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Full Length Research Paper

Household drinking water; knowledge and practice of purification in a community of Lamingo, Plateau state, Nigeria.

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Drinking water is an absolute necessity, its quality being as important as its availability. Consumption of unsafe drinking water contributes to the 4 million annual cases of diarrhoeal cases worldwide. This study aimed to determine the knowledge and practices of water purification and to assess the quality of drinking water at the point of use in a semi-urban community of Plateau State, Nigeria. A total of 368 respondents from a corresponding number of households were selected through a multistage sampling method. Data was obtained with the use of a semi-structured interviewer administered questionnaire. Water samples were then obtained from a subset of 90 households for physicochemical and microbiological analysis. A total of 368 respondents were selected. Knowledge of water purification practice was good in 26.1% of respondents and 54% practiced at least one method of purification in their household. Commonest method of water purification was the addition of alum (43.3%).Relationship between water purification and occurrence of diarrhoea in children was found to be statistically significant ($p < 0.05$). Physicochemical parameters were essentially normal for obtained water samples with coliforms detected in 40% of the samples. Health education messages and household water treatment interventions would be of benefit in this community.

Key words; household drinking water, purification practices, knowledge, quality

INTRODUCTION

It is not enough to have adequate quantity of water but of ultimate importance is the quality of water. The World Health Organization (WHO, 2014) estimates that about 2.2 million cases of death result from diarrhoeal disease annually and occur mostly among children in developing countries which it attributed to the consumption of unsafe water. Water purification is the process of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water with the aim of making it fit for drinking or a specific purpose. Processes aimed at purifying water at home in this environment include protection of the source, storage, sedimentation and decantation, boiling, filtration and various forms of chemical disinfection. (Lucas AO and Gilles HM, 2003; Obionu C, 2007)

There are different means by which individuals get access to water and this depends on a person's geographical location and level of development. Though the Millennium Development Goal (MDG) target of halving the proportion of people without access to improved sources of drinking water has been met, 780 million people are yet to be served, these being predominantly in developing countries. (UNICEF and WHO, 2012) As at 2004, only about 40% of the population in Jos had access to clean potable water. (Ince M et al, 2010) Individual studies in Nigeria have

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shown varied sources of drinking water which include streams, lakes, wells, boreholes, municipal water supply, local water vendors and rain water harvesting. (Chinedu SN et al., 2011; Aderogba K et al., 2012; Okonko IO et al.,2008)

Unsafe water consumption and usage is a medium through which diseases such as diarrhoea, cholera, infective hepatitis and schistosomiasis are transmitted. The WHO (2005) attributes 88% of the 4 million annual cases of diarrhoeal disease to consumption of unsafe drinking water, inadequate sanitation and hygiene. Another 1.8 million people are also estimated to die from diarrhoeal disease each year. The WHO (2007) estimates that 94% preventable through modification of the environment including improving availability to safe drinking water, improving sanitation and hygiene.

The purification of water reduces the concentration of particulate matter including suspended particles, parasites, bacterial, algae, viruses, fungi and a range of dissolved and particulate material derived from the surface that water may have made contact with after falling as rain. This will reduce the prevalence of diarrhoeal disease that is associated with consumption of unsafe water. Treatment of water at the household level has been shown to be one of the most effective and cost-effective means of preventing waterborne diseases. Hence vulnerable populations take ownership of their water security by treatment and safe storage of household water.(UNICEF, 2008)

Parameters are set by the WHO (2008) and environmental protection agencies in countries with which the quality of drinking water can be measured. (SON, 2007) Guidelines provide parameters for the maximum allowable concentrations of microbiological, chemical and organic constituents in drinking water that will have no adverse effects. Physical quality requires that the water be colourless, odourless, tasteless, not turbid, with a pH range of 6.5-8.5. Total coliform count measured in cfu (colony forming units) per 100ml of water gives an indication of feacal contamination and is used in microbiological assessments. Coliforms should not be detectable in water. Thermotolerant coliform bacteria such as *Escherichia coli* are also acceptable for use as they are definite indicators of faecal contamination. Others include *Citrobacter*, *Klebsiella* and *Enterobacter*. Organic and inorganic constituents are also expected at minimum levels though iron, nitrates, aluminium, residual chlorine and fluorine are expected to be routinely monitored.

The critical point at which water supplies need to be safe from and free from pathogenic organisms is at the point of consumption. All the work in providing water in sufficient quantity and high quality is lost if consumers do not display hygienic practices and behaviours. Studies have shown that contamination at point of use can occur from use of contaminated utensils, poor storage practices and poor personal and domestic hygiene. (Oswald WE et al., 2007; Hoquea BA et al., 2006; Boateng et al., 2013; McGarvey et al., 2008).

This study aimed to determine the knowledge and practice of household purification of drinking water, its relationship with the occurrence of diarrhoea in children and to assess physicochemical and microbiological quality of the point of use drinking water in the selected community.

METHODS

Study Area

The study was conducted in Gwafan community of Lamingo ward of the Jos North Local Government Area (LGA) of Plateau State. It is a community located 1,407m above sea level and with a population of 139,494 as at 2006. (NPC, 2006) The population of this community has been on the increase since the re-location of the Federal Government's Teaching Hospital to its permanent site located in the ward. Many ethnic groups reside in the area. The dominant native tribe residing here is the Jarawa (Afizere). Other tribes native to the area are the Anaguta and Berom. The predominant religion is Christianity. Historically, the natives are farmers and hunters. Currently other occupations found in the community include farmers, traders, vulcanizers, students, civil servants and self employed individuals. The prevalence of diarrhoea in Plateau State was found to be 5.6% in the National Demographic and Health Survey (NDHS). (NPC, 2014).

Study population

The study population consisted of adult members of the community. Respondents should have lived in the area for up to a year.

Study design

It was a descriptive cross sectional study of the knowledge of respondents on water purification, household drinking water purification practices and analysis of physical and microbiological quality of obtained water samples from a subset of selected households.

Sample size determination

For this study the sample size was calculated using the formulae forcross sectional studies, $n = z^2pq/d^2$, where n

= Data was analysed using the epidemiological software Epi Info version 3.5.4. Permission to conduct the study calculated minimum sample size, z = standard normal deviate at 95% confidence level, p = prevalence rate household water purification, q = 1-p and d = precision level of 5%. With the prevalence rate of 33% obtained from a previous study (Ghislaine R and Clasen T 2010), calculated minimum sample size was 340. With an adjustment made for a 5% non-response, the sample size was determined to be 357.

Sampling technique

Selection was done using a multistage sampling technique where in the first stage, simple random sampling was done to select Gwafan community out of the list of 20 communities in the area. In the second stage, household numbering was conducted and the community was found to have a total of 733 households. Systematic sampling technique was used to select 368 households after a sampling interval of 2 had been calculated. For the last stage, in each household, simple random sampling by balloting was done to select one adult member of the household as a respondent.
Simple random sampling was used to select 90 households from among the previously selected households for collection of water samples for analysis.

Data Collection

A pre-tested semi-structured interviewer administered questionnaire was used to collect data from respondents regarding their bio-data, knowledge of domestic water purification and management, storage practices, purification practices and occurrence of diarrhoea in children less than 5 years of age.

Knowledge was scored based on a maximum attainable score of 15. Good knowledge was graded for a score of 11 and above, 6 – 10 was fair while less than 5 and less was graded as poor knowledge.

Water was sampled from storage containers used for drinking water in the selected households. Samples were obtained in sterile bottles and transported in a cold box and analyzed within the first 9 hours. The physicochemical parameters analysed were pH, turbidity and colour using the electrode method, absorptiometric and the alpha-platinum-cobalt standard method respectively. Microbial analysis of the sample was based on the coliform count using the Agar plate count method. The samples were incubated at temperatures of 22 - 37 ℃ 22 - 37 ℃ in eosin methylene-blue agar for the community head, household heads and from the selected participants 48 hours. Parameters were measured against WHO guidelines for drinking water quality. was obtained from

RESULTS

The response rate for this study was 100%. Table 1 shows that a total of 368 respondents were interviewed. The mean age of respondents was 32.7 ± 10.0. The male to female ratio was 1:1.1. Christianity was the dominant religion with 97.8%. Most (48.4%) of the respondents were of Jarawa (Afizere) ethnicity, the native tribe for the area. Half (50%) had completed secondary school education and most (60.6%) were married. Occupations were varied and included students (23.4%), traders (20.7%), civil servants (18.8%), farmers (16.0%), the self employed (14.9%) and a few unemployed (5.2%). The average number of household members was 5 with many (47.3%) having 6 or more members. A total of 230 (62.5%) households had children less than 5 years of age. The average number of children was 3 per household.

Knowledge of water purification was good among 26.1% of the population, 59.8% was fair while 14.1% had poor knowledge. Knowledge was found to be statistically significant ($p<0.05$) with level of education as shown in Table 2. Sources of information included health personnel (64.8%), family and friends (23.0%), radio and television (7.4%), newspapers (2.8) and posters/bills (2.1%). Methods that were mentioned included boiling (26.1%), addition of alum (4.4%), filtration (6.6%), sedimentation with decantation (2.4%) and majority (54.7%) stated that a combination of methods could be used while 7.6% could not mention any method. Diseases that are treated by unsafe water that were mentioned by respondents included typhoid (42.2%), diarrhoea (35.2%), cholera (7.8%), dysentery (4.2%), guinea worm (2.3%) and poliomyelitis (1.6%). However, 6.8% could not name any disease. When respondents were asked specifically about the cause of diarrhoea 80.6% stated correctly that germs were the cause. Other answers provided included hot/cold weather (6.3%), curses/spells (0.6%) and 12.5% stated that they didn't know the cause.

Sources of drinking water for the households included wells (54.6%), boreholes (6.3%), river/stream (1.1%), sachet water (0.3%) and some used multiple sources (37.8%). All the households were found to store drinking water. Methods for storage included the use of buckets (58.7%), jerry cans (32.0%), clay pots (6.2%) and galvanized tank (0.3%). Most (95.1%) stated that the stored water was covered but 213 (58.0%) stated that there was no dedicated container for fetching the water. Also, 244 (66.7%) of respondents stated that children easily had access to the stored water. Only 45.4% of

Table 1: Socio-demographic characteristics of respondents

Parameter	Frequency (%) N = 368
Age group	
≤ 19	13 (3.5)
20-29	154 (41.8)
30-39	119 (32.3)
40-49	59 (16.0)
50-59	16 (4.3)
≥ 60	7 (1.9)
Sex	
Female	196 (53.3)
Male	172 (46.7)
Religion	
Christianity	360 (97.8)
Islam	8 (2.2)
Ethnicity	
Jarawa/Afizere	178 (48.4)
Berom	77 (20.9)
Igbo	26 (7.1)
Angas	23 (6.3)
Yoruba	20 (5.4)
Anaguta	16 (4.3)
Others*	28 (7.6)
Level of Education	
None	12 (3.3)
Adult Literacy Programme	1(0.3)
Primary	94 (25.5)
Secondary	184 (50.0)
Tertiary	77 (20.9)
Marital status	
Single	133 (36.1)
Married	223 (60.6)
Widowed	7 (1.9)
Divorced	3 (0.8)
Separated	2 (0.5)
Occupation	
Students	86 (23.4)
Traders	76 (20.7)
Civil servants	69 (18.8)
Farmers	59 (16.0)
Self employed	55 (14.9)
Unemployed	19 (5.2)
Others**	4 (1.1)
No. of household members	
1	56 (15.2)
2	8 (2.2)
3	29 (7.9)
4	49 (13.3)
5	52 (14.1)
≥6	174 (47.3)

*Rom, Idoma, Igala, Tiv, Mushere
** Plumbing, tailoring, laundry services

Table 2: Relationship of knowledge of household drinking water purification and selected demographic profiles

Variable	Knowledge N = 368	p-value

Age group	Good N = 96 Freq (%)	Fair N = 220 Freq (%)	Poor N = 52 Freq (%)	
≤19	3 (0.8)	7 (1.9)	3 (0.8)	
20-29	47 (12.8)	91 (24.7)	16 (4.3)	
30-39	30 (8.2)	74 (20.1)	15 (4.1)	.28
40-49	13 (3.5)	34 (9.2)	12 (3.3)	
50-59 & ≥60	3 (0.8)	14 (3.8)	6 (1.6)	
Sex				
Female	41 (11.1)	129 (35.1)		
Male	55 (14.9)	91 (24.7)		.03
Level of education				
None/ Adult literacy programme	3 (0.8)	4 (1.1)	6 (1.6)	
Primary	5 (1.4)	60 (16.3)	29 (7.9)	.0000001
Secondary	43 (11.7)	125 (34.0)	16 (4.3)	
Tertiary	45 (12.2)	31 (8.4)	1 (0.3)	

Table 3: Relationship between purification of water and occurrence of diarrhoea in children

	Children (<5 years) with diarrhoea in last 6 months		
Purification of water	**No**	**Yes**	**Total**
No	16 (6.9%)	107 (46.5%)	123 (53.4%)
Yes	77 (33.5%)	30 (13.0%)	107 (46.5%)
	93 (40.4%)	137 (59.5%)	230 (100.0%)

p = 0.000000.....

Table 4: Physicochemical parameters of stored water samples

Parameter	**Unit**	**Range**	**Mean**	**Maximum permitted values**
Colour	TCU*	0.00-0.1	0.015 ± 0.0183	5
pH	-	5.5 – 8.5	6.56 ± 0.5195	6.5 – 8.5
Turbidity	NTU†	0-15	4.8 ± 5.5646	15

*TCU – True Colour Unit
†NTU – Nephelometric Turbidity Units

respondents stated they would wash their hands before handling the drinking water.

One hundred and ninety nine (54.1%) of respondents stated that the household drinking water had undergone at least a method of purification while 169 (45.9%) did no form of water purification. Methods that were used included addition of alum (43.3%), boiling (24.9%), filtration (21.4%), sedimentation and decantation (10.5%). The reasons provided for the preferred method of purification were that it's easy to use (63%), cheap (18.5%), and readily available (12.0%). A statistically significant relationship was found between purification of drinking water in the household and the occurrence of diarrhoea amongst children ($p<0.05$) as shown in Table 3.

Samples of stored drinking water from a total of 90 households were analysed. Most (62.2%) had been sourced from the borehole while 34 (37.8%) had been sourced from the wells. Fifty (55.6%) of the stored water samples had undergone at least a method of purification. The physical parameters of turbidity and colour fell within normal values as demonstrated in Table 4. Sixteen (17.8%) of the samples had a pH less than 6.5. Coliforms were detected in 36 (40%) samples, the mean total coliform count was 12.5 ± 22.8 cfu/100ml. The presence of coliforms was not found to be statistically significantly related to the purification of water as shown in Table 5. Bacterial isolates included Citrobacter spp., Enterobacter spp., Escherichia coli, Klebsiella spp. and Serratia spp. The coliform count measures were cross tabulated with the type of storage container, use of a cover for the container, use of a dedicated fetcher, ease of accessibility to children and presence of diarrhoea in children less than 5 years of age and number of household members of which no statistically significant relationship was found (Table 6).

DISCUSSION

The community in this study shows heterogenicity in the ethnic makeup though it is still predominantly occupied by

Table 5: Relationship between water purification and presence of coliforms in water stored for drinking

	Presence of coliforms (N = 90)			
Water purified	Absent (0 cfu/100ml)	Present (≥1 cfu/100ml)	X^2	p-value
Yes	29 (32.2%)	21 (23.3%)	0.1875	0.665006
No	25 (27.8%)	15 (16.7%)		

Table 6: Relationship between coliform count and potential sources of contamination and diarrhoea in children <5years

Variable	Coliforms (N=90)		p-value
	Absent (0 cfu/100ml)	Present (≥1 cfu/100ml)	
Storage container			0.50
Wide-mouthed	41 (45.5)	25 (27.8)	
Narrow mouthed	13 (14.4)	11 (12.2)	
Storage container covered			
Yes	52 (57.8)	36 (40.0)	0.24
No	2 (2.2)	0 (0.0)	
Dedicated fetcher			
Yes	19 (21.1)	12 (13.3)	0.86
No	35 (38.9)	24 (26.7)	
Number of household members			
1	12	9	
2	1	1	
3	3	1	0.14
4	5	6	
5	7	4	
≥6	26	15	
Easily accessible to children			
Yes	36 (40.0)	28 (31.1)	0.25
No	18 (20.0)	8 (8.9)	
Diarrhoea in children <5years (N=58)			
Yes	20 (34.5)	18 (31.0)	0.37
No	13 (22.4)	7(12.1)	

the native inhabitants. The level of education is also high as most respondents had completed secondary and tertiary levels of education.

Knowledge of water purification

Many of the respondents had fair to good knowledge of domestic water purification as they were able to identify methods of purification, recognize the importance of purifying drinking water and identify diseases that can result from drinking unclean water. This was statistically significantly related to their level of education. This finding is similar to an interventional study conducted in a peri-urban community in Tanzania (Davis J et al., 2011) which at baseline found that 69% could name at least one method of household drinking water treatment and boiling was the commonest method stated. Information had been obtained most from health personnel and indicates that the community might be having regular contact with health workers probably due to its proximity to the tertiary health institution.

Sources of drinking water and storage practices

The sources of water for this community were mostly wells and boreholes, with a complete absence of pipe-borne water. It has been recognized that there is an abundance of underground water sources in Nigeria (Ezeabasili ACC et al, 2014) and approximately 70% of urban and peri-urban communities in Nigeria have access to improved sources of water. (NPC, 2014) However, there are regional differences with the North-Central region, where Plateau State is located, having 52.2% access. (Onabolu B et al.,2011) Underground water sources stand the risk of contamination as has been found in some parts of this country.(Abiola OP,

2010; Adekunle et al., 2013; Dami A et al., 2013) The benefit of public water supply systems, especially if chlorinated is the provision of residual protection even if the water is stored.(Sule IO et al., 2009) The absence of piped water into households encourages the storage of drinking water as was seen in this study where all the studied households stored drinking water. Storage in wide mouthed containers specifically buckets and clay pots were most prevalent. Use of wide mouthed containers for storage of drinking water has been found in other studies and is associated with increased microbial contamination. (Onigbogi O and Ogunyemi O, 2014; Jensen PK et al. 2002)

Practice of water purification

Only about half of the households were found to purify their water, with the commonest method being the addition of alum. Aluminium sulphate commonly referred to as 'alum' is a common coagulant traditionally used as a clarifying agent and as a flocculant in municipal water treatment plants. It has been documented to improve the quality of water and prevent cholera during epidemics. (Crump JA et al, 2004) In this study reasons provided for this preferred choice included its ease of use, low cost and availability. Boiling and filtration were less used in this population. Though boiling is a common means of treating water with proven effectiveness against microbiological contamination, it is a costly method due to the need for energy resources. (Clasen TF et al., 2008) The complete absence of the use of disinfection with household chemicals in this study was worrisome as it is a low cost readily available option that improves water quality while in storage or at its point of use as has been demonstrated in other countries.(Clasen TF, 2009)

Relationship between water purification and occurrence of diarrhoea in children

There was a statistically significant relationship between those who purified their water and the occurrence of diarrhoea in children less than 5 years of age in the household similar to a study conducted by Kakulu RK (unpublished thesis) in 2012 in Tanzania. There is evidence to show that low cost technologies that improve water hygiene consequently reduce the occurrence of diarrhoea in children who suffer most the impact of this disease. (WHO, 2007; Diouf K et al 2014; Cairncross S et al., 2010)

Physicochemical and microbiological analysis findings

Physicochemical parameters were essentially normal though the pH was found to be lower than the recommended value in 17.8% of the samples indicating acidity of the water sources. From the samples that were taken, among those that had undergone purification, almost half were found to contain coliforms. The presence of faecal coliforms in drinking water indicates that the water has been contaminated by an outside source. (EPA, 2012) Studies have shown that there is a decline in water quality from source to the point of use due to contamination. (Claten TF and Bastable A, 2003; Wright J et al., 2004) However this study was not able to demonstrate the potential sources of this contamination as no statistically significant relationship was found with commonly associated sources of contamination. Though household water treatment improves water quality as has been earlier shown, no statistically significant relationship was also found in this study with the water having undergone at least one method of purification. This may suggest an inadequacy of treatment.

CONCLUSION

This study found that there was a fair knowledge of water purification among respondents but practice was done by less than half of the households. Drinking water purification was found to be statistically related to the occurrence of diarrhoea in under-five children. The study was also able to demonstrate the presence of coliforms in drinking water at the point of use. There is a need for further education on the importance of water purification and proper storage practices. The households would benefit from interventions with more effective low-cost technologies of water treatment.

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