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Household Water Quality and Management Survey : Paynesville City, Greater Monrovia

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ABSTRACT

Proper management and storage of drinking water remains a greater challenge for family members in the study area. Poorly managed of drinking water at home exposed the water to microbial contaminant. Microbial contaminant is associated with water borne illness. Thus, the objective of the survey was to identify the storage container use to safe drinking water at home and the proper handling of water to eliminate or reduce effluents.

Methods: A face-to-face survey questionnaire was used to gather information relating to the drinking water sources, storage container, and sanitation. The study was conducted in the Duport Road community, Paynesville city, Greater Monrovia. A town hall was held to select the participant/family that meets the inclusion criteria.

Results and Discussion: The primary source of water infrastructure constructed to collect groundwater use for drinking was 31% community hand pump, 24% from a private hand pump, and 32% from private shallow well. In the community, 65% of the participants preferred to treat water before drinking by adding bleach. For the storage , 48% of the family stored drinking in narrow-mouthed gallon limiting the direct hand to water contact. Sanitation is a fundamental concern and associated to the groundwater pollution. In the community, 28% of the family practiced open defecation. The prevalence rate for open defcation in the study area is 2.5%. from the logistic regression analysis, the Naegleria's R^2 of 0.692 indicates a moderately weak to the strong relationship between the predictors and the observed variables. However, the predictor success overall was 90.9% (92.6% accepting that the primary drinking source safe without treatment while 88.2% for decline). **Conclusion.** Household water treatment and Drinking storage need immediately attention to provide quality drinking for the home thereby improving quality health.

Keywords: Groundwater, Storage Container, Recontamination, Open Defecation, Treatment, Storage Period, Household Water Treatment, Physical Appearance

I. INTRODUCTION

Groundwater is typically less polluted compared to surface water, but human developmental [1], and geological [2] activities have contributed to the vulnerability of groundwater. The human activities associated with population growth and increased economic and tourist activities with progressive increased on water quality [3]. Provision of groundwater remains a challenge in developing nations. In the study area, Duport Road community, Paynesville city, Greater Monrovia, the delivery of pipe water by either the city or central government is rare where the citizenry relies extensively on either groundwater or surface water for drinking and domestic work. Globally, groundwater is used by about 25% of a human for local activities while 50% used for portable water purpose [4]. About 780 million people in the world, mostly in developing countries, lack access to clean and safe drinking water [5]. A study from South Africa showed that two-third of the population relied on groundwater for domestic and portable water purposes, but the groundwater contaminated with high iron concentration [6].

The uncontrolled dumping of municipal wastes (solid & liquid wastes) has become a major factor to quality groundwater in many developing countries. Inadequate solid waste management is a major environmental health problem [7] in developing nations where properly designed waste facilities are inexistent [8]. In the natural environments, water quality grounded on the hydrogeology of the environment [9]. The hydrogeological property of the groundwater within the study areas is unknown. Thus the type of pollution associated with the water is yet to be categorized. The study is novel within the study area but not new to household water quality.

Quality water to impact health depends on proper management of the source and the storage of water at the household. Poorly manage water at home exposed drinking water to microbial contaminant. Microbiological contaminant acute effect [10] is associated with waterborne diseases [11] because of its acute effect as compares to chemical contaminants chronic effects. Ingestion of water contaminated with fecal bacteria increased the risk of diarrheal disease [10]. Diarrhea [12] and dysentery associated with estimated 2.5 million children deaths per year in developing countries with diarrhea accounts for 23,900 deaths of children under five years in Tanzania [5]. Diarrhea is one of the top ten diseases that cause death among children under 5years in Liberia [13].

In Liberia, diarrhea disease is among the top ten leading cause of death among children under five years. In Kenya, for children below the age of 5 years, diarrhea prevalence is about 3.5 cases per child per year, which is 10 % higher than the world average of 3.2 cases per child per year [14]. The study location is Duport Road community, Paynesville city, Greater Monrovia, Paynesville City. The greater Monrovia located 5.55 kilometer away from the country (Liberia) capital-Monrovia. Due to the economic situation in the community, most of the household rely on shallow wells and hand pump for potable water. Water from the shallow wells extracted using shared or personal dipping utensil. Geographically, Paynesville City is located at latitude 6.276 and longitude -10.718 [15].

Therefore, the objectives of the survey focus handling and storage of collected groundwater use for drinking and domestic work at the household. The goal is to work with the family to properly manage and to produce quality drinking water at the home thereby improving the health of the vulnerable populations.

II. METHODS AND MATERIAL

The survey divided into parts, town hall meeting, selection of the family, and completion of the survey questionnaire.

Townhall Meetings. The procedure of the research study begins with a town hall meeting and ends with some intervention methods depending on the contaminant that may be present in the water source. There were two town hall meetings held. The first town hall meeting brings together the community and its leadership to discuss the significance, purpose, and benefit of the survey. The purpose of the survey is to identify the water sources used for drinking and domestic activities and handling of water from transport to storage. The community was informed on the methods associated with the conduction of the survey.
The second town hall meeting at the end of the study provide the community with findings on household water management and the management water infrastructure.

Participants: The survey questionnaire was conducted using a face-to-face personal interview. Any one person completed the survey questionnaire from each household. However, some home identified a proxy to complete the questionnaire on behalf of the family. The anticipated time used to complete the study was between five to ten minutes.

Inclusion criteria. The inclusion criteria were used to select a family for the survey. The criteria include (1) Participant must be a permanent resident of the community and had resided in the community for a minimum residence period of five years. (2) Participant must be a family person with ages from 20 to 65yrs with children. (3) Participant must be a primary user of either private or community water infrastructure (hand pump or shallow wells or borehole) for drinking and domestic activities located in the community.

Exclusion Criteria. (1) Participants with access to a continuous supply of pipe borne water and or surface water. (2) participants not a permanent resident of the community and may relocate at any time desire.

III. RESULTS AND DISCUSSION

All analysis was one using SPSS version 24.

Table 1 : Demography

Questions	N	MEAN ± SD
RESPONDENT GENDER		0.48 ± 0.50
• MALE	52 (52%)	
• FEMALE	48 (48%)	
EMPLOYMENT		1.12 ± 1.33
• NOT EMPLOYED	48 (48%)	
• SELF	19 (19%)	
• EMPLOYED	33 (33%)	
ANIMAL/BIRD AT HOME		0.45 ± 0.500
• Yes	55(55%)	
• No	45 (45%)	

Demographic. Results from the pilot study indicate that the number of homes per water infrastructure was **607/43**. The water infrastructure in the community is defined as either hand pump, and opened and covered wells. The family size from the 100 homes visited during the pilot study was 1131. Children under 15 years made up 19.5% and 18.75% of male and female respectively. Of the family size, 33% employed, 19% self-employ and 48% unemployed, Table 1. The demographic results showed that respondents were 52% male and 48% female. The respondents are either family member or a proxy identified by the family. The average respondent and employment were 0.48 ± 0.50 and 1.12 ± 1.33 respectively.

Table 2 : Drinking Water Source

Questions	N	MEAN ± SD
SOURCE USE FOR COOKING		2.07 ± 1.094
Community Hand Pump	*26 (26%)*	
Private Hand Pump	*11 (11%)*	
Private Wells	*63 (63%)*	
PRIMARY DRINKING SOURCE		0.56 ± 0.499
Community Hand Pump	*31 (31%)*	
Private Hand Pump	*24 (24%)*	
Private Wells	*32 (32%)*	
Sac Water	*13 (13%)*	
TIME(MIN) TO TRANSPORT WATER		1.55 ± 1.184
Water on Premises	*28 (28%)*	
Take 5 minutes	*18 (18%)*	
Take 10 minutes	*25 (25%)*	
Take 20 minutes	*29 (29%)*	
PERSON TRANSPORTING WATER		1.37 ± 1.212
Adult Female	*36 (36%)*	
Female Child < 15 years	*16 (16%)*	
Male child < 15 years	*23 (23%)*	
Adult Male	*25 (25%)*	
TREAT PRIMARY SOURCE		0.35 ± 0.479
Yes (1)	*65 (65%)*	
No (0)	*35 (35%)*	
TREATMENT METHOD		0.73 ± 0.952
Add Bleach	*35(35%)*	
Boil water	*3 (3%)*	
No treatment	*62 (62%)*	
WATER AVAILABILITY/YEAR		0.98 ± 1.054
Yes (1)	*38 (38%)*	
No (0)	*44 (44%)*	
WATER SHORTAGE		0.18 ± 0.390
January-April	*36(36%)*	
October-December	*8 (8%)*	
PRIMARY SOURCE SMELLS		0.69 ± 0.465
Yes (1)	*31 (31%)*	
No (0)	*69 (69%)*	
PRIMARY SOURCE WITH TASTE		0.45 ± 0.500
Yes (1)	*55(55%)*	
No (0)	*45(45%)*	
PRIMARY SOURCE APPEARANCE		0.36 ± 0.482
Clear (1)	*64(64%)*	
Cloudy (0)	*36(36%)*	

Drinking Water Sources. The Drinking water sources in the study areas were hand pump/borehole/tube well or opened and covered wells that are 31% of the selected family get drinking water from community hand pump, 24% from a private hand pump, and 32% from the private shallow well (Table 2).

Consuming of contaminated water even a small fraction of the time can attenuate diarrhea reductions attributable to household water treatment. Homes also reduced the health impact of increased household treatment and safe storage practices [16].

For treatment purposed of water in the community, 65% treat water in any way for drinking. 35% add bleach and 3% boil water as a treatment method. The average treatment method is 0.35 ± 0.48. For the physical properties, 31% of the family drinking water smells, 55% foul taste, and 36% cloudy. The physical appearance of the drinking water statistically significant. The odds of family cloudy drinking water 4.47 times at risk.

It is estimated that poor sanitation and hygiene account for 7% of deaths in low and middle-income countries (LMICs). Use of improved sanitation has been found to reduce transmission of enteric pathogens and intestinal parasites, as well as reduce morbidity and mortality, especially in children [17]. The failure to adequately contain and manage human excreta is associated with a broad range of health problems and a significant disease burden [18]. The physical properties of drinking in the community was a major concern as 31% of the selected family complain that their drinking water smells, 55% drinking water with foul taste and 36% complaint about the cloudiness of their drinking water, especially during the rainy season. The shortage of water in the community is experienced between January to April (36%) and 8% October to December.

Table 3: Container for storage and transporting water to home

Questions	N (%)	MEAN ± SD
CONTAINER USE TO TRANSPORT WATER *Narrow-mouthed gallon* *Wide-mouthed gallon* *Purchased Sac water*	 48(48%) 39(39%) 13(13%)	0.69 ± 0.465
STORAGE DRINKING CONTAINER *Narrow-mouthed gallon* *Wide-mouthed gallon* *Purchased Sac water*	 *48(48%)* *39(39%)* *13(13%)*	*0.65 ± 0.702*
DOMESTIC STORAGE CONTAINER *Narrow-mouthed gallon* *Wide-mouthed gallon*	 *44(44%)* *43(43%)*	0.69 ± 0.692
DRINKING WATER STORAGE PERIOD *Stored for 3-day or less* *Stored for 6-day or more*	 74(74%) 26(26%)	3.78 ± 1.323
DOMESTIC storage CONTAINER COVER *Yes* *No*	 64(64%) 36(36%)	0.36 ± 0.482
DRINKING storage CONTAINER COVER *Yes* *No*	 53(53%) 47(47%)	0.33 ± 0.473
Is DRINKING WATER SAFE *Yes* *No*	 44(44%) 56(56%)	0.47 ± 0.502

From table 5, the odds of failing to treat drinking water in any for make it safe for drinking was 3.98times at risk of consuming water contaminated with microbial contaminant.

Storage and Transportation of Drinking Water. A study conducted in the Brazilian town of Shanty, show a statistically significant effect of drinking storage water container and microbial recontamination. The recontamination was approximately 20% indicating the vulnerability of water quality to household water storage. Samples were three times to recontamination in a clay pot (wide mouthed container) tested positive for microbe as compare to bottle storage (narrow-mouthed container) [19]. From Table 3, 48% of the family stored drinking water in narrow-mouthed gallon while 39% used wide-mouthed gallon as a storage container for drinking water. The wide-mouthed container for the study is defined as bucket or tub where anyone can have direct access to the stored water in the vessel.

Recontamination of drinking water in the home is significant in water quality survey. Recontamination can either be 'domestic domain' transmission corresponding to in-house contamination, or 'public domain' transfer that corresponds to pollution directly at the water source [20]. The domestic domain does occur from the size of the storage vessel mouth, transfer of water between containers from collection to storage, hand-to-water contact, and dipping of utensils. Large-mouthed containers have significantly higher odds of recontamination than small-mouthed containers. [21]. The pilot project recontamination of drinking water was not directly measured, but the type storage vessel for potable water was used to associate the transmission. During the completion of the survey questionnaire, the drinking water container was seen physically for verification. From Table 5, the odds of storing drinking water in wide mouthed gallon was 4.44 times statistically prone to recontamination as compare to family storing drinking water in narrow-mouthed gallon. From the survey questionnaire, 60.4% of the population stored drinking water for more than three days. The odds of storing drinking for ≤ 3days are 0.86 less likely to recontaminate drinking water as compared to a family that saved water for more than three days. Recontamination occurs base on two pathways, 'domestic domain' transmission corresponding to in-house contamination, and 'public domain' transfer that corresponds to pollution directly at the water source [20]. The domestic domain from the pilot study was the mouth of the storage container, transfer of water between containers from source to storage container at home, hand-to-water contact, time length of water storage and dipping of utensils. Large-mouthed containers have significantly higher odds of recontamination than small-mouthed containers [21].

Table 4: Sanitation

Questions	N (%)	Mean ± SD
Toilet Facility Flush Pit latrine Open Defecation	 46(46%) 26(26%) 28(28%)	0.82 ± 0.85
Shared Toilet Facility Yes No	 29(29%) 71(71%)	0.71 ± 0.46
Wash Hands Yes No Sometime	 60(60%) 28(28%) 12(12%)	0.28 ± 0.451

Sanitation. Out of the hundred homes visited, 28% reported practiced open defecation, 26% reported pit latrine and 46% used the flush toilet (Table 4). The only toilet facility has been shared in the community is pit latrine. Of the 26% of the family that own pit latrine, 29% shared with another family. Open defecation is a major cause of fatal diarrhea. Open defecation is a fundamental source of water contamination, especially during the rainy season. During the rainy season, fecal matters get eroded to either groundwater or surface water. Every day about 2000 children aged less than five succumbs to diarrhea and every 40 seconds a life is lost [22]. Inadequate sanitation is associated with significant morbidity from diarrheal disease, soil-transmitted infection, trachoma, and malnutrition [23]. Liberia open defecation prevalence was 51% in 2005 with a 16% projected reduction in 2015 [24]. Results from the study showed that the prevalence of open defecation is 2.5% in the selected community-Duport Road, Paynesville city.

A study in Kenya showed that the eradicating open defecation coupled with improving hygienic practices is associated with the reduction of diarrhea among children [25]. The Wald criterion (Table 5) demonstrated that drinking water storage container, treatment of primary source, and the physical appearance of the drinking water made a statistically significant contribution to the prediction ($p < 0.05$).

The Nagelkere's R^2 of 0.692 indicates a moderately weak to the strong relationship between the predictors and the observed variables. Predictor success (Table 6) overall was 90.9% (92.6% for accepting and 88.2% for decline).

Table 5: Logistic Regression

Predictor variables	B	Standard Error	Wald	Exp(B)	P-Value
X_1	-	1.18	0.046	0.778	1.17
X_2	0.251	1.63	0.117	1.74	0.73
X_3	0.556	1.47	4.44**	21.9	0.03
X_4	3.09	0.388	0.158	0.857	1.31
X_5	-	1.37	0.369	0.440	1.45
X_6	0.154	1.51	3.98**	0.049	0.04
X_7	-	1.64	1.88	9.44	0.17
X_8	0.820	1.39	2.55	0.109	1.89
X_9	-3.01	1.47	0.137	1.72	0.71
X_{10}	2.25	1.65	4.47**	32.8	0.03
Constant	-2.22	4.49	0.001	1.15	0.98
	0.542				
	3.49				
	0.142				

*** p-value < 0.05;* $X^2_{(10,100)}$ *=31.4, p = 0.001; Nagelkerke* R^2 *= 0.692;* X_1*=Domestic Storage Container,* X_2*= Container to Transport Water,* X_3*=Storage Drinking Water Safe,* X_4*=Drinking Water Storage time in days,* X_5*=Person responsible for transporting water to home,* X_6*=Treatment of Primary Source,* X_7*=Water shortage,* X_8*=Drinking water smells,* X_9*=Drinking water has foul taste,* X_{10}*=Drinking water physical appearance.*

Table 6: Classification table for the model building data (100 homes visited)

Observed		Predicted		
		Primary Source Safe for Drinking		Percentage Corrected
		Yes	No	
Primary Source Safe for Drinking	Yes	25	2	92.6
	No	2	15	88.2

IV. CONCLUSION

From the prediction equation, the container used for transporting water (X2), storage of drinking water (X3), water storage (X7), drinking water with the foul smell (X9) and the drinking water appearance (X10) have a positive impact on household water and do need immediate attention. Finally, the results showed that drinking in the from the selected was poorly manage. All participants prefer to treat water directly at the source but the household water treatment is the preferable according to the CDC & Prevention.

V. REFERENCES

[1]. An, X., et al., The patterns of bacterial community and relationships between sulfate-reducing bacteria and hydrochemistry in sulfate-polluted groundwater of Baogang Rare earth tailings. Environ Sci Pollut Res Int, 2016.

[2]. Bamousa, A.O. and M. El Maghraby, Groundwater characterization and quality assessment, and sources of pollution in Madinah, Saudi Arabia. Arabian Journal of Geosciences, 2016. 9(8).

[3]. Ben Ammar, S., et al., Identifying recharge and salinization sources of groundwater in the Oussja Ghar el Melah plain (northeast Tunisia) using geochemical tools and environmental isotopes. Environmental Earth Sciences, 2016. 75(7).

[4]. Conti, K.I. and J. Gupta, Global governance principles for the sustainable development of groundwater resources. International Environmental Agreements-Politics Law and Economics, 2016. 16(6): p. 849-871.

[5]. Elisante, E. and A.N.N. Muzuka, Sources and seasonal variation of coliform bacteria abundance in groundwater around the slopes of Mount Meru, Arusha, Tanzania. Environmental Monitoring and Assessment, 2016. 188(7).

[6]. Demlie, M., E. Hingston, and Z. Mnisi, A study of the sources, human health implications and low cost treatment options of iron rich groundwater in the northeastern coastal areas of KwaZulu-Natal, South Africa. Journal of Geochemical Exploration, 2014. 144: p. 504-510.

[7]. Basavaraddi, S.B., H. Kousar, and E.T. Puttaiah, Iron a Specific Heavy Metal Concentration in the Ground Water of Tiptur Town and Its Surrounding Areas, Tumkur District, Karnataka, India. International Journal of Research Studies in Biosciences (IJRSB), 2015. Vol 3(7): p. 5-15.

[8]. Aboyeji, O.S. and S.F. Eigbokhan, Evaluations of groundwater contamination by leachates around Olusosun open dumpsite in Lagos metropolis, southwest Nigeria. J Environ Manage, 2016. 183: p. 333-41.

[9]. Bourke, S.A., et al., Partitioning sources of recharge in environments with groundwater recirculation using carbon-14 and CFC-12. Journal of Hydrology, 2015. 525: p. 418-428.

[10]. Engstrom, E., et al., Prevalence of microbiological contaminants in groundwater sources and risk factor assessment in Juba, South Sudan. Science of the Total Environment, 2015. 515: p. 181-187.

[11]. Olaoye, O.A. and A.A. Onilude, Assessment of microbiological quality of sachet-packaged drinking water in Western Nigeria and its public

health significance. Public Health, 2009. 123(11): p. 729-34.
[12]. Ferguson, A.S., et al., Comparison of fecal indicators with pathogenic bacteria and rotavirus in groundwater. Sci Total Environ, 2012. 431: p. 314-22.
[13]. WHO, LIBERIA: WHO Statistical Profile. 2015.
[14]. Brouwer, R., et al., Comparing willingness to pay for improved drinking-water quality using stated preference methods in rural and urban Kenya. Appl Health Econ Health Policy, 2015. 13(1): p. 81-94.
[15]. TAGEO, Tageo, in Tageo Website. 2016.
[16]. Gruber, J.S., et al., A stepped wedge, cluster-randomized trial of a household UV-disinfection and safe storage drinking water intervention in rural Baja California Sur, Mexico. Am J Trop Med Hyg, 2013. 89(2): p. 238-45.
[17]. Sara, S. and J. Graham, Ending open defecation in rural Tanzania: which factors facilitate latrine adoption? Int J Environ Res Public Health, 2014. 11(9): p. 9854-70.
[18]. Spears, D., A. Ghosh, and O. Cumming, Open defecation and childhood stunting in India: an ecological analysis of new data from 112 districts. PLoS One, 2013. 8(9): p. e73784.
[19]. Copeland, C.C., et al., Faecal contamination of drinking water in a Brazilian shanty town: importance of household storage and new human faecal marker testing. J Water Health, 2009. 7(2): p. 324-31.
[20]. Jensen, P.K., et al., Domestic transmission routes of pathogens: the problem of in-house contamination of drinking water during storage in developing countries. Trop Med Int Health, 2002. 7(7): p. 604-9.
[21]. Levy, K., et al., Following the water: a controlled study of drinking water storage in northern coastal Ecuador. Environ Health Perspect, 2008. 116(11): p. 1533-40.
[22]. Ambesh, P. and S.P. Ambesh, Open Defecation in India: A Major Health Hazard and Hurdle in Infection Control. J Clin Diagn Res, 2016. 10(7): p. IL01-IL02.
[23]. Boisson, S., et al., Promoting latrine construction and use in rural villages practicing open defecation: process evaluation in connection with a randomised controlled trial in Orissa, India. BMC Res Notes, 2014. 7: p. 486.
[24]. Galan, D.I., S.S. Kim, and J.P. Graham, Exploring changes in open defecation prevalence in sub-Saharan Africa based on national level indices. BMC Public Health, 2013. 13: p. 527.
[25]. Njuguna, J., Effect of eliminating open defecation on diarrhoeal morbidity: an ecological study of Nyando and Nambale sub-counties, Kenya. BMC Public Health, 2016. 15: p. 712.