Despite substantial gains in improved drinking water facilities, notably in the last decade or so, many countries in Sub-Saharan Africa have barely achieved their Millennium Development Goal target of halving the number of people without access to improved drinking water. Over 64 % of households in the region do not have access to basic sanitation and 42 % lack safe drinking water (Waldman et al. 2013; WHO 2013). Existing water infrastructure can barely keep up with demands from spiraling populations. Drinking water sources, while already inadequate, are also subject to increasing threat of contamination. Only a third of the region's population has access to household piped-water connections (Seager 2010), forcing many to use contaminated water sources (Akple et al. 2011; Gleick 2014). Women and female children are often the most affected as they have to walk considerable distances in search of water. The long walking distance and the storage practices sometimes contaminate the water (Boateng et al. 2013). The socio-economic and public health implications are severe (UNICEF 2013). Other reports have noted striking intra-urban disparities in access to both water and sanitation. In most cases, average figures about access for urban and rural areas may fail to show the intra-urban and intra-rural disparities. For example, according to the WHO progress report on water and sanitation access, residents in urban areas tend to have better access to water than those in low income informal settlements. Yet, most country and regional reports using average figures tend to obscure these disparities as urban areas are lumped together—with barely any consideration for low income settlements where the situation may even be worse than rural areas in some instances.

Poor sanitation and the quality of potable water are inseparable. In addition to affecting the quality of drinking water, poor sanitation has health and economic implications. Rural residents in Sub-Saharan Africa usually rely on pit latrines with also many resorting to open defecation; a phenomenon proven to contaminate surface water through run-off (Yap 2007). Lack of improved sanitation remain one of the biggest contributing factors of under-five childhood mortality in developing countries, mostly through diarrhea and other water-related illnesses (Dunlap et al. 2001; Tumwine et al. 2002; Sobsey et al. 2008). In Latin America, Teixeira et al. (2012) highlight a close association between increased water and sanitation access and decreased childhood mortality. In rural areas of India, improved access to water significantly reduced cases of diarrhea among children under-5 years (Jalan and Ravallion 2003). Dunlap et al. (2001) propose that improving sanitation is the single most important way to reduce childhood mortality. Recent studies have reported that point-of-use water treatment has the potential to improve the quality of drinking water, and ultimately reduce water borne illnesses (Sobsey et al. 2008; Larson et al. 2006; Buttel and Flinn 1978). The economic consequences of inadequate potable water and sanitation facilities often come through lost productivity days and health related costs (Hutton et al. 2007). Lack of access to safe drinking water is linked to low GDPs and poor health (Hunter et al. 2009). Efforts to solve the aforementioned problems related to lack of potable water and sanitation facilities would not only require huge financial resources and political will; it would require improved understanding of how socio-economic factors, especially of households, tend to shape access dynamics.

This study advances the state of scholarship on the socio-economic predictors of water and sanitation access through a quantitative analysis of secondary data. Socio-economic and demographic factors found to predict access to water quality and sanitation include education, income, household size, education, age, gender, and marital status. Tiwari and Nayak (2013) found that education and literacy rates are significant predictors of water and sanitation access. Larson et al. (2006) showed a strong correlation between income, education, and household water use and access, arguing that wealthy households tend to have higher education levels, coupled with better access to water because they can often afford the upfront costs of household connections. Individuals with higher levels of income/wealth are more likely to afford the cost of water services while those with higher education levels may understand the costs associated with using unimproved drinking water sources and poor sanitation. Conversely, (Yang et al. 2013) found that household income was not an important predictor of water and sanitation access.

Our study builds on the burgeoning scholarship in the water, sanitation, and hygiene (WASH) domain. Based on the 2008 Ghana Demographic and Health Survey,[1] we investigated the socio-economic and demographic predictors of water and sanitation access. Knowledge of the significant predictors will aid in the formulation of policies geared towards the provision of clean water and safe sanitation which will improve public health and save lives. The rest of the paper provides a synthesis on the literature on access to water and sanitation in Ghana. This is followed by a section on methods, analysis, and results. Finally, we highlight the policy implications that emerge from our discussion of empirical findings.

2 Access to Water and Sanitation in Ghana

According to the United Nations Joint Monitoring Program, although Ghana has achieved its Millennium Development Goal on water, it lags behind on improved sanitation (UN JMP 2013). The 2008 Demographic and Health Survey report shows that 83 % of the Ghanaian population have access to improved sources of water; however, only 12 % of the population have access to improved sanitation facilities. The gains in access to water are not uniform across urban and rural areas. The urban–rural disparities in access are worrying. About 93 % of the urban population has access to improved water sources as opposed to 76 % in rural areas (WSMP 2009). While access has rapidly improved for urban areas, rural and informal settlements continue to struggle. Dependence on unsafe water sources is thus higher in rural areas where most people use groundwater sources such as small ponds and unprotected wells (Atipoka 2009; Awuah et al. 2009).

Inter-regional disparities in water access are also prevalent in Ghana. The Greater Accra region has the worst water access mainly due to its highly populated settlements. The Upper-West region currently has the greatest access coverage (WSMP 2009). In terms of improved sanitation facilities, the Greater Accra region has the highest coverage as

[1] Demographic and Health Surveys is a USAID project responsible for collecting multiple indicator surveys on health and population in developing countries. For Ghana, the 2008 report is the most current data available.

opposed to the northern region. Residents in peri-urban and informal settlements mostly use public latrines. Ghana loses over 19,000 people including children under-5 years yearly to water-related illnesses (WSP 2010). Poor sanitation costs the country approximately 290 million US dollars (WSP 2010). Given this, it is imperative that socio-economic and demographic factors that influence access to improved water and sanitation are well understood. This study explores this need by using generalized linear models in identifying the key predictors of access to improved water and sanitation in Ghana.

3 Data and Methods

3.1 Data Description

Data for the study were drawn from the Ghana 2008 Demographic and Health Survey (Ghana Statistical Service 2009). The GDHS is a nationally representative survey administered by the Ghana Statistical Service (GSS) and Macro International. It was designed to monitor the population and health status in Ghana (Ghana Statistical Service 2009). Households for the survey were selected from enumeration areas across the country through a two-stage stratified sampling technique. The GDHS identified 5096 women aged 15–49 from 11,778 households out of which 4916 were interviewed, resulting in a response rate of 97 %. Approximately 4769 eligible men aged 15–59 years were also identified. Out of this, 4568 were interviewed resulting in a response rate of 96 %. The data were collected by a team of trained interviewers under the supervision of the GSS. Missing data on the study variables were below 2 % of the total sample (11,778), therefore, the listwise deletion technique was used.

3.2 Measures

The three major dependent variables used for this study were ‘source of drinking water’, ‘sanitation facilities’ and ‘time to water source in minutes’. Based on World Health Organization categorization, the ‘source of drinking water’ variable was dichotomised into improved sources (1) and non-improved sources (0). Improved sources of water included piped water into dwelling, yard or plot, public tap or standpipe, tube-well or borehole, protected dug well, protected spring and rainwater. Non-improved sources included unprotected dug well, unprotected spring, and mostly surface water sources such as rivers, ponds, and streams. *Sanitation* was dichotomised into (1) improved sanitation and non-improved sanitation (0). Improved sanitation facilities included flush toilet, septic tanks, pit latrine with slab, ventilated improved pit (VIP), and compost toilet while non-improved facilities comprised of pit latrines without slab, bucket latrines, publicly shared latrines, and open defecation in bush or field.

Seven independent variables comprising *wealth, education, number of household members, marital status, gender of household head, region, and place of residence* were used. In the case of modeling access to improved water and sanitation sources, *time to water source* was added as an independent variable. The wealth index is a composite indicator constructed as a measure of economic status in the DHS data set. Ownership of materials such as television, bicycle, land, access to electricity, and type of toilet facility were used to construct the index. It was constructed from weighted scores of household consumer items and dwelling characteristics. The index, constructed using principal components analysis, is a composite measure of the cumulative living standard of a household, which places individual households on a continuous scale of relative wealth (Boateng et al. 2014). We then divided the index into population quintiles, with the lowest quintile representing the poorest 20 % and the highest quintile representing the wealthiest 20 % of households in Ghana. It was necessary to create a scale because (1) many people do not know their income or only know it in broad ranges; and people try to hide their income from interviewers. (2) The reporting of unearned income (interest on loans, property rents, or gambling) is problematic. Wealth was differentiated into (a) Poorer, (b) Poor (c), Middle (d), Richer and (e) Richest. The household head variable was coded into (0) males and (1) females. Education of household head was coded as (0) no education, (1) primary education, (2) secondary education and (3) tertiary education. Marital status was coded as never married (0), currently married (1), widowed (2), and divorced (3). Place of residence was coded as rural (0) and urban (1) while region of residence was coded as Greater Accra (0), Central (1), Western (2), Volta (3), Eastern (4), Ashanti (5), Brong Ahafo (6), Northern (7), Upper East (8), and Upper West (9). Household size was treated as a continuous count variable and not recoded.

3.3 Data Analysis

Two of our dependent variables 'source of drinking water' and 'sanitation facilities' were recoded into dichotomous variables. Under the assumption of binary response, there are three potential alternatives: the logit model, probit model and complementary log–log model. Both logit and probit links have the same property, which is link $[\pi(x)] = -\text{link}\,[1-\pi(x)]$. This means that the response curve for $\pi(x)$ has a symmetric appearance about the point $\pi(x) = 0.5$ and so $\pi(x)$ has the same rate for approaching 0, as well as for approaching 1. When the data given is not symmetric in the [0, 1] interval, and increase slowly at small to moderate value but increases sharply near 1, as in the case of the outcome variables in this study, a complementary log–log link function is appropriate. In this study, source of drinking water and sanitation facilities do exhibit asymmetrical relations (14.84 %, 85.16) and (34.76 %, 65.24) respectively. Therefore, logit and probit models that rely on (50, 50 %) curves are considered inappropriate. The complementary log–log model gave a better representation (Boateng et al. 2014). The third dependent variable 'time to get to water source in minutes' was considered as a continuous variable, hence, the analysis followed an ordinary least squares regression model. By the application of these two models, we were able to estimate the relationship between the various predicting variables and the dependent variables using STATA 12.

4 Results

Our descriptive statistics provided in Table 1 show that approximately 85 % of the respondents used water from improved sources while 15 % used water from non-improved sources. Approximately 34.76 % of the respondents were without access to improved sanitation facilities while 65.24 % used improved sanitation facilities. About 68 % of the households were headed by males. Households were evenly distributed across the wealth index, with 21 % in poorest category and 19 % in the wealthiest category. Majority of the respondents were married (65 %) and almost half (48 %) of them were educated up to a minimum of secondary school level.

Table 2 summarizes the bivariate relationships of the dependent variables and independent variables. Female headed households were 1.21 times more likely to have access

Table 1 Descriptive analyses of variables for modeling water sanitation and health (N = 11,619)

Variables	Percent (%)	Mean	Min	Max
Source of drinking water			0	1
Non improved source	14.84			
Improved source	85.16			
Sanitation facility			0	1
Unimproved sanitation	34.76			
Improved sanitation	65.24			
Wealth index			1	5
Poorest	21.04			
Poorer	19.46			
Middle	19.99			
Richer	20.42			
Richest	19.09			
Sex (household head)			1	2
Male	68.27			
Female	31.73			
Education (household head)			0	3
No education	31.13			
Primary	12.94			
Secondary	47.95			
Higher	7.98			
Marital status (household head)			0	4
Never married	12.71			
Married	65.65			
Widowed	10.5			
Divorced	11.14			
No. of household members		3.95	1	32
Time to water source		14.62	0	400
Place of residence (interviewer)			0	3
Capital, large city	20.4			
Small city	15.73			
Town	23.33			
Countryside	40.51			
Place of residence			0	1
Rural	56.03			
Urban	43.97			
Region			1	10
G. Accra	14.26			
Central	8.63			
Western	9.55			
Volta	8.71			
Eastern	10.58			
Ashanti	15.88			
Brong Ahafo	9.3			

Table 1 continued

Variables	Percent (%)	Mean	Min	Max
Northern	8.89			
Upper east	6.98			
Upper west	7.22			

to improved water sources and 2.54 times more likely to have access to improved sanitation facilities compared to male headed households. Married, divorced, and widowed respondents were less likely to have access to an improved source of water compared to those who were never married. Respondents with secondary education were 1.41 times more likely to have access to an improved source of water as opposed to those who had no education at all. Furthermore, the likelihood of having access to an improved source of water is 2.18 times greater for respondents with tertiary education as opposed to those with no education. Similarly, those with secondary and tertiary education were 2.15 times and 2.81 times more likely to have access to improved sanitation facilities respectively. Respondents with access to improved water source were also more likely to have access to an improved sanitation facility.

Household size was negatively associated with access to an improved source of water and sanitation facility. Larger households tended to have better access to improved water sources compared to smaller households. Richer households significantly had higher odds of having access to an improved source of water and sanitation. As such, the magnitude of the odds ratio increased across the wealth index from poorest to richest. Respondents in urban areas had higher odds of having access to improved source of water and sanitation facilities compared to respondents in rural areas. With the exception of the Upper West region, other regions in Ghana had significantly reduced odds of having access to improved water sources compared to Greater Accra, the region where the capital city is located.

Table 3 shows multivariate relationships between the outcome and predictor variables. Model 1 of the logistic regression estimates the association between two factor variables (wealth index and gender) and the dependent variable—access to improved source of water. Wealthier households were significantly more likely to have access to an improved source of water when we controlled for gender. Female household heads were also 1.13 times more likely to have access to an improved source of water compared to male household heads, controlling for wealth status of households. When we controlled for education and household size, wealth index and gender showed significant associations with access to an improved source of water, although minor changes in the odds ratio were observed. In model 3, the significant relationship between the marital status of respondents and access to improved water source was displaced after controlling for place of residence and region of residence. This implies that the introduction of these two theoretically relevant factor variables fully mediated the association between education and access to an improved source of water. Respondents in urban settings were 19 % more likely to have access to an improved source of water than those in rural areas. With the exception of respondents residing in Eastern, Brong Ahafo, Northern, and Central regions, we found a significant relationship between the other regions and access to an improved source of water. Specifically, respondents in the Ashanti, Upper East, and Upper West regions demonstrated higher odds of having access to an improved source of water, with those in the Volta and Western regions reporting lower odds of having access to an improved source of water in comparison to those in the Greater Accra region.

Table 2 Bivariate analyses of variables modeling access to improved water source and sanitation (N = 11,619)

Variables	Improved water source		Improved sanitation	
	OR	SE	OR	SE
Wealth index				
Poorest	1.00		1.00	
Poorer	1.17***	(0.04)	3.15***	(0.19)
Middle	1.90***	(0.07)	5.50***	(0.31)
Richer	2.90***	(0.12)	7.58***	(0.43)
Richest	3.91***	(0.02)	11.11***	(0.66)
Sex (household head)				
Male	1.00		1.00	
Female	1.21***	(0.03)	2.54***	(0.11)
Education (household head)				
No education	1.00		1.00	
Primary	1.03	(0.04)	1.46***	(0.06)
Secondary	1.41***	(0.04)	2.15***	(0.07)
Higher	2.18***	(0.12)	2.81***	(0.14)
Marital status (household head)				
Never married	1.00		1.00	
Married	0.76***	(0.02)	0.80***	(0.03)
Widowed	0.81***	(0.04)		
Divorced	0.88*	(0.04)		
No. of household members	0.97***	(0.01)	0.93***	(0.01)
Place of residence				
Capital, large city	1.00		1.00	
Small city	0.79***	(0.04)	0.73***	(0.03)
Town	0.54***	(0.03)	0.53***	(0.02)
Countryside	0.31***	(0.31)	0.23***	(0.01)
Place of residence				
Rural	1.00		1.00	
Urban	2.19***	(0.06)	2.59***	(0.07)
Region				
G. Accra	1.00		1.00	
Central	0.66***	(0.04)	0.81***	(0.04)
Western	0.34***	(0.02)	0.46***	(0.02)
Volta	0.29***	(0.02)	0.39***	(0.02)
Eastern	0.48***	(0.03)	0.62***	(0.03)
Ashanti	0.78***	(0.04)	0.81***	(0.04)
Brong Ahafo	0.38***	(0.02)	0.75***	(0.04)
Northern	0.34***	(0.02)	0.14***	(0.01)
Upper east	0.85*	(0.06)	0.05***	(0.01)
Upper west	0.92	(0.06)	0.20***	(0.01)

Numbers in parenthesis () are standard errors

OR odds ratio

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

Table 3 Multivariate analyses of predictor variables for access to improved water source (N = 11,619)

Variables	Model 1		Model 2		Model 3	
	OR	SE	OR	SE	OR	SE
Wealth index						
Poorest(Ref.)	1.00		1.00		1.00	
Poorer	1.16***	(0.04)	1.19***	(0.05)	1.58***	(0.08)
Middle	1.85***	(0.07)	1.91***	(0.08)	2.48***	(0.14)
Richer	2.84***	(0.12)	2.92***	(0.13)	3.48***	(0.24)
Richest	3.87***	(0.20)	3.92***	(0.24)	4.54***	(0.38)
Sex (household head)						
Male(Ref.)	1.00		1.00		1.00	
Female	1.13***	(0.33)	1.11**	(0.04)	1.13***	(0.04)
Education (household head)						
No education(Ref.)			1.00		1.00	
Primary			0.88**	(0.04)	0.96	(0.04)
Secondary			0.93*	(0.03)	1.04	(0.04)
Higher			1.05	(0.08)	1.22*	(0.11)
Marital status (household head)						
Never married(Ref.)			1.00		1.00	
Married			0.84***	(0.04)	0.9	(0.05)
Widowed			0.88*	(0.06)	0.93	(0.06)
Divorced			0.89*	(0.05)	0.98	(0.07)
No. of household members			1.00	(0.01)	0.99	(0.01)
Place of residence						
Rural(Ref.)					1.00	
Urban					1.19***	(0.05)
Region						
G. Accra(Ref.)					1.00	
Central					1.08	(0.08)
Western					0.65***	(0.04)
Volta					0.62***	(0.04)
Eastern					0.93	(0.06)
Ashanti					1.41***	(0.09)
Brong Ahafo					0.88	(0.06)
Northern					1.09	(0.08)
Upper east					3.36***	(0.31)
Upper west					3.05***	(0.34)
Log pseudo likelihood	−4094.19		−4078.69		−3552.55	

Numbers in parenthesis () are standard errors

OR odds ratio, *Ref.* reference categories

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

Results from the OLS regression summarizing the linear relationships between selected independent variables and the ‘time to water source’ dependent variable is presented in Table 4. In model 1, the relationship between wealth index and time to a water source was

Table 4 OLS analyses of predictors of time to access improved water source (N = 11,619)

Variables	Model 1		Model 2		Model 3	
	COEF.	SE	COEF.	SE	COEF.	SE
Wealth index						
Poorest(Ref.)						
Poorer	−9.28***	(0.68)	−7.59***	(0.71)	−2.72***	(0.77)
Middle	−13.49***	(0.66)	−11.49***	(0.71)	−4.38***	(0.83)
Richer	−14.72***	(0.61)	−14.73***	(0.67)	−5.85***	(0.87)
Richest	−20.05***	(0.59)	−20.05***	(0.67)	−9.36***	(0.96)
Education (household head)						
No education(Ref.)						
Primary			−3.17***	(0.65)	−1.17	(0.61)
Secondary			−2.89***	(0.50)	−0.82	(0.47)
Higher			−1.87*	(0.81)	−2.26**	(0.79)
No. of household members			0.83***	(0.11)	0.48***	(0.11)
Region						
G. Accra(Ref.)						
Central					−1.31*	(0.59)
Western					4.82***	(0.60)
Volta					2.72***	(0.74)
Eastern					−1.72**	(0.54)
Ashanti					−0.25	(0.42)
Brong Ahafo					0.63	(0.67)
Northern					15.84***	(1.28)
Upper east					8.31***	(0.86)
Upper west					11.76***	(1.09)
Place of residence						
Capital, large city(Ref.)						
Small city					0.77	(0.49)
Town					3.09***	(0.67)
Countryside					5.71***	(0.64)
Constant	27.12***	(0.53)	23.88***	(0.7)	11.42***	(1.01)
R-Squared	0.13		0.15		0.20	

Numbers in parenthesis () are standard errors

COEF coefficient, *Ref* reference categories

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

explored. Results show that wealthier households have reduced time to water sources compared to poor households. What is more, the magnitude of the coefficients increased substantially with increasing wealth index. After controlling for education in model 2, the relationship between wealth and time to water source remained significant. Respondents with higher education levels had reduced time to water sources. Once region and place of residence were controlled in Model 3, the relationship between primary and secondary education was fully mediated, although the other levels of education remained significantly associated with time to water source. Those with higher education still had decreased time to water source compared to those without any form of education. Results also reveal that respondents in the Central and Eastern regions of Ghana had significantly decreased time to an improved water source compared to those in the Greater Accra region. On the contrary, respondents of Western, Volta, Northern, Upper East, and Upper West regions had increased time to a source of water compared to those in the Greater Accra region. Similarly, those residing in small towns and the countryside had increased time of access to a water source. The R-squared increased from 13 % in model 1–20 % in model 3, making household wealth a key factor influencing time to access of improved water source.

Table 5 shows multivariate relationships between the predictors and improved sanitation facility. Model 1 of the logistic regression estimates the association between wealth index, source of drinking water, time to water sources, and improved sanitation. On a continuum of poorest to richest, access to improved sanitation increased significantly when access to improved water and time to water source were controlled. Respondents who had access to improved source of drinking water were 1.36 times more likely to have an improved sanitation facility relative to those without improved water sources. Also, time to water source was negatively correlated with access to improved sanitation facility. After controlling for education, household head, and household size in model 2, wealth index, improved source of drinking water, and time to water sources were still significantly associated with improved sanitation. Respondents with at least secondary education were 1.08 times more likely to have an improved sanitation facility compared to those with less than secondary level education.

In model 3, the significant relationship between education, household size, and access to improved sanitation facility was displaced after we controlled for place of residence and region. Wealth and access to improved water sources continued to have a significant relationship with improved sanitation facility although with reduced magnitudes. Relative to those in the capital city, respondents in the small cities, towns and the country side were 0.79, 0.68, and 0.58 times less likely to have an improved sanitation facility respectively. With the exception of respondents residing in the Western and Volta regions of Ghana, there was a significant relationship between the other regions and improved sanitation facility. Specifically, respondents in the Central, Eastern, Ashanti, and Brong Ahafo reported higher odds of having access to an improved sanitation facility while those in the Northern, Upper East, and Upper West regions reported lower odds of having an improved sanitation facility relative to those in the Greater Accra region.

5 Discussion

This section outlines a cautious interpretation of our main findings. We explored the socio-demographic factors associated with access to improved water and sanitation in Ghana. Consistent with other studies such as Garriga and Foguet (2013), Joshi et al. (2013) and Rahman et al. (2013), our findings support the hypothesis that income and household wealth are important predictors of access to improved water and sanitation facilities although Yang et al. (2013) suggested that this trend differs across countries. In their study, Yang et al. (2013) reported that in Ethiopia, and to a lesser extent Nicaragua and Nigeria, poorer households tended to use more contaminated sources of water. However, in Tajikistan and Jordan, this was not the case" (p. 1227). This notwithstanding, our results indicate that poorer households are less likely to have access to safe water and improved sanitation facilities compared to richer households in Ghana. As expected, the magnitude of the odds ratio increased with each wealth quintile. Poorer households are often unable to

Table 5 Multivariate Analyses of Access to Improved Sanitation (N = 11,529)

Variables	Model 1		Model 2		Model 3	
	OR	SE	OR	SE	OR	SE
Wealth index						
Poorest(Ref.)	1.00		1.00		1.00	
Poorer	2.85***	(0.17)	2.69***	(0.17)	1.82***	(0.12)
Middle	4.59***	(0.27)	4.25***	(0.27)	2.57***	(0.18)
Richer	6.01***	(0.37)	5.59***	(0.37)	3.14***	(0.24)
Richest	8.32***	(0.54)	8.05***	(0.58)	4.33***	(0.38)
Source of drinking water						
Non improved source(Ref.)	1.00		1.00		1.00	
Improved sources	1.36***	(0.07)	1.35***	(0.06)	1.44***	(0.07)
Time to water sources	0.99***	(0.01)	0.99***	(0.01)	0.99***	(0.01)
Education (household head)						
No education(Ref.)			1.00		1.00	
Primary			1.07	(0.05)	0.99	(0.05)
Secondary			1.08*	(0.04)	0.97	(0.04)
Higher			0.95	(0.06)	0.99	(0.07)
Sex (household head)						
Male(Ref.)			1.00		1.00	
Female			1.15***	(0.04)	1.07*	(0.04)
No. of household members			0.98***	(0.01)	0.99	(0.01)
Place of residence						
Capital, large city(Ref.)					1.00	
Small city					0.79***	(0.05)
Town					0.68***	(0.04)
Country side					0.58***	(0.04)
Region						
G. Accra(Ref.)					1.00	
Central					1.55***	(0.11)
Western					0.99	(0.07)
Volta					1.06	(0.09)
Eastern					1.37***	(0.09)
Ashanti					1.42***	(0.09)
Brong Ahafo					2.00***	(0.16)
Northern					0.50***	(0.04)
Upper east					0.19***	(0.02)
Upper west					0.73***	(0.06)
Log pseudo likelihood	−5217.36		−5188.25		4773.11	

Numbers in parenthesis () are standard errors

OR odds ratio, *Ref.* reference categories

* $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

afford household tap water connections or pay for water from safe sources, forcing them to rely on unsafe sources. Not only did wealthier households have greater access to safe drinking water, they were also in close proximity to these improved water sources compared to the poorest households. This could be because wealthier household can afford private water connections or use protected dug wells well within close proximities at home.

Our results show that wealthier households are better able to afford improved toilet facilities compared to poorer households. It is not surprising however that those wealthy households with better access to water also have improved access to sanitation facilities. These findings suggest that inequalities in access to safe drinking water and improved sanitation facilities are highly correlated to household wealth. Put differently, household poverty reduces the likelihood of using safe water and improved sanitation facilities.

Our findings also highlight the importance of education and gender in understanding access to safe drinking water and improved sanitation in Ghana. Households with highly educated heads were more likely to have access to an improved water source and better sanitation facilities compared with households with less educated household head. This parallels the findings of Keshavarzi et al. (2006) that a significant relationship often exists between education and access to water and sanitation. This is not surprising because household heads with better education may be more knowledgeable about the potential health risks associated with using unsafe drinking water and poor sanitation facilities. Another plausible explanation for this trend is that wealthy and more educated households may be more inclined towards making the necessary investments for their households to have better access to water and sanitation facilities. Similarly, better-educated households were also found to have reduced time of access to an improved water source, implying close proximity to public improves sources of water and in most cases, have their own household water connections. Additionally, household heads with better education levels may mostly be well employed, earn more income, and better able to afford improved water and sanitation facilities.

Consistent with extant scholarship, our results revealed that female headed households have a greater likelihood of having access to safe drinking water and proper sanitation facilities compared to male headed households. Abebaw et al. (2011) argued that the responsibility of fetching water in many African countries rests usually on women and children; therefore, as household heads, women are more risk averse and are more inclined to use clean water for household purposes to minimize health related consequences. While this finding is surprising, it has the potential to inform future studies that will seek to understand household divisions of labor regarding water and sanitation provision. Regional variations in access to improved water and sanitation were evident. As anticipated, respondents in smaller cities and towns had lower odds of using improved sanitation facilities compared to those in larger cities. This may be due to the fact that larger cities are often more endowed with water and sanitation infrastructure compared to smaller cities. Also, wealthier people are more likely to live in larger cities than poorer people who are often limited to rural areas, smaller towns, and slum settlements.

6 Conclusions

The findings from our study clearly suggest that revamping initiatives aimed at addressing internal regional inequities in access and proximity to improved water sources and proper sanitation facilities are critical steps towards sustainable delivery of water and sanitation in Ghana. Our findings have important lessons for governmental agencies and other stakeholders involved in water and sanitation policy formulation and implementation. Based on our findings, we recommend that water policies should be drafted with greater emphasis on helping poorer people afford household taps. Our data analysis showed that respondents, particularly the poor, put a lot of time into accessing water, because improved sources are not in close proximity. Even in situations where household tap connections may not be feasible, reforms aimed at enhancing delivery should target the poor and focus on equitable distribution of water points in such less endowed neighborhoods. This will ultimately help poor households to channel time savings into other productive ventures. Public investment in water and sanitation needs to be accompanied by interventions in education and income-poverty reduction as our study shows that wealthier and well educated households have better access to safe water and better sanitation facilities. The poor water access levels recorded in the northern regions of Ghana calls for policy attention towards deprived areas where people are hardly able to afford the cost of potable water. As Ghana continues to face challenges in terms of improving water and sanitation facilities, it is necessary for major stakeholders in Ghana's water sector, such as the Ghana Water Company Limited (GWCL) and the Community Water and Sanitation Agency (CWSA) to work in tandem with the Ministry of Water Resources, Works and Housing to improve access. Finally, we recognize that lack of access to sanitation is linked to limited access to clean water. The challenge has been lack of jurisdictional coordination between the separate sectors that deal with water and sanitation issues. Placing equal attention to both the water and sanitation sectors will be key to advancing sustainable development in Ghana.

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