Factors influencing householders' access to improved water in low-income urban areas of Accra, Ghana

Ayisha Matuamo Mahama, Kwabena Asomanin Anaman and Isaac Osei-Akoto

ABSTRACT

We analysed householders' access to improved water for drinking and other domestic uses in five selected low-income urban areas of Accra, Ghana using a survey of 1,500 households. Our definitions of improved water were different from those suggested by the World Health Organization (WHO). The results revealed that only 4.4% of the respondents had access to improved drinking water compared to 40.7% using the WHO definition. However, 88.7% of respondents had access to improved water for domestic uses compared to 98.3% using the WHO definition. Using logistic regression analysis, we established that the significant determinant of householders' access to improved drinking water was income. However, for access to improved water for other domestic uses, the significant factors were education, income and location of the household. Compared to migrants, indigenous people and people from mixed areas were less likely to have access to improved water for other domestic purposes. For the analysis using the WHO definitions, most of the independent variables were not statistically significant in determining householders' access, and those variables that were significant generated parameter estimates inconsistent with evidence from the literature and anecdotal evidence from officials of public health and water supply companies in Ghana.

Key words | Accra, Ghana, water demand, water quality, water supply

Ayisha Matuamo Mahama
Kwabena Asomanin Anaman (corresponding author)
Isaac Osei-Akoto
Institute of Statistical, Social and Economic Research,
University of Ghana,
Post Office Box LG74,
Legon, Accra,
Ghana
E-mail: *kwabenaasomanin@hotmail.com*

LIST OF ABBREVIATIONS

WHO	World Health Organization
UNICEF	United Nations Children's Fund
GWC	Ghana Water Company
FRAMICS	Fourth Round Accra Multiple Indicator Cluster Survey
SPSS	Statistical Package for Social Sciences

INTRODUCTION AND PROBLEM STATEMENT

Access to improved water for drinking and other domestic uses, such as bathing, cooking and washing of clothes, is a major developmental challenge in many developing countries. Almost 1.1 billion people worldwide do not have access to clean water and over twice this number, more than 2.5 billion, lack access to basic sanitation facilities. More than 80% of these 2.5 billion people are in Asia and Sub-Saharan Africa as documented by the World Health Organization (WHO) and the United Nations Children Fund (UNICEF) in 2009 (WHO/UNICEF 2009). In a WHO 2010 study, it was reported that only 35% of the urban population in Sub-Saharan Africa have access to a piped water connection in their households (Zuin *et al.* 2011).

The need to provide access to good quality water and sanitation services to low-income urban residents cannot be overemphasized. Many governments in Sub-Saharan African countries concentrate their priorities on middle and upper income households to the detriment of the poor

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(Kähkönen 1999), mainly due to the political power of the middle and upper classes. The absence of proper water facilities and services leads to health problems with the major one being the creation of a network of increased ill-health through diseases such as acute eye infections, cholera, intestinal worms, malaria and typhoid fever. Reither *et al*. (2007) estimated that about 16% of deaths in children younger than 5 years are directly attributable to diarrhoeal diseases in Africa. This burden on society caused by early deaths of children applies very much to Ghana. For instance, malaria, upper respiratory tract infections, diarrhoea, skin disease and injury are reported as the leading causes of out-patient visits, with malaria accounting for about 40% of childhood and under-five mortality in Ghana (Ghana Statistical Service 2005).

These preventable diseases contribute to increasing substantially the financial health expenditure of government, exemplified by the large increases in the expenditures of the nation-wide government health insurance system introduced in 2003 in Ghana. For instance, the amount of money paid to healthcare providers of Ghana's National Health Insurance Scheme increased from 241.836 million Ghana cedis in 2009 to 394.270 million Ghana cedis in 2010 (Ghana Statistical Service 2012). (One Ghana cedi was worth US$0.50 in July 2013). The Institute of Statistical, Social and Economic Research, University of Ghana (ISSER 2013) indicates that Ghana loses about 420 million Ghana cedis annually due to the excessive time taken to search for water, loss of productivity and the medical costs of treating water and sanitation-related diseases.

It is the urban poor who normally have the least access to proper healthcare delivery services due to the high costs involved in accessing proper medical and health facilities (Nwaka 2005). The urban poor also tend to suffer the extra burden of the increases in the cost of living, lower income earning potentials and riskier lives, especially the women and children (Bosch *et al.* 2001). Many urban areas in Ghana continue to experience unprecedented growth, thereby creating problems related to limited and inadequate access to safe drinking water and water for other domestic uses. This unbalanced growth poses great danger to the health of residents especially among the urban poor who reside in informal dwellings that often lack proper water and sanitation facilities. More attention needs to be paid to ensure safe and quality water supplies to people especially those in low-income urban areas.

The main objective of the present study was to determine the factors influencing householders' access to improved water in selected low-income urban areas of Accra, the capital city of Ghana. The specific objectives were to determine the level of access to improved water for drinking and other domestic uses and to determine the factors influencing householders' access to improved water in the selected low-income areas of Accra. We were particularly concerned with defining improved water for drinking and other domestic uses, with emphasis on its quality aspects in line with the perceptions of various segments of the Ghanaian population, as ascertained from various experts working directly in the areas of provision of water supply services, health personnel dealing with water-borne diseases and producers of official statistics, such as the Ghana Statistical Service. The frequent occurrences of water-borne diseases, such as cholera and typhoid, in Ghana have made the segments of the population classified as middle and upper classes more conscious of the quality of water including pipe-borne water distributed to homes. These definitions were often in conflict with those suggested by WHO, due to the perceptions of the quality of water received by households.

LITERATURE REVIEW

Access to improved water

The importance of water cannot be overemphasized as it is used for many purposes such as domestic household chores, drinking and for non-domestic purposes. The 1977 Mar Del Plata Action Plan adopted by the UN General Assembly enshrines access to water as an essential human right. This human right relating to water includes having access to drinking water of adequate quality and quantity. Exclusion of anyone from access to improved drinking water due to poverty or place of habitation is a violation of their human rights (Grönwall 2008).

According to the United Nations Development Programme (UNDP 2006), a person not having access to at least 20 litres of clean water each day has his or her

fundamental human rights violated. In 1993, the WHO defined basic access to water as 50 litres per person per day (Smith & Hanson 2003). However, in 2003 the WHO redefined basic access to water as having access to average quantities not below 20 litres per capita per day and with a total collection time of 5 to 30 minutes (Howard & Bartram 2003). This definition notwithstanding, for one to be able to do laundry, get enough to drink, cook and ensure basic hygiene, about 30 to 40 litres of water per capita per day are required (Bartlett 2003). UN-Habitat (2009) suggests several factors that are required for the achievement of a minimum level of safe and affordable drinking water. These are: (1) the households must have 20 litres of water per person per day; (2) the drinking water must not cost more than 10% of the total household income; and (3) it must be available without extreme effort which means less than 1 hour per day for collection of water.

Though water supply coverage in developing countries has generally improved, there are still high proportions of the population without reliable access to safe water. Governments are faced with many challenges, such as finance, in improving people's access to these services. A major problem that has hindered their ability to cater for the water and sanitation services is the rapid increase in the numbers of people in urban areas, which has led to deepening of the poverty situation in many cities (Kurian & McCarney 2010). Thompson *et al*. (2002), as cited in Mudege & Zulu (2011), posit that the reduction in access to safe drinking water is partly attributed to the increasing pressure on the relatively few available facilities. In Kenya, for instance, there has been a continuous decrease in access to quality water. The ratio of piped to un-piped households has decreased from about 8:1 in 1967 to 2.6:1 in 2005 due to pressure on piped water facilities in municipalities. The study further reveals that the problem with access is not just because of scarcity but also due to its unequal distribution and the marginalization of people in informal areas and settlement in development plans.

In a focus-group discussion study conducted in four informal settlements in Nairobi, Kenya by Amuyunzu-Nyamongo & Taffa (2004), it was found that not only did community members have to travel long distances to collect water, some of the landlords in the community contributed to limiting their access to water as these landlords rationed water, such that it was only available on specific days of the week and at specific times. Also, the study found that the costs of water paid by residents without piped connections were higher than those paid by households with piped water paid.

Improved water sources are those that are designed such that they are devoid of any contamination, especially from faecal matter (Osman & Khan 2011). The WHO defines improved sources of drinking water to include water piped in homes, piped into a yard, piped into a neighbour's house, rainwater, boreholes and wells. However, water from boreholes, wells and rivers is more often than not contaminated with pollutants, such as bacteria, faecal matter and chemicals, hence should rather be considered as unimproved sources (Obeng-Odoom 2012).

In both urban and peri-urban areas of Ghana, a common observation is that relatively rich people have constructed their houses near piped water delivery networks of the government-owned Ghana Water Company (GWC) allowing them direct access to subsidized piped water from GWC. Rural villages and poorer urban communities are often served by the government through the Community Water and Sanitation Boards, which charges residents of these poor communities several times the rate of water delivery to affluent areas serviced by GWC. Thus, from January to September 2013 at AyiMensah, a very poor suburb of Accra, residents paid about 2.75 Ghana cedis per kilolitre of water accessed through the Kweiman-Danfa Community Water Board. This was in contrast to the payment of 0.85 Ghana cedis per kilolitre paid by affluent and middle-class customers of GWC living in Adenta Municipality which is about 5 km from AyiMensah.

Limiting access to water to mean only coverage is not sufficient to reflect the true picture of Ghana's situation. Rather, access to water should be looked at by considering the quality of water and reliability of the supply of quality water. Quality should ensure that the drinking water is safe, such that there are no pollutants or chemicals in it, while reliability considers regular flow of water. According to a survey by the World Bank in 2010, about 46% of households in Ghana with a piped water connection rarely had their pipes flowing while about 5% of these households had never had piped water (Obeng-Odoom 2012).

Determinants of householders' access to improved water

Income

Smith & Hanson (2003) established that household income is one of the main determinants of access to water and sanitation facilities. From their study conducted in Cape Town, South Africa, households with lower incomes (below 800 rands) have limited opportunities to improve their water and sanitation conditions. Similarly, UNICEF estimates that households in the lowest wealth quintile are 5.5 times more likely to lack improved water access and 3.3 times more likely to lack adequate sanitation, compared with households in the highest wealth quintile in the same country. The burden of poor access is normally borne by women and children. This is because they are normally responsible for the majority of water collection.

Bosch *et al.* (2001) also indicated income levels of households as among the factors that determine their access to water and sanitation facilities and services. This is because, the low-income groups are hardly able to afford high connection fees to piped water and hence limit their connectivity. Also, while the higher income groups can afford to buy more and are also able to afford private alternatives in times of shortages, these may be too expensive for the urban poor as they are barely able to meet the three basic needs (food, water and shelter). In Ghana, low-income communities who depend on public piped water receive less water and face greater shortages than high-income communities because of the higher income communities' greater purchasing power (Stephens (1996), as cited in Howard & Bartram (2003)).

Another determinant of access to water is related to how equitably the facility is distributed. Even though there could be a general increase in access to water, there is normally inequitable distribution as distribution of piped water normally tends to favour high-income neighbourhoods to the detriment of poor neighbourhoods. According to the Ghana Statistical Service (2007), about 43% of households in the highest income quintile classification have piped water connections as compared to only 18.5% of households in the lowest income quintile classification (Obeng-Odoom 2012).

Location and distance

As pointed out earlier, urban households in slums or informal areas are more likely to have limited connectivity to piped water partly due to the haphazard nature of their settlements. More often than not the water and sanitation needs of poor urban communities are hardly incorporated into urban and regional planning (Bosch *et al.* 2001). Franceys & Gerlach (2008) indicate that though most of the urban poor are housed in slums, many such areas are often denied access or face cumbersome administrative procedures when it comes to connecting them to official water sources partly because of lack of security guarantees for land and pipelines as well as the problems of affordability. Though utility prices are cheaper for those connected to the water systems, most of the poor are denied access because they lack formal property rights to where they live. Their places of residence serve as a barrier to getting access to these facilities because of undeveloped infrastructure networks. For example, in some places road accessibility is poor and this implies difficulties in the removal of waste. Hence, it becomes very difficult for households in these areas to get connected to these services (UNDP 2006).

In a review conducted by Howard & Bartram (2003), it was revealed that distance is a crucial factor in determining access to water and sanitation facilities. The further away the source of water is to a household, the less water is consumed. In areas where people walk for more than 1 kilometre or spend more than 30 minutes for collection of water, the per capita water use drops to about 5 to 10 litres per day. At that level of service, it becomes very difficult to meet adequate hygienic standards. This notwithstanding, in the urban areas, a major deterrent factor may be time taken to get water and not the distance, as more people are most likely to reduce consumption of water if they have to walk shorter distances but have to queue for longer hours to draw the water (Bosch *et al.* 2001).

Cairncross & Cuff (1987), as cited by Osman & Khan (2011), also suggest that the amount of time involved in getting water is probably more important than the distance covered to the water source as a determinant of access to water. This is because there are some areas where scarcity of water is so severe that it takes longer to obtain water

than to reach the water source. For example, in a study conducted in Mueda in Mozambique, women spend about 2 hours getting to a water source and about 3 hours queuing for the water due to the relative scarcity of available water (Cairncross & Cuff 1987).

Studies by Ako *et al.* (2010) confirmed that the further away a water source is from a household, the more time is spent in sourcing water. When householders have to travel for about 3–30 min to get drinking water, then they are able to meet their daily requirements of about 15–25 litres per person per day. However, they tend to compromise on drinking water if they have to spend beyond 30 min to get access to the water. In Lesotho, it was revealed that about 25% of households spend about 2.5 hours in collecting water while the majority of households in East Africa and North Cameroon spend close to 5 hours and 6 hours, respectively, per day collecting water for household needs.

Howard & Bartram (2003) show that the average amount of water a household consumes depends on the location of the water source. Those who have water piped into their homes consume average quantities of about 155 litres per person per day. However, those households who get their water from a piped source in a yard or place outside their homes decrease consumption to about 50 litres per person per day and those whose water source is outside the home further reduce their daily average consumption level.

Emphasizing the issue of location as a determinant, Bartlett (2003) indicates that in Burkina Faso mothers with piped water within their homes are three times more likely to practise safe hygiene as compared to those whose sources of water are outside their compounds. Similarly in urban Brazil, householders who resort to using public standpipes were five times more likely to experience infant death than households with water piped to their homes.

Hygiene levels maintained by households are sensitive to the service level. Households with water piped into their homes tend to use more water for personal hygiene while those who resort to using water sources outside their homes, use smaller quantities for personal hygiene. For example, in studies conducted in Tanzania, Kenya and Uganda, households with piped water connections within their homes use about 16.3 litres per capita for washing dishes and clothes and 17.4 litres per capita for bathing, while those whose sources of water are outside homes use an average of 6.6 litres per capita for washing dishes and clothes and 7.3 litres per capita for bathing (Howard & Bartram 2003). Giles & Brown (1997) also state that those with a piped water supply and proper installation demand far more water than those without piped connections to their homes.

In a study by Mercado & Kjellstorm (2008) to determine the social determinants of health equity in urban settings, it was shown that the burden of inadequacy of water and sanitation is borne by women and children. Apart from the fact that most of them without toilet facilities in their households have to travel great distances to relieve themselves, they also delay their sanitary needs during the daytime until night due to modesty and unavailability of water. According to Bartlett (2003), the further children have to travel to search for water, the more calories they burn and hence have less energy to undertake other activities in the homes. Further, they are made to carry heavy containers in order to get more water. These can cause some physical deformities and affect the growth of their bones. Jain & Singh (2010) indicate that, with regard to women, the more time spent in search and collection of water, the less time is available to cater for other domestic needs such as cooking, caring for children and pursuit of other income-earning activities.

Education

Apart from location and distance, educational achievement also determines one's access to improved water. Lack of or inadequate level of educational achievement serves as a great barrier to empowerment. The lower the educational achievement of an individual, the more they have limited opportunities to demand better facilities from the authorities as he or she is powerless (Bosch *et al.* 2001). Lack of or inadequate water and sanitation facilities also tend to affect the education of children, especially girls, as the burden of water collection is borne by them. More often than not, the number of hours spent in collecting the water interferes with their school attendance. Schools with poor sanitary and toilet facilities further discourage children, especially girls, from going to school regularly, which consequently affects their performance and perpetuates the vicious cycle of illiteracy and poverty (Bartlett 2003).

Health effects of use of unimproved water

The goals of human development as indicated by improved education and health access rely mainly on sufficient improvement in the access to sufficient quality water and sanitation services. According to Brenneman & Kerf (2002), there is a strong relationship between improvement in water and sanitation infrastructure and health outcomes. Their findings indicate that improvement in these infrastructures leads to a significant reduction in water- and sanitation-related diseases among many households. In situations where there is lack of access to water, sewage or solid waste management systems, there tends to be severe effects on the health of the population and the health costs in dealing with these impacts are huge and contribute to the draining of a country's financial resources. For instance, a million or more infants still die each year from diseases related to inadequate provision of water and sanitation, especially among low-income urban households in illnesses such as cholera, typhoid and dysentery (United Nations 2011).

In a report by Aramayo *et al*. (2009), it is established that about 94% of the diarrhoeal burden of disease is attributable to the environment and is associated with risk factors, such as unsafe drinking water, poor sanitation and poor hygiene. Also, a study by Macassa *et al*. (2006) among infants in Stockholm in the late 19th and early 20th century indicates that the incidence of diarrhoea cases is reduced greatly in places where running water and hygienic latrines are provided. Again, Macassa *et al*. (2006), as cited in Metwally *et al*. (2007), indicate that children living in households with no toilet facility or where their source of water is from a well stand are at a higher risk of death compared to those who live in areas with pipe-borne water and flushing toilet facilities.

Rationale for the definitions of improved water sources used in this study

The literature review reported in this paper basically asserts that piped water is necessarily improved and hence its consumption will result in healthy outcomes. In this study, we stress the quality aspects of water available to householders and suggest that the patterns of choice of sources of water can be influenced by socio-economic characteristics even in relatively homogeneous low-income populations. Based on anecdotal evidence gathered from the survey areas and formal and informal discussions with officials of water supply services such as the Ghana Water Company, officials of the Ministry of Health and the Ghana Statistical Service, the producer of official national statistics, we have defined improved water sources as those with little likelihood of contamination with faecal matter and other pollutants.

Our definition of improved water for drinking used in this study is supported by data from the 2010 Population and Housing of Ghana, which showed that the proportion of the population using bottled water for drinking in Ghana increased from virtually 0% in 2000 to 0.4% in 2010 and as much as 3.0% in parts of Accra, the capital city of Ghana. Further, the proportion of the population using sachet water for drinking nationwide jumped from virtually 0% in 2000 to 9.0% in 2010 (Ghana Statistical Service 2012). Sachet water is of two types: (1) regulated quality-assured, produced by government-accredited factories; and (2) unregulated, produced by small businesses and home-based entities which is of dubious quality. Our study did not establish the proportions of respondents who use regulated and unregulated sachet water. The proportion of the population using pipe-borne water inside dwellings has remained virtually the same: 14.3% in 2000 compared to 14.5% in 2010.

The fear of contaminated water from various sources has pushed many of the emerging upper-class and middle-class people to use bottled water or factory-manufactured sachet water for drinking, as exemplified by the rapid growth of factories in Ghana producing government-certified bottled and sachet water. Nevertheless, there has also been an explosion of growth of informal sachet water production using unimproved water bagged in plastic material widely sold at lorry parks and transportation nodes in the country. The problem of illegal production of bottled water based on unscrupulous people filling used water bottles with unimproved water and selling them to the public has largely disappeared with the tight packing and sealing of bottles used by manufacturers of bottled water. The definition that we used for improved water for other domestic uses, such as cooking and bathing, is not stringent given

the common practice of boiling water for bathing and also for cooking which greatly reduces the impact of pathogens.

METHODOLOGY

Study area

The survey which formed the basis of this study was carried out in five localities in the Greater Accra region namely: Nima, Accra New Town, La, James Town and Bubuashie. Nima and Accra New Town are places settled by people not originally from Accra, that is these people are mainly migrant or first-generation migrants. They come from several ethnic groups, with those from the three northern regions of Ghana constituting the majority. The residents of James Town and La are mainly the indigenous Ga people of Accra. Bubuashie has a population of mixed ethnic character. Apart from La, all the other localities are under the jurisdiction of the Accra Metropolitan Assembly (AMA 2010). The 2010 population of the Greater Accra region was estimated to be 4,010,054 compared to the 2000 population of 2,905,726, the 1984 census population of 1,431,099, the 1970 population of 851,614 and the 1960 population of 491,817 (Ghana Statistical Service 2012). The population of Greater Accra increased more than eightfold from 1960 to 2010. Rural–urban migration accounts for much of the population increase in Accra. While the high population serves as a huge and vibrant market for investors, there are attendant severe problems of poor water access, low quality sanitation and poor waste management, as well as major traffic congestion.

Survey procedures and administration

The data for this study were obtained from the Fourth Round Accra Multiple Indicator Cluster Survey (FRAMICS) conducted in 2010/2011 by the Institute of Statistical, Social and Economic Research, University of Ghana, Legon, Accra, Ghana. Four sets of questionnaires were used to solicit data. These were (1) household questionnaire, (2) women's questionnaire, (3) men's questionnaire and (4) under-five questionnaire. Apart from information on the social and demographic characteristics, other questions asked were on access to sanitation and water facilities, health status of children, attitudes and sexual behaviour of men and women.

The sample size was 1,500 households selected based on 100 enumeration areas with 15 households selected from each enumeration area. The selection of the enumeration areas from each locality was based on the 2010 Population and Housing Census framework proportional to the size of the population. With a household listing of each enumeration area, the 15 households were then selected using the systematic sampling approach. Out of the 1,500 households selected, 1,409 were successfully interviewed constituting men and women between 15–49 years and children under 5 years. The respondents interviewed were household heads or household members with extensive knowledge of the working of their household.

For the measurement of income, the survey uses household 'asset' index which reveals the socio-economic status of the population. The index was constructed by using principal component analysis based on the ownership of household durables. The indices derived are relative measures of socio-economic status. Hence while this type of measure is useful for considering inequality between and among households, it cannot provide information on absolute levels of poverty within a community. It, however, reflects significant differences in income levels since the stock of assets for households is highly related to income status of household members. The index was divided into five socio-economic status groups (income groups) for analysis.

Analysis of survey data

The survey data were analysed with the Statistical Package for Social Sciences (SPSS) using simple frequency and descriptive analysis to summarise the important socio-economic features of the sampled respondents. Logistic regression analysis was also employed using SPSS to establish the significant factors influencing the likelihood of households having access to improved water for drinking and improved water for other uses.

The sources of water considered as improved according to this study are water piped into dwellings and bottled water. However, according to WHO (2008) and

the WHO/UNICEF Joint Monitoring Programme for Water Supply & Sanitation (2013), sources of water considered as improved include water piped into dwellings, water piped into compounds/yards/plots, water piped into a neighbour's property, protected wells, protected springs, boreholes and public standpipes. Our study limits improved water sources to piped water into dwellings and bottled water.

Water produced at the plant of the Ghana Water Company is generally considered to be excellent and in line with international standards. However, extensive leakages and damages to the pipelines linking homes lead to contamination of the end source water, often with water from adjacent gutters near pipelines. Thus in Accra, water purifiers are regularly purchased by affluent households and hotels to further process piped water before drinking.

For our study, unimproved water sources for drinking are water piped into compounds/yards/plots or into a neighbour's property, sachet water, rivers/streams, dams/lakes/ponds/canals, tanker trucks, springs, rainwater, carts with small tank/drum, public taps and boreholes. Unimproved water sources for drinking according to WHO are sachet water, tanker trucks, carts with a small tank/drum, bottled water, rainwater, unprotected wells and springs.

For our study, the sources of water considered as improved for other domestic purposes are water piped into dwellings, into compounds/yards/plots and into a neighbour's property and rainwater. We chose these sources of improved water as most households boil water for cooking and even for bathing in Ghana. Improved water sources for other domestic purposes suggested by WHO are water piped into dwelling, into compounds/yards/plots and into a neighbour's property, public taps or standpipes, boreholes, protected wells and springs, and rainwater.

Unimproved water for other purposes as defined by the study includes sachet water, rivers/streams, dams/lakes/ponds/canals, tanker trucks, springs, rainwater, carts with a small tank/drum, public taps and boreholes. Based on the WHO definition, unimproved water for other purposes includes dams/lakes/ponds/canals, tanker trucks, springs, rainwater and carts with a small tank/drum.

Several socio-economic characteristics influence the likelihood of households having access to improved water. These variables have been discussed in the literature review. The important socio-economic characteristics that we consider in our study are gender, income, educational achievement, religion and locality of residence of respondents. These variables are used as independent variables in a logistic regression model to estimate factors influencing the likelihood of households using improved water for drinking and improved water for other domestic uses.

Description of the binary logistic regression analysis

A binary logistic regression analysis was undertaken to determine socio-economic characteristics that significantly influenced access of households to improved sources of drinking water and water for other domestic purposes. The general logistic regression model is stated below.

$$\mathbf{ACCESS} = ß_0 + ß_1\mathbf{HINCOME} + ß_2\mathbf{EDUCATION} + ß_3\mathbf{RELIGION} + ß_4\mathbf{GENDER} + ß_5\mathbf{LOCALITY1} + ß_6\mathbf{LOCALITY2} + U_i \text{ where:}$$

ACCESS was a dummy variable with 1 representing householders having access to improved water and 0 for those with access to only unimproved water sources. Separate models were estimated for improved drinking water and improved water for other domestic uses.

HINCOME was the wealth group index of respondents with higher numbers indicating higher wealth. There were five groups, 1, 2, 3, 4 and 5.

EDUCATION was the level of educational achievement of the respondent.

RELIGION was a dummy variable used for religious affiliation of the respondents with followers of Islam designated as 1 and non-Muslims as 0.

GENDER was the sex of the respondent.

LOCALITY1 referred to respondents living in James Town and La. These people were largely Ga indigenes. The value of 1 was used for people living in James Town and 0 was used for all others.

LOCALITY2 referred to respondents living in Bubuashie. These people came from mixed ethnic backgrounds and included both migrants and indigenes. The value 1 was used for people living in Bubuashie while 0 was used for all other people in the sample.

U_i was the error term assumed to have a 0 mean and constant variance.

RESULTS AND DISCUSSION

Background information on respondents

Based on the frequency analysis, the majority of the respondents were males constituting about 65.7% of the sample. Females constituted the other 34.3% (Table 1). With regard to religion, about 71.5% of the respondents were Christians; Muslims constituted 22.4% and adherents of traditional African religions made up 6.2% of the respondents. The findings with regard to religious affiliation are similar to those obtained for the 2010 National Report of the Population and Housing Census (Ghana Statistical Service 2012). Ga/GaDangmes indigenes formed the largest group with about 34.2% share of the respondents. Non-Ghanaians constituted the smallest ethnic group accounting for about 3.2% of the total respondents. Akans, Ewes and Mole-Dagbani people accounted for about 27.7, 15.6 and 10.6%, respectively.

Table 1 | Socio-economic characteristics of respondents based on frequency analysis

Item	Percentage frequency
Gender	
Female	34.3
Male	65.7
Religion	6.2
Christian	71.5
Islam	22.4
Traditional African religions	6.2
Ethnicity	
Ga/GaDangmes	34.2
Ewe	15.6
Akan	27.7
Mole-Dagbani	10.6
Non-Ghanaians	8.7
Others	8.7
Educational achievement	
None	15.1
Completed primary school	10.1
Completed middle/junior high school	38.1
Completed secondary school and above	36.6
Locality	
Accra New Town	21.0
Bubuashie	16.0
James Town	5.0
La	32.0
Nima	26.0
Wealth or income class	
Poorest	22.4
Second Poorest	19.7
Middle	20.2
Fourth Poorest	19.3
Richest	18.4

The highest educational level achieved by the majority of the respondents was the middle or junior high school constituting about 38.1% of the respondents, followed by those who completed secondary school and above representing about 36.6%, while those who completed primary level accounted for 10.1%. About 15.1% of the total respondents had received no formal education. Therefore about five out of six of the respondents (85%) were literate in terms of receiving some formal education.

In the five poor urban localities considered for the study, the largest portion of the respondents (32%) were based in La, an indigenous town, and 26% of the respondents lived in Nima, primarily a migrant area. Accra New Town (predominantly migrant) and Bubuashie (mixed) were home to 21 and 16%, respectively. James Town, a largely indigenous community, had about 5% of the respondents as shown in Table 1. In terms of wealth status, the poorest group was the most dominant accounting for almost one-quarter of the respondents (22.4%). The middle or the third poorest group was the second most dominant of the groups classified by wealth status.

Sources of water for drinking

The sources of water for drinking are reported in Table 2. The main source of water for drinking was the sachet water used by about 59% of the sample. Sachet water consisted of two types, either (1) manufactured in a proper factory certified by government regulators or (2) packaged by informal vendors often using impure water. The study did not directly incorporate the type of sachet water used by the respondents. Overall, about 39.3% of the respondents used pipe-borne water for drinking delivered through

Table 2 | Sources of water for drinking

Source	Improved/ unimproved[a]	Frequency	Percentage
Piped into dwelling	Improved	46	3.3
Piped into compound/ yard/plot	Unimproved	230	16.3
Piped into a neighbour's property	Unimproved	226	16.0
Public tap/standpipe	Unimproved	52	3.7
Tube well/borehole	Unimproved	2	0.1
Protected well	Unimproved	2	0.1
Tanker/truck	Unimproved	3	0.2
Bottled	Improved	16	1.1
Sachet water	Unimproved	832	59.0
Total		1,409	100.0

[a]Based on our study.

Table 3 | Sources of water for other domestic uses

Source	Improved/ unimproved[a]	Frequency	Percentage
Piped into dwelling	Improved	76	9.0
Piped into compound/ yard/plot	Improved	331	39.1
Piped into a neighbour's property	Improved	344	40.6
Public tap/standpipe	Unimproved	77	9.1
Tube well/borehole	Unimproved	1	0.1
Protected well	Unimproved	3	0.4
Tanker/truck	Unimproved	12	1.4
Cart with small tank	Improved	3	0.4
Total		847	100.0

[a]Based on our study.

various modes. Bottled water, a status symbol of the middle and upper classes, was the main source of water for only 1.1% of the respondents. Based on the definition used in this study, the proportion of the respondents using improved water for drinking was 4.4%, made up of 1.1% of respondents using bottled water and 3.3% with access to piped water in their dwellings (Table 2). Therefore our study concluded that the remaining 95.6% of the respondents used unimproved water for drinking.

Using the WHO definition of sources (see section on 'Analysis of survey data'), the proportion of respondents with access to improved drinking water was 39.6%. The remaining 60.4% of the respondents used unimproved water for drinking.

Sources of water for other domestic purposes

Based on the definition used in this study (see section on 'Analysis of survey data'), the proportion of the respondents using improved water for other domestic purposes was 88.7% (Table 3). The two most important sources of water used by respondents were water piped into a neighbour's property (40.7%) and water piped into compounds/yards/plots (39%); both were considered to be improved sources of water in our study.

Using the WHO definition (see section on 'Analysis of survey data'), the proportion of respondents with access to improved water for other domestic uses was 98.3%. The remaining 1.7% of the respondents used unimproved water for other domestic purposes (Table 3).

Other aspects of water access and availability

With respect to the location of water source, the vast majority of respondents (91%) had to travel outside their homes to fetch water while only 4% of the respondents had water sources in their dwelling. The other 5% of households had water within their own yards or plots. Of the 91% of respondents who travelled elsewhere to fetch water, the majority (60.2%) spent about 1–5 min getting to a water source, while 16.2 and 21.3% spent about 6–10 min and 11–30 min, respectively, getting to water. Overall, the vast majority of the respondents who travelled outside their homes to fetch water (97.7%) took a maximum of 30 min to collect the water. With regard to persons who collected water for household use, adult women aged 15 years and above constituted the largest group of people collecting water (48.9%). The second largest group was made up of adult men aged between 15 years and above (34%). Children, defined as people less than 15 years of age, made up 12% of the respondents who collected water, with girls accounting for a larger share of this group of water collectors (8.5%) than boys (3.5%).

Discussion of results of logistic regression analysis of factors influencing householders' access to improved water

According to the logistic regression analysis of factors influencing access to improved drinking water sources, only income (wealth) was statistically significant (5% level of significance) in determining an individual's level of access to improved sources of water for drinking (Table 4). This means that as an individual's level of income increases, he or she is likely to have access to improved sources of water for drinking because he or she has a higher purchasing power. This assertion is supported by Bosch *et al.* (2001) who posit that the higher income groups can afford to buy more and are also able to afford private alternatives in times of shortages compared to the urban poor.

According to the logistic regression analysis of factors influencing access to improved sources of water for other domestic uses, both education and wealth were significant in positively influencing access to improved water by householders (Table 5). This implied that as educational and wealth status of household heads' increased, there was a higher likelihood that they would have access to improved water sources to meet their domestic household chores such as cooking and bathing.

Both locality variables were also statistically significant in influencing householders' access to water for other domestic purposes. This result must be interpreted with respect to the base locality variable, migrant locality status, implying that compared to migrants, indigenes and people from mixed areas were less likely to have access to improved sources of water for other domestic purposes.

Table 4 | Logistic regression analysis results for factors influencing the likelihood of householders having access to improved drinking water

Explanatory variable	Parameter estimate	Standard error	Probability level of significance
Intercept	−5.807	0.654	0.000[a]
Gender	0.138	0.317	0.663
Education	0.000	0.160	1.000
Wealth	0.725	0.126	0.000[a]
Religion	0.657	0.353	0.063
Locality1 (indigene)	0.077	0.321	0.881
Locality2 (mixed)	−0.861	0.561	0.095

[a]Significant at the 5% level.
The power of the model is high as the percentage correctly classified was 95.6%.

Table 5 | Logistic regression analysis results for factors influencing the likelihood of householders having access to improved water for other domestic uses

Explanatory variable	Parameter estimate	Standard error	Probability level of significance
Intercept	1.051	0.414	0.011[a]
Gender	−0.379	−0.253	0.134
Education	0.255	0.120	0.035[a]
Hincome	0.173	0.088	0.050[a]
Religion	−0.267	−0.292	0.360
Locality1 (indigene)	−0.753	0.326	0.021[a]
Locality2 (mixed)	−0.818	0.302	0.007[a]

[a]Significant at the 5% level.
The power of the model is high as the percentage correctly classified was 88.5%.

Discussion of results of logistic regression analysis of factors influencing householders' access to improved water based on WHO definitions

The results of the logistic regression analysis of factors influencing householders' access to improved water for drinking and improved water for other domestic uses based on using WHO definitions of improved water are presented in Tables 6 and 7, respectively. For the analysis dealing with improved drinking water, the results showed that four of the independent variables, Gender, Education, Religion and Hincome, had statistically significant influence on the likelihood of using improved water for drinking. The negative signs for the coefficients of Education and Wealth, however, were clearly inconsistent with economic theory and were also different from the comparative results reported in Table 4. The inconsistency of the WHO-based results with economic theories and a priori expectations suggest on preliminary grounds the lack of validity of the WHO definitions as applicable to the study area. This suggestion is supported by the relatively low power of the model with only 64.9% of correct classification (Table 6)

Table 6 | Logistic regression analysis results for factors influencing the likelihood of householders having access to improved drinking water based on definitions used by WHO

Explanatory variable	Parameter estimate	Standard error	Probability level of significance
Intercept	0.955	0.212	0.000[a]
Gender	0.521	0.132	0.000[a]
Education	−0.212	0.067	0.001[a]
Hincome	−0.382	0.046	0.000[a]
Religion	−0.419	0.165	0.011[a]
Locality1 (indigene)	0.120	0.140	0.393
Locality2 (mixed)	0.122	0.180	0.498

[a]Significant at the 5% level.
The power of the model is high as the percentage correctly classified was 64.9%.

Table 7 | Logistic regression analysis results for factors influencing the likelihood of householders having access to improved water for other domestic uses based on definitions used by WHO

Explanatory variable	Parameter estimate	Standard error	Probability level of significance
Intercept	4.045	1.005	0.000[a]
Gender	−0.715	−0.620	0.248
Education	0.492	0.274	0.073
Hincome	−0.130	0.203	0.523
Religion	−0.564	−0.684	0.409
Locality1 (indigene)	−0.957	−0.614	0.119

[a]Significant at the 5% level.
The power of the model is high as the percentage correctly classified was 98.2%.
Locality2 was not admissible in the model due to high multicollinearity with one or more of the other independent variables.

compared to the comparative power of 95.6% reported in Table 4. The literature review included a clear statement linking use of improved drinking water sources to increased income and wealth.

For the logistic regression results dealing with improved water for other domestic uses, the results indicated that none of the six independent variables was statistically significant in influencing the likelihood of use of improved water (Table 7). Compared to the results based on the definitions used in our study, which had as many as four statistically significant independent variables (see Table 5), the WHO definitions could be seen to be invalid for the area of the study.

CONCLUSIONS

We analysed householders' access to improved water for drinking and other domestic uses in five selected low-income urban areas of Accra, Ghana using a survey of 1,500 households. Our definitions of improved water were different from those suggested by the WHO. The results of our study showed that only 4.4% of the respondents had access to improved drinking water compared to 40.7% using the WHO definition. However, 88.7% of respondents had access to improved water for domestic uses based on our definitions compared to 98.3% using the WHO definition. Comparison of the logistic regression model based on our study's definitions and an identical model using WHO definitions showed that most of the WHO-based variables were not statistically significant in determining householders' access to improved water and the few that were significant had parameter estimates which were clearly inconsistent with economic theories and findings reported in the literature.

A finding of our study is that the WHO definitions of improved water are too broad for all countries and even for all groups within a particular country. As such, there is a requirement for WHO to revise their standard definitions to relevant country-specific indicators with regard to what constitutes improved and unimproved water given changes in the dynamics of the populations, especially with the emergence of a small but increasing number of middle- and upper-class people in developing countries, such as Ghana, who place emphasis on the quality of water in addition to the quantity of available water. This is because what might be considered improved in one country might not be considered so in other countries or even in the same country, and what might be considered improved in a previous era would be deemed unimproved in current times.

We argue that access to water can only be meaningfully addressed if we consider what people agree to be good or bad sources of water in development policies. For example, if drinking water being used by low-income people primarily from migrant backgrounds of poorer quality than that used by other people, it poses a problem of inequality that can be

captured in health outcomes and can also be related to civil conflicts in urban areas. Based on our study, which is one of the largest surveys conducted in low-income urban areas in Ghana on access to water, we have established the factors influencing access to improved water using definitions that are consistent with the preferences of the population as revealed by the various population and housing censuses in Ghana including the latest census conducted in 2010.

In order to combat and eliminate the regular epidemics of cholera and other water-borne diseases, such as typhoid, in urban areas of Africa like Accra, we need to emphasize quality control issues related to the production and availability of drinking water and water for other domestic uses. As indicated in our study, the quality of the pipe-borne water can be treated as suspicious if there is contamination along the pipeline system due to factors such as breakages and leakages resulting from underground and subsurface construction activities common in low-income urban areas that experience unplanned housing development. So while high-income people may choose to use the pipe-borne water for cooking, they do not use it for drinking. The contamination of pipe-borne water due to the breakages in the system which allow many items and impure water effluents to mix with the treated water (originally produced at government-owned water works) may partly explain the regular epidemics of water-borne diseases often originating from low-income areas of Accra.

Our study shows that, based on more acceptable definitions of improved water, much of the population of the low-income areas in the study areas do not have access to improved water for drinking. However, given the fact that water is boiled for cooking, middle-class consumer preferences are tilted towards using pipe-borne water for domestic uses such as cooking and factory-based sachet water and bottled water for drinking. Therefore, the issue of access to water in low-income areas cannot be seen only in terms of the quantity of water supplied but also the quality of the water being used by these people. The quality of water issue needs government intervention through regular quality control testing of water used by poor householders and regular repair and maintenance of pipelines carrying water to homes and collection points.

A limitation of our study is the focus of the data on only low-income areas of a large urban area. The results that we obtained may be different from studies that combine data from low-income urban areas with data from other segments of the country. Future research work could extend the analysis by combining data from urban and rural areas and also data from low-income and high-income areas. Further, future research could extend the statistical analysis from the simple binary logistic regression analysis to multinomial logistic regression analysis. The latter technique can allow for the classification of water sources into at least three groups: (1) unimproved, (2) semi-improved and (3) improved. This classification can then allow for the designation of piped water sources that have a high probability of pollutant contamination due to breakages in the pipeline system as semi-improved rather than the unimproved designation that we use in our study.

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