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Perception of Households Towards Quality of Water: An Appraisal of Household Drinking Water in Urban Ghana

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Abstract

The goal of ensuring water quality is to improve the livelihood and health of citizens in different regions by improving access to potable water, safe sanitation and hygiene. Ensuring drinking-water quality, concerns assessing microbial priorities, and chemical priorities. The study was a descriptive cross-sectional survey and employed only quantitative data collection methods in selecting 150 participants. The study was done in the East Akim Municipality of the Eastern Region of Ghana. The study was done from April to October 2016 and study-specific structured questionnaires were used in the data collection over a period of three weeks. Water quality within the Municipality was almost universal, as 92% confirmed their water was of good quality. Notwithstanding, 73% paid for water at all times and 77% experienced water shortage. More than half of the respondents (53%) confirmed treating their water before drinking. The main sources of water for drinking ($p<0.018$), sources of water used for other purposes ($p<0.002$), and frequency of water shortage ($p<0.001$) were variables associated with quality of water. Further analysis indicates that neither borehole (AOR 1.875, 95%CI: 0.407 - 8.633) nor sachet water (AOR 0.420, 95%CI:.175-1.008) determined the quality of water. Among this group of households interviewed, less than half of the respondents were associated with the use of quality water. Stakeholder advocacy on the proper treatment and use of quality water among community members will help improve living standards and ensure community water quality continuously meets WHO and national quality standards in Ghana.

Keywords

Water Quality, East Akim, Microbial, Households, Perception, Appraisal, Drinking Water

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1. Introduction

The development of every growing nation largely relies on government's ability to improve the quality of water, water sources and socioeconomic living standards [1]. An enhanced water supply indicates the presence of an efficient and functioning public stand-post/pipe, a borehole, a protected spring or well, or collected rain water which are considered hygienic [2] However, contaminants in water sources may lead to decline in water quality standards [3], especially when households lack access water from improved sources. In previous literature, households were cited as obtaining drinking-water from either an improved or unimproved water

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source, but considered water from improved sources as safe for consumption [4]. Additionally, approximately three out of five persons in developing countries do not have access to quality drinking water [5]. To ensure the quality of drinking water means assessing the presence of microbial priorities, and chemical priorities [6]. Subjectivity associated with water quality has led to the functional separation of water quality into three measurable criteria; (1) water free of disease causing organisms, (2) water with harmful chemicals below defined thresholds and physical parameters within acceptable ranges, and (3) water with radioactive compounds below defined thresholds [7]. In addition, other standard parameters indicating water quality is the contamination of water with Fecal Coliform Bacteria (FCB), Total Coliform Bacteria (TCB), Ammonia (NH3), Biochemical Oxygen Demand (BOD), and Dissolved Oxygen (DO) [8].

In ensuring water quality, assessment is done based on human health perspective, outlining the diseases, environmental risk and their effects on human health [7]. In previous literature, an estimated 80% of all diseases in the world are associated with poor sanitation, polluted water or presence of water contaminants. This has compelled agencies such as the World Health Organization (WHO) and Centers for Disease Control (CDC) to set exposure standards and safety limits of contaminants in drinking water [9].

In Ghana and other developing countries, water quality standards are observed according to the WHO drinking water quality limits [10, 11, 12] mostly regulated by periodic inspection and treatment (with limited resources) by the Ghana water company limited, under the Ministry of Water, Works and Housing [13]. The goal of ensuring water quality in Ghana is to improve the livelihood and health of citizens in different regions by improving access to potable water and safe sanitation and hygiene [13]. Notwithstanding, the indirect effect of environmental and water quality related risk on mortality adds more than 40% to the cost of directly caused mortality in Ghana [14]. Aside this, there exist a dearth of research data that supports the situation of water quality assessment in Ghana, especially at the household level. More importantly, only limited research have focused on assessing water quality from the user perspective. Consequently, this research assessed the availability and quality of household water among residential households.

2. Materials and Methods

2.1. Study Design, Area, Population, and Inclusion Criteria

The study was a cross-sectional survey and employed only quantitative data collection methods. The study was done in the East Akim Municipality of the Eastern Region of Ghana. The population of the East Akim Municipal, according to the 2010 Population and Housing Census, is 167,896 representing 6.3 percent of the region's total population [15]. The municipality has a household population of 164,896 with a total number of 42,092 households. The target population in this study includes family heads and households who consume water on daily bases. This study defines a household head as any individual who oversees the overall wellbeing of a family or group of people living together as a unit. They were eligible to partake in this study if they were within the defined category of this study. The researchers' choice of household heads was informed by the limited data on the quality of water used by households and based on the consideration that their (heads of households) expressions will reflect the real experiences of the community.

2.2. Sampling Technique and Sample Size

A simple random sampling method was used, selecting every third household head considered eligible. The sample size for the study was calculated based on the assumed prevalence of water quality in the general population, since data on the prevalence of water quality at the household level was not available. The sample size for this study was calculated as follows (1):

$$n = Z^2 \times PQ/d^2 \quad (1)$$

where n represents the desired sample size, Z is the normal standard deviate, whose value at 95.0% confidence level is 1.96, P = assumed water quality rate; 0.5, Q = 1-P = 0.5, and d = the set margin of error; 0.05. Thus minimum sample size, n = 383. The figure was upwardly adjusted by 5% to cater for possible non-respondents or recording errors. Resultant sample size was 402. However, due to time and resource constraints, only 150 participants were reached before termination of the data collection.

2.3. Data Collection

The researchers interacted with heads of households using structured-interviewer administered questionnaire. Before the commencement of the data collection, permission was first sought from the heads of households. Once a participant was considered eligible, he/she was invited orally to participate in the interview. All 150 participants who were eligible consented and participated in the study, giving a 100% response rate.

2.4. Data Collection Tools and Procedures

Before the start of the data collection, there was recruitment and orientation of research assistants. The research assistance were guided on the purpose of the research, the focus of the research, the administration of complete questionnaires without any form of coercion, and handling of unresponsive

interviewees. The structured questionnaires were then distributed to the research assistants for administration over a period of three weeks. Questionnaire included socio-demographic characteristics of respondents and sections that assessed the factors influencing water quality.

2.5. Data Analysis

The data entry and analysis were performed using the "IBM SPSS Statistics" (SPSS version 20) data processing software. Before the entry, all necessary differences and errors were rectified. The data were then processed afterwards into tables to show the frequency and percentages of the distribution of the data. Uni-variate analysis was used to generate frequencies. Simple logistic regression analysis was done to further test the strength and direction of the association between several independent variables and the outcome variable. In a multiple logistic regression model, adjusted odds ratios (AOR) were calculated to control for confounders. Variables with p <0.05, at the simple logistic regression analysis were selected into the multiple regression models.

3. Results

3.1. Background Attribute of Respondents

From table 1, more than half of all respondents (65%) were males and majority of the respondents were between ages 41 and 50 (36%). While those between ages 31 and 40 were 35%, those in the older category of 50 years above were only 18%. The rest were less than 10% of the population sampled. A little above half of the respondents (62.7%) were married, most had attained tertiary education (40%) and 18% had attained senior high level education. Another group educated was the Junior high school graduates (29%), while the least group had non-formal education. Three quarters of the respondents were employed (77%) and close to half of them belonged to a household size of between 4 and 6, the smallest household size were those that had between 7 and 10. On the area of residence, most respondents (68%) were urban dwellers within East Akim Municipality (*See table 1).*

Table 1. Background Attributes of Respondents.

Attributes	Frequency	Percent %
Gender		
Male	98	65.3
Female	52	34.7
Age		
10 – 20	4	2.7
21 – 30	12	8.0
31 – 40	53	35.3
41 – 50	54	36.0
50+	27	18.0
Marital status		
Married	94	62.7
Single	56	37.3
Educational level		
Non Formal Education	19	12.7
JHS/Middle	44	29.3
SS/S.H.S/Tech/Vocation	27	18.0
Tertiary	60	40.0
Employment status		
Unemployed	34	22.7
Employed	116	77.3
Household size		
1-3	64	42.7
4-6	73	48.7
7-10	13	8.7
Area of residence		
Urban East Akim	102	68.0
Rural East Akim	48	32.0

3.2. Relationship Between Background Attributes and Quality Water and Sanitation

In examining the association between background characteristics and quality of water, age of the respondent (p<0.003) and level of education (p<0.001) were the only variables associated with what respondents considered as quality water. On the other hand, marital status (p<0.162), employment status (p<0.131), the size of the household (p<0.073) and respondents area of residence (p<0.233) were not statistically associated with quality of water and sanitation. *(Reference, Table 2).*

Table 2. Relationship between Background Attributes and Quality Water and Sanitation.

Attributes	Perceived Quality water		
	Yes; n (%)	No; n (%)	P-value
Age in Years			
10 – 20	0 (0)	4 (100)	.003
21 – 30	3 (25)	9 (75)	
31 – 40	34 (64.2)	19 (35.8)	
41 – 50	24 (44.4)	30 (55.6)	
50+	19 (70.4)	8 (29.6)	
Marital status			
Married	46 (48.9)	48 (51.1)	.162
Single	34 (60.7)	22 (39.3)	
Educational level			
Non Formal Education	16 (84.2)	3 (15.8)	.001
JHS/Middle	22 (50)	22 (50)	
SS/S.H.S/Tech/Vocation Inst.	7 (25.9)	20 (74.1)	
Tertiary	35 (58.3)	25 (41.7)	
Employment status			
Unemployed	22 (64.7)	12 (35.3)	.131
Employed	58 (500	58 (50)	
Household size			
1-3	36 (56.2)	28 (43.8)	.073
4-6	41 (56.2)	32 (43.8)	
7-10	3 (23.1)	10 (76.9)	
Area of residence			
Urban East Akim	51 (50)	51 (50)	.233
Rural East Akim	29 (60.4)	19 (39.6)	

3.3. Household Water Sources and Cost of Water

On the sources of water for drinking, seven in every ten

(74.7%) of the respondents uses sachet water as the main source of drinking water, 17% uses pipe borne water and 8% rely on borehole water. For water that is used for other purposes, pipe borne water was the topmost and mostly used source (48.7%), 21% used borehole water, 18.7% used protected hand-dug and 9% mostly used unprotected well. Most water sources (45%) were located with respondents' house of stay, and 34% had to rely on sources of water from a neighbor's house. Those who used public and shared sources of water were only 18%. However, 84% had access to water throughout the year, irrespective of the source. Among those who lacked water, 38% run out of water every two weeks, 25% were usually out of water on monthly basis, and 22.7% did not have access to water twice every month. Access to water was at a cost and among all respondents, 72.7% had to access water at a cost. As a result, 36.7% confirmed paying a cost of between GHS 0.20 to 0.50 for a 20 liter of bucket, 34.7% paid between GHS 0.10 to GHS 0.20 and the rest paid above GHS 0.50 for one 20 liter bucket of water. Access to water was a cost on daily basis, and most of the respondents (20%) paid GHS 2.50 to GHS 3.00, another group (18.7%) said they were paying GHS 2.00 to GHS 2.50 per day to have access to water. Considering the cost of water for households, about 25.3% used 15 to 20 buckets of water on daily basis, 22% used 21 to 26 buckets, and 21.3% used above 27 buckets of water every day. Even among those who had access to water, three quarters of them (76.7%) had problems with water delivery and supply *(Refer to table 3).*

Table 3. Household Water Sources and Cost of Water.

Attributes	Frequency	Percent %
Main source of household drinking water		
Piped	26	17.3
Tubed well/borehole	12	8.0
Sachet water	112	74.7
Main source of water for other purposes		
Piped	73	48.7
Tubed well/borehole	32	21.3
Protected hand-dug	28	18.7
Unprotected well	14	9.3
Bottled Water	3	2.0
Location of household water		
In own house	68	45.3
In neighbor's house/yard	51	34.0
Public place	27	18.0
At an institution (mosque, church, school etc.)	4	2.7
Yearly flow of water from main source		
Yes	126	84.0
No	24	16.0
If no, how often does it run out		
One's a Week	20	13.3
Twice a Week	58	38.7
One's a month	38	25.3
Twice a month	34	22.7
Payment of water		
Yes	109	72.7
No	41	27.3
If yes, cost of 20 liter bucket of water		
Between GHS 0.10 to GHS 0.20	52	34.7
Between GHS 0.20 to 0.50	55	36.7
Above GHS 0.50	43	28.7
Challenges with water supply and delivery		
Yes	35	23.3
No	115	76.7

3.4. Relationship Between Household Sources of Water, Cost and Perceived Quality of Water

In establishing the relationship between the sources of water, cost and quality of water, the main sources of water for drinking ($p<0.018$), sources of water used for other purposes ($p<0.002$), and frequency at which respondents were out of water ($p<0.001$) were the variables associated with what respondents considered as quality water. Other variables like location of household water ($p<0.350$), weather water last throughout the year ($p<0.153$), payment for water ($p<0.292$), cost of water per day ($p<0.391$), average buckets of water used by households on daily basis ($p<0.559$), and the problems associated with water supply and delivery ($p<0.606$) were all not statistically associated with the outcome of interest. *See Table 4.*

Table 4. Relationship between Household Sources of Water, Cost, and Perceived Quality water.

Attributes	Perceived Quality water		
	Yes; n (%)	No; n (%)	P-value
Main source of household drinking water			
Piped	10 (38.5)	16 (61.5)	.018
Tubed well/borehole	3 (25)	9 (75)	
Sachet water	67 (59.8)	45 (40.2)	
Main source of water for other purposes			
Piped	50 (68.5)	23 (31.5)	.002
Tubed well/borehole	10 (31.2)	22 (68.8)	
Protected hand-dug	13 (46.4)	15 (53.6)	
Unprotected well	7 (50)	7 (50)	
Bottled Water	0 (0)	3 (100)	
Location of household water			
In own house	38 (55.9)	30 (44.1)	.350
In neighbor's house/yard	24 (47.1)	27 (52.9)	
Public place	17 (63)	10 (37)	
At an institution (mosque, church, school etc.)	1 (25)	3 (75)	
Yearly flow of water from main source			
Yes	64 (50.8)	62 (49.2)	.153
No	16 (66.7)	8 (33.3)	
If no, how often does it run			
One's a Week	3 (15)	17 (85)	.001
Twice a Week	39 (67.2)	19 (32.8)	
One's a month	19 (50)	19 (50)	
Twice a month	19 (55.9)	15 (44.1)	
Payment of water			
Yes	61 (56)	48 (44)	.292
No	19 (46.3)	22 (53.7)	
If yes, cost of 20 liter bucket of water			
Between GHS 0.10 to GHS 0.20	31 (59.5)	21 (40.4)	.099
Between GHS 0.20 to 0.50	32 (58.2)	23 (41.8)	
Above GHS 0.50	17 (39.5)	26 (60.5)	
Challenges with water supply and delivery			
Yes	20 (57.1)	15 (42.9)	.606
No	60 (52.2)	55 (47.8)	

3.5. Method of Household Water Treatment

In ensuring that water is wholesome before drinking, more than half of the respondents (53%) confirmed treating their water before drinking and among those who treated their water, 49% added bleach and chlorine, 25% used solar disinfection and 16% strain it through a cloth before drinking. Only 11% boiled their water to ensure that it is treated and wholesome for drinking. In considering the relationship, the method used in treating water did not have any significant relationship with the quality of water ($p<0.485$). *Reference table 5.*

Table 5. Method of Water Treatment and Association between Water and Sanitation Quality.

Attributes	Frequency	Percent %
Treatment of water before drinking		
Yes	80	53.3
No	70	46.7
Mode of water treatment		
Boil	16	10.7
Strain it through a cloth	24	16.0
Add bleach/chlorine	73	48.7
Solar disinfection	37	24.7

Attributes	Perceived Quality water		
Mode of water treatment	Yes; n (%)	No; n (%)	P-value
Boil	7 (43.8)	9 (56.2)	.485
Strain it through a cloth	15 (62.5)	9 (37.5)	
Add bleach/chlorine	41 (56.2)	32 (43.8)	
Solar disinfection	17 (45.9)	20 (54.1)	

3.6. Accessibility and Quality of Stored Water

Table 6 indicate that distance from respondents' house to the source of water was a challenge, as eight in every ten (85%) of the respondents had to walk close to 300 feet to have access to water, 13 travelled about 100 feet and only 3% walked a km distance to access water. Majority of the respondents (88%) used plastic drums as storage containers for water but those who used poly tank and metal drums were less than 10%. Almost all respondents (93%) used water vessels with lids as water storage containers but only 31% washed these storage containers on daily basis, another 39% washed on weekly basis and a further significant number (29%) cleaned containers on monthly basis. When the opinions about the quality of water were assessed, close to all respondents (92%) confirmed the quality of water was good, 5% thinks their water is salty and 3% thinks the type of water

they use contained particles. Details presented on table 6.

Table 6. Accessibility and Storage of Water.

Attributes	Frequency	Percent %
Distance from house to water source		
Less than 300 feet	127	84.7
100 feet	19	12.7
1 km	4	2.7
Means of storing water		
Poly tank	8	5.3
Metal drum	10	6.7
Plastic drum	132	88.0
Does water vessels have lid		
Yes	140	93.3
No	10	6.7
Frequency of washing water storage vessel		
Everyday	47	31.3
Once a week	59	39.3
Once a month	44	29.3
Opinion about quality of drinking water		
Good	138	92.0
Salty	8	5.3
Has some particles in it	4	2.7

3.7. Relationship Between Water Accessibility, Water Storage, and Quality Water

Table 7 contains a chi-square test of association between water accessibility, water storage and quality of water. The results suggest that distance from house to water source ($p<0.122$), the means of water storage ($p<0.546$), weather water vessels have lids or not ($p<0.827$), frequency of washing water storage containers ($p<0.494$), and opinions about the quality of water ($p<0.164$) were all not statistically significant and had no relationship with water and sanitation quality.

Table 7. Relationship between Water Accessibility, Water Storage, and Quality Water.

Attributes	Perceived Quality water		
	Yes; n (%)	No; n (%)	P-value
Distance from house to water source			
Less than 300 feet	72 (56.7)	55 (43.3)	.122
100 feet	6 (31.6)	13 (68.4)	
1 km	2 (50)	2 (50)	
Means of storing water			
Poly tank	4 (50)	4 (50)	.546
Metal drum	7 (70)	3 (30)	
Plastic drum	69 (52.3)	63 (47.7)	
Water vessels with lid			
Yes	5 (50)	5 (50)	.827
No	80 (53.3)	70 (46.7)	
Frequency of washing water storage vessel			
Everyday	22 (46.8)	25 (53.2)	.494
Once a week	32 (54.2)	27 (45.8)	
Once a month	26 (59.1)	18 (40.9)	
Opinion about quality of drinking water			
Good	72 (52.2)	66 (47.8)	.164
Salty	4 (50)	4 (50)	
Has some particles in it	4 (100)	0 (0)	

3.8. Determinants of Water Quality

In order to control for (the) confounders and determine the predictors of water quality in East Akim Municipality, a multiple logistic regression was calculated. The model took into consideration all significant variables at the simple logistic regress level, using an alpha value of 0.05. The result indicates that, respondents between the ages of 10 to 20 years (AOR 2.50, 95%CI: 1.028-6.120), and 21 to 30 years (AOR 3.81, 95%CI: 1.002-14.486) were three times more likely to be associated with perceived water quality. Those who were between 41 to 50 years were less likely to be associated with perceived quality of water (AOR 0.139, 95%CI: 0.034-0.566) while the older population who were 50 years and above were five times more likely to be associated with perceived quality of water (AOR 5.3, 95%CI: 1.359-20.934).

Considering education, respondents within the non-formal education level were twice more likely to have an association with perceived quality of water (AOR 2.33, 95%CI: 1.359-2.624). Similarly, those who had completed junior high school (AOR 2.33, 95%CI: 1.359-2.634) and those with tertiary education (AOR 3.238, 95%CI: 3.387-6.55), both had almost equal odds of being associated with perceived water quality.

The main source of drinking water for households also had an association with its quality at the simple logistic level but further analysis indicates that neither borehole (AOR 1.875, 95%CI: 0.407 - 8.633) or sachet water (AOR 0.420, 95%CI:.175-1.008) determined the quality of water. *See Table 8.*

Table 8. Determinants of Water Quality (Multiple Logistic Regressions).

Determinants	Perceived Quality water		
	Adjusted Odds Ratio	95% CI	
Age			
10 – 20	Ref		
21 – 30	2.508	1.028	6.120
31 – 40	3.810	1.002	14.486
41 – 50	.139	.034	.566
50+	5.333	1.359	20.934
Educational level			
Non Formal Education	Ref		
JHS/Middle	2.333	1.359	2.634
SS/S.H.S/Tech/Vocation Institution	3.238	3.387	6.553
Tertiary	3.810	1.002	14.486
Main source of household drinking water			
Piped	Ref		
Tube dwell/borehole	1.875	.407	8.633
Sachet water	.420	.175	1.008
Main source of water for other purposes			
Piped	Ref		
Tube dwell/borehole	4.783	1.952	1.715
Protected hand-dug	2.508	1.028	6.120
Unprotected well	2.174	.683	6.922
Bottled Water	.176	.044	.703

4. Discussion

Data from this survey indicate that only 13% of respondents had no formal education. While level of illiteracy can influence a community's living standards, as high as 38% of respondents were found in other studies not to have any form of education [16]. A situation that is quite detrimental to ensuring community water safety. However, both studies indicated the influence of age and use of quality water, as all age groups (except age 41 to 50 which had a reduced odds) in this study were at a higher odd of being associated with the outcome of interest. As compared to 63% of married respondents, [9] found 49% of his respondents being married people. However, both studies failed to establish any relationship between marriage and use of quality water. Conversely, earlier studies done in Australia found all respondents to be married [17]. While marriage may not have any relationship with water quality, it is sometimes argued that married people are much concern about the use of quality water as a result of their large family or household size. In previous literature, the importance of education to both hygiene and water quality have been emphasized [18, 19] confirming the findings of this study where education was found to be a strong predictor of the desire for and use of quality water. Results indicate that respondents with all levels of education as mentioned by respondents were three times more likely to be associated with perceived quality of water. Contrary to this, respondents' education did not influence their perception of quality water [20].

Findings from this study indicate that water used for other purposes aside drinking could determine household water quality. Except bottled water, all sources of water had twice or more odds of determining the perception of respondents towards water quality. Predominant water sources cited by this current study including pipe water and hand-dug wells were also found to dominant the sources of water in other studies [21]. It is however worth noting that these water sources were also found to be positive for total coliforms and fecal coliforms in other studies [22], indicating a source of danger to human health. Again, while this study found only 11% of households boiling water before use, as much as 86% of respondents in a similar study said they boiled their drinking water [23], even though this study failed to establish an association between boiling of water and perceived quality of water. In previous studies, the importance of distance from a household to the water source in reducing diarrhea was highlighted [24], while in this study distance was not a determinant of water quality. Opposing views shared by Ersel [25] suggest that the maximum distance from any household to the nearest water point should be 500 metres, however, only 3% of respondents in this study travelled a distance of 1km to access water, even though distance did not influence the perception of respondents towards quality of water used by households. The implication however is that the carrying of water over long distances is considered a health hazard [16] and should be minimized.

This study is not without limitations. One major limitation of this study was that the estimated sample size was not reached due to time factor, considering that it was a graduate thesis and the investigators were working within time. Secondly, the study was only limited to East Akim Municipality and only household heads were interviewed.

5. Conclusions

Household water quality and safety is relevant to most countries, especially in Africa where resources to ensure safety are lacking. Aside quality, access to good drinking water is also a challenge and assessment of these two components will ensure strategies to improve the quality and access of water, especially in developing countries. Among households interviewed, there was inadequate access to safe water and water accessed was not properly treated before use. Most people were therefore exposed to water related diseases since they used river water, well water and unprotected spring water which was potentially unsafe. We found that majority of the respondents use sachet water as the main source of drinking water, with a little percentage relying on borehole water. We also found that residents had to walk or travel a long distance to access water which contained impurities. There was a gap between health education and actual practice of ensuring water safety and hygiene. It is recommended that responsible authorities should design a means of increasing and sustaining access to safe water. Additionally, focus should be on bridging the gap between households' perception about water quality, sanitation and hygiene and their actual practices of ensuring water quality.

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