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Original Research Article

Assessment of Water Handling Practices and Prevalence of Water Borne Diseases, East Nile Locality, Khartoum State

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Abstract: Water is one of the important requirements for human health and life. However, it is also the most effective carrier of pathogens causing a number of infectious diseases. Water borne diseases are the most common prevalent infectious diseases in developing countries especially in rural areas, and is still a major public health and environmental concern. The living conditions in rural areas are poor, which makes rural populations more vulnerable to inaccessibility to safe drinking water and high risk of water borne diseases .Water safety in a community depends on a range of factors, from the quality of source water to storage and handling in the domestic setting. This is a descriptive cross sectional community based study conducted in East Nile locality in the capital state of Khartoum in Sudan among 384 households from April to June 2019, to assess water handling practices on a household level and the factors associated with the prevalence of water borne diseases. A questionnaire was used to collect data and the data was analysed by using Statistical Packages for Social Sciences (SPSS). The result revealed that artesian wells were the commonest source of drinking water used by 81% of participants. The majority of the respondents (80.2%) didn't treat their water at household level and only 3% used boiling. 2.9% of the respondents washed their hands before collecting water, 3.4% of the respondents cleaned their water container regularly and 91.7% covered their water collection container. The prevalence of water borne diseases was 79% and diarrhoeal disease were the most prevalent water borne diseases among households in all the selected villages accounting for 52.1% of the total followed by typhoid fever at 38%. The study concluded that the practice of hygienic water handling practices among participants was poor. Source of drinking water, socioeconomic status as well as the adoption of measures to treat water were the major factors responsible for the occurrence of waterborne/diarrheal disease.

Keywords: Water borne diseases, drinking water, diarrhoea, water handling practices.

INTRODUCTION

Water is one of the paramount natural resources of all living organisms with uses including human consumption, food production, economic development and other domestic and developmental purposes in our day to day activities (Bibi *et al.*, 2016).

Sustainable Developmental Goal 6 (SDG 6), one of the 17 Sustainable Developmental Goals established by the UN in 2015, calls for clean water and sanitation for all people. The goal has eight targets to be achieved by at least 2030 (UNDP, 2019). Consumption of clean water is necessary for human health all over the world. Since water is a universal solvent, it is a major source of infections. According to World Health Organization (WHO) 80% of diseases are water borne. Drinking water in various countries does not meet WHO standards (Khan *et al.*, 2013). About 3.1% deaths occur due to the unhygienic and poor quality of water (Pawari and Gawande, 2015). Overall, microbial risk of drinking water is related to faecal contamination as the result of discharging sewage to water resources (Odeyemi, 2015). Unsafe water and poor sanitation and hygiene have been reported to rank third among the 20 leading risk factors for health burden in developing countries, including Sudan (Shanan *et al.*, 2015).

Water borne diseases are infectious diseases that spread primarily through contaminated water.

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These diseases can be contracted directly or indirectly through exposure to infected vectors, but water is the primary medium for their spreading. Pathogens are bacteria, viruses, protozoa, or parasitic worms capable of producing diseases. Diarrhoea, hepatitis cholera and typhoid are the more common water borne diseases (Ray, 2010).

Safe water chain includes all processes involved in ensuring that water is not contaminated through all stages from the water source to consumption. Key stages in the safe water chain include water collection, handling, transportation, storage and treatment, and consumption. Interventions focused on improving household water quality such as improving water storage or treatment have registered positive outcomes in terms of disease reduction (Semugabo *et al.*, 2019).

MATERIALS AND METHODS

This is a descriptive cross sectional community based study conducted among selected villages in a rural area in East Nile Locality in Khartoum State, Sudan.

Khartoum State is one of the 18 states of Sudan. It is the most populous and contains the capital city and by extension as in all developing countries the majority of the country's infrastructure.

East Nile (Sharg Elneel) locality is located in the south east part of Khartoum State and is one of the seven localities comprising Khartoum State, it is bordered to the north by River Nile State, from the south the eastern side of Aljazeera State, the east is bounded by the States of Kassala and Gedaref and to the west it is bounded by Khartoum Bahary locality and the Blue Nile River. It is administratively divided into in eight administrative units: two of them considered as urban (SharqAlneel and Alhaj-Yousif) and the other six are rural (Alalafoon, Umdawanban, Alasailat, Wadi Suba, Wad Abu-Salih, and Abu-Dlaig). So the majority of the populations are poor rural individuals.

Four villages were selected from Wad Abu Salih administrative units for the study (Alfaree-Alahamdah- Wad Shion- Eid Allnis).

Map of study area

The inclusion criteria were both adult males and females, who live in the four villages and agreed to be the part of the study. The exclusion criteria were people living outside these four villages, people who disagreed to be the part of the study and children. The sample size was determined by ready table for measuring sample size (Glenn D.Israel, 2013), where confidence level= 95% and P= 0.5,so as the total number of population for the four selected villages was 6697, taken from health survey Ministry of health– Khartoum State, Administration of Primary Health Care, East Nile Locality (2018-2019). According to the table the sample size was 384 participants, who were then selected by a random sample technique from April to June 2019, through a house to house survey by the health care providers. The houses in the village were visited and during the visit their practices regarding procurement, storage and consumption of water were observed by the interviewer. The data collection tool was a questionnaire prepared by the researcher, consisting of closed and open questions with different contents such as socio-demographic characteristics, water facilities and water treatment and storage practices. Data consistency was checked and exported to Statistical Package for the Social Sciences (SPSS) for the analysis.

Ethical approval

Was obtained from the Institutional Review Boards of: Alzaiem Alazhari University, Ministry of health– Khartoum State-Administration of health promotion- East Nile Locality- Administration of Primary Health Care and the local community leaders. After all these were prepared verbal consent was obtained from each subject who agreed to be part of the study, confidentiality of information was maintained and explained to the participants.

RESULTS

A total of 384 of households were including in the study. Most participants ages were between 31 to 40 years. Half of them (51.8%) were illiterate and more than half of the participants (62.5%) were of moderate socioeconomic class with the head of the household earning 2.001 – 3.000 S.P (Sudanese Ponds) per month (table1).

Table-1: Socio-demographic characteristic of the participants

Socio-demographic characteristic of the participants	Frequency	Percent
Age		
21 to 30 years	11	2.9
31 to 40 years	278	72.4
Above 40 years	95	24.7
Total	**384**	**100.0**
Level of education of study participants		
Illiterate	199	51.8
Khalwa	12	3.1
Primary	163	42.4
Secondary	9	2.3
University	1	.3
Total	**384**	**100.0**
Households income every month		
1,000 and less	5	1.3
1,001 - 2,000	131	34.1
2,001 - 3,000	240	62.5
More than 3,000	8	2.1
Total	**384**	**100.0**

The main source of drinking water in the study area was artesian wells (figure 1) used by 81% of the respondents while 19% obtained their water from rain water collection (hafir).

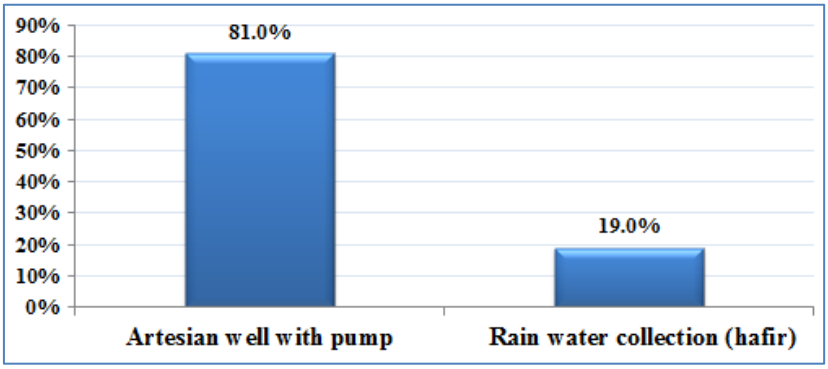

Fig-1: Sources of drinking water

Nearly all of the households (99.5%) transported the water from the sources to their houses using barrels carried by donkeys while only (0.5%) used buckets (figure 2).

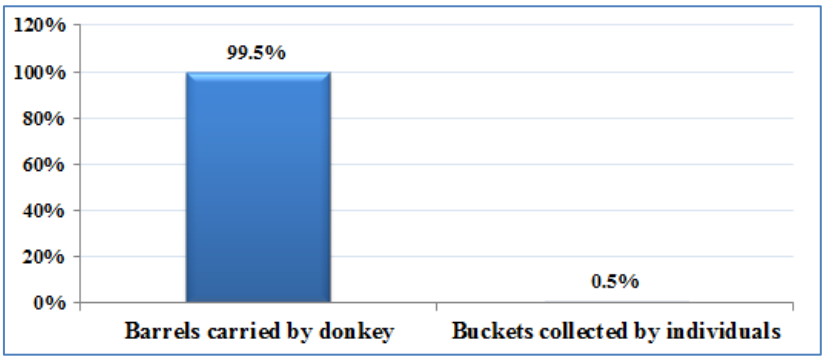

Fig-2: Water transport from point of source to the house

For water handling practices (table 2) our study showed that safely stored drinking water was found in 91.5% of households as they kept their drinking water in clean covered containers. It also revealed that all the participants used barrels for storage of drinking water. From the total respondents only 3.4% cleaned their water containers before storing the water and documented that the great majority of households 99.5% used cups with hands to draw water from the containers. Few households 2.9% washed their hands before handling water and most of the households 80.2% did not use any method to treat water in their households. Only 0 .3% of the families used boiling whereas16.4% strained it through a cloth, followed by 2.9% letting it sediment and settle and 0.3% exposing it to sun light as a method water treatment.

Table-2: Household water handling practices

Household water handling practices	Frequency	Percent
Drinking water stored in a covered container		
Yes	352	91.7
No	32	8.3
Storage vessels used for drinking water at home		
Storage barrels	384	100
Storage buckets	0	0
Open tanks	0	0
Pots (Alzeer)	0	0
Container cleaned with water and soap before storing water		
Yes	13	3.4
No	371	96.6
Utensils used for drawing drinking water from storage vessels		
Cup with hand	382	99.5
Cup without hand	2	.5
Hand wash with soap and water before handling stored water from container		
Yes	11	2.9
No	373	97.1
Participants who treat water in any way to make it safer to drink		
Yes	76	19.8
No	308	80.2
What participants do to the water to make it safer to drink		
Boiling	1	.3
Strain it through a cloth	63	16.4
Use water filter (ceramic, sand, etc.)	0	0
Let it to sediment and settle	11	2.9
Exposure to sun light in closed container for 6 hr	1	.3

The study shows that the prevalence of water borne diseases was 79% and the most prevalent of water borne diseases among participants was diarrheal diseases (52.1%), followed by typhoid fever (38%), dysentery (20.8%) and lastly14.8% gastroenteritis (figure 3).

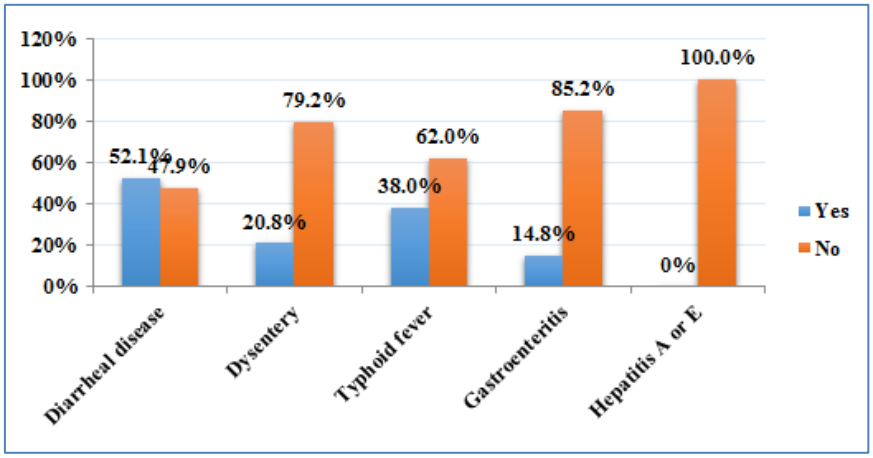

Fig-3: Showed distribution of participants affected with water borne diseases during the last six months from (January to June 2019), diarrheal disease was most prevalent (52.1%).

Education level was found to be positively associated with home water treatment with 92.9% of participants with primary level of education straining water through a cloth to make it safer to drink (table 3).

Table-3: Association between level of education and what participants do to the water to make it safer to drink

Level of education	What participants do to the water to make it safer to drink					Total	P value
	Boiling	Strain it through a cloth	Use water filter (ceramic, sand, etc.)	Let it to sediment and settle	Exposure to sun light in closed container for 6 hr		
Khalwa	-	-	-	-	-	-	0.091
Illiterate	1	37	-	10	0	48	
	(2.1%)	(77.1%)	-	(20.8%)	(0.0%)	(100%)	
Primary	0	26	-	1	1	28	
	(0.0%)	(92.9%)	-	(3.6%)	(3.6%)	(100%)	
Secondary	-	-	-	-	-	-	
University	-	-	-	-	-	-	
Total	1	63	-	11	1	76	
	(1.3%)	(82.9%)		(14.5%)	(1.3%)	(100%)	

The prevalence of diarrhoea was also associated with level of education with the prevalence of diarrhoea being high 54.5% among illiterate participants (table 4). This was however not statistically significant.

Table-4: Relation between level of education and prevalence of water borne diseases (diarrhoea)

Diarrheal disease	Level of education					Total	P value
	Khalwa	Illiterate	Primary	Secondary	University		
No	7	90	84	2	1	184	0.247
	(3.8%)	(48.9%)	(45.7%)	(1.1%)	(0.5%)	(100%)	
Yes	5	109	79	7	0	200	
	(2.5%)	(54.5%)	(39.5%)	(3.5%)	(0.0%)	(100%)	
Total	12	199	163	9	1	384	
	(3.1%)	(51.8%)	(42.4%)	(2.3%)	(0.3%)	(100%)	

Water borne diseases were also associated with economic status and are more prevalent in participants having poor financial positions. Our results showed that households with high income (earning more than 3.000 S.P per month) were more affected with diarrhoea 75.0% (table 5).

Table-5: Association between households income every month and prevalence of water borne diseases (diarrhoea)

Households income every month	Diarrheal disease		Total	P value
	No	Yes		
1.000 and less	2	3	5	0.103
	(40.0%)	(60.0%)	(100%)	
1.001 – 2.000	54	77	131	
	(41.2%)	(58.8%)	(100%)	
2,001 - 3,000	126	114	240	
	(52.5%)	(47.5%)	(100%)	
More than 3,000	2	6	8	
	(25.0%)	(75.0%)	(100%)	
Total	184	200	384	
	(47.9%)	(52.1%)	(100%)	

Water treatment also shows a significant relationship with diarrhoeal disease with those who treated water being the least affected. In this study we found that high incidence of diarrhoea (55.8%) among households who don't apply water treatment (table 6).

Table-6: Relation between Participants who treat water in any way to make it safer to drink and prevalence of water borne diseases (diarrhoea)

Participants who treat water in any way to make it safer to drink	Diarrheal disease		Total	P value
	No	Yes		
Yes	48	28	76	0.003
	(63.2%)	(36.8%)	(100%)	
No	136	172	308	
	(44.2%)	(55.8%)	(100%)	
Total	184	200	384	
	(47.9%)	(52.1%)	(100%)	

Practice of hand washing with soap also showed an association with diarrhoea as only 2.2% of households who washed their hands before handling water were affected with diarrhoea (table 7).

Table-7: Association between prevalence of water borne diseases (diarrhoea) and participants who wash their hands with soap and water before handling water

Diarrheal disease	Participants who wash their hands with soap and water before handling water		Total	P value
	Yes	No		
No	4	180	184	0.436
	(2.2%)	(97.8%)	(100%)	
Yes	7	193	200	
	(3.5%)	(96.5%)	(100%)	
Total	11	373	384	
	(2.9%)	(97.1%)	(100%)	

Source of drinking water was one of the key factors contributing to the frequency and burden of diarrheal disease and our analysis showed that households that had a higher history of diarrheal episodes (86.5%) among family members were the ones who used artesian well as sources of water compared to that of hafir water (table 8).

Table-8: Relation between sources of drinking water and prevalence of water borne diseases (diarrhoea)

Diarrheal disease	Sources of drinking water		Total	P value
	Artesian well	Rain water collection (hafir)		
No	138	46	184	0.004
	(75.0%)	(25.0%)	(100%)	
Yes	173	27	200	
	(86.5%)	(13.5%)	(100%)	
Total	311	73	384	
	(81.0%)	(19.0%)	(100%)	

DISCUSSION

Water is one of the precious natural resources and is an essential element of our life. Safe and healthy drinking water is the right of every individual. Contaminated drinking water increases the risk of numerous water related diseases such as typhoid fever, diarrhoea, dysentery, etc. Household water treatment and safe storage (HWTS) is a proven intervention to improve drinking-water quality and reduce diarrhoeal disease.

This study aimed to assess water handling practices among household's level and factors associated with the prevalence of water borne diseases. The majority of participants ages were between 31 to 40 years .More than half of the participants (62.5%) belonged to the moderate socioeconomic class with the head of the household month (table 1).

In the current study illiteracy rate among participants was (51.8%), this result is consistent with a cross-sectional study conducted in Bona District, Southern Ethiopia (Berhanu and Hailu, 2015) where 49.3% was the level of illiteracy rate. The main sources of drinking water in the study area was artesian well used by (81%) of the respondents while (19%) obtained their water from rain water collection (hafir) which is considered as not safe for drinking (figure 1).

With respect to the householder's perception towards water handling our study finding showed that all of households 99.5% transported the water from points of sources to their houses using barrels carried by donkeys while only (.5%) used buckets (figure 2).This finding disagreed with the study done by (Pradhan *et al*, 2017) in field practice, India, where buckets (54%), steel container (22.8%), and pipes (23.2%) were used as transport vessels.

Water with an initially acceptable microbial quality often becomes contaminated with pathogens during transport and storage especially during the latter. Contamination can occur if the water containers are not fully covered. The present study found that safely stored drinking water was found in 91.5% of households as they kept their drinking water in clean covered containers which was consistent with a cross sectional community base study, conducted in Forta Woreda , North west Ethiopia (Kassie and Hayelom, 2017) which found that about 90.3% of drinking water containers were fully covered. Also similar to this was a study conducted by (Bharti *et al.*, 2013) in a rural block of Haryana, India; covered drinking water was found in 96.8% of households. These results could be attributed to the fact that covering of containers will prevent contaminants such as dust and dirt from coming into contact with water.

Drinking water storage containers varied widely in capacity and type. In our study all the participants used barrels for storage of drinking water which disagreed with a community base cross sectional study among rural communities of Dire Dawa Administrative Council, Dire Dawa, Ethiopia (Amenu, 2013) that showed 66.2% of households used clay pots for households water storage, while the remaining (33.8%) stored water in jerrycans, and it also contrasts with study conducted in Mangalore, South India (Mynit *et al.*, 2015) which documented that the storage of drinking-water was done in clay pots (28%), plastic bottles of 20-litre capacity (44.1%), and ceramic jars (23.7%).

The practice of washing water storage containers, especially with soap and water helps prevent formation of a slimy layer and build-up of a biofilm inside the storage containers. A study by Kuberan *et al.*, 2015 in Thandalam village, Chennai, India ,found that most of participants (70%) cleaned water containers daily in contrast with our finding in this study in which only 3.4% cleaned water containers with soap and water.

The lack of basic hand washing hygiene adversely affects household water quality as the household members dip their hands in storage containers to access water for household purposes. However in the current study few households (2.9%) washed their hands before handling water which contrasted with a study conducted in Kolladiba, Ethiopia (Sharma *et al., 2013*) where nearly two thirds of the participants (62.6%) washed their hands before collecting water.

Pouring water as a method of drawing water from the container when compared to dipping was protective against having contaminated water at the point-of-use , so the practice of drawing water from its container has the risk of microbial contamination through potentially contaminated hands. Our study documented the highest number of households (99.5%) used cups with hands to draw water from the containers, distinct from another study (Gizachew *et al.*, 2020) in Boloso Sore woreda, Wolaita zone, Ethiopia, which found that 90.5% of households preferred pouring methods for withdrawing water from storage vessels.

Safe drinking water by using techniques of water treatment helps to reduce occurrence of water borne diseases in a community. In this study 80.2% of participants did not use any water treatment method contrasting with several studies. Umar *et al.*, 2018 in Sokoto State Nigeria, found that 5.9% of the population did not use any water treatment method and this was in line with a study (Kaniambady *et al.*, 2017) in Sullia taluk, Karnataka , India, revealed that (4.2%) of the households did not use any of the water treatment methods before drinking. In the current study, only 0 .3% of the families used boiling whereas 16.4% strained it through a cloth followed by letting it sediment and settle (2.9%), and 0.3% exposed it to sun light as a method water treatment. This finding contrasted with a study conducted in Dabat District, Northwest Ethiopia (Bitew *et al.*, 2017) which revealed that 71.1% of participants used plain sedimentation, boiling was used by 68.8% filtration with a clean cloth was used by 27.1% and sunlight and heat were used by 1.3%. These results are in stark contrast to another study (Gaude and Dessai, 2019) in Sakhawar a tribal village of Palghar district, Mumbai, Maharashtra, India–which found that the majority of participants (80.7%) boiled water or strained it through a cloth (3.7%).

The present study clearly shows that the most prevalent of water borne disease among participants was diarrheal diseases (52.1%),followed by typhoid fever (38%), dysentery (20.8%) and lastly (14.8%) gastroenteritis. This finding is consistent with a community based survey study in Slums of Karachi, Pakistan (Rehman, 2017), the results of which showed that the highest number of the respondents (63.6%) suffered from diarrheal diseases but disagrees with another study conducted in Endegagn Woreda, Gurage Zone, Southern Ethiopia by (Essa, 2015) which revealed that typhoid fever (24.6%) was the most prevalent one.

Homes with higher household incomes or more years of education for adults in the home were

statistically significantly more likely (P-value 0.091) to have home water treatment. In the current study education level was found to be positively associated with home water treatment, a result which is supported a study (Abera *et al*, 2018) conducted in Northwest Ethiopia.

A literate household head is more likely to understand health-related issues including the need to consume safe water. In a study conducted by (Fadel *et al*, 2014) in Lebanon and Jordan it was found that hygienic practices and the likelihood of developing diarrhoea, was associated with the level of education. This finding is with in line with our result, which is statistically significant (p-value 0.247).

Water borne diseases are also associated with economic features and are more prevalent in participants having poor financial positions. In contrast our result showed that households with high income were more affected with diarrhoea, perhaps due to contaminated sources of drinking water or poor water handling practices, in contrast to a study conducted in Rawalpindi and Islamabad, Pakistan by (Siddiqui, 2012) which concluded that poor socioeconomic status of the study population had a strong association with water borne diseases, with a statistically significant difference (P-value 0.103).

Water treatment mechanism also shows a significant relationship (P-value 0.003).with diarrhoeal disease with those who treated water being the least affected. In this study we found that high incidence of diarrhoea among households who don't apply water treatment, which was consistent with a study conducted in Ethiopia (Essa, 2015).

The practice of washing hands with soap is a vital step known to be effective in preventing transmission of waterborne infection. In the current study 2.2% of households who washed their hands before handling water were affected with diarrhoea.

One of the key factors contributing to the frequency and burden of diarrheal disease is the quality sources of water. Our analysis showed that households that had a higher history of diarrheal episodes among family members were the ones who used artesian well as sources of water 86.5% compared to that of hafir water and this was statistically significant (P-value 0.004) .This result indicates that well water was contaminated or is contaminated during transport from the source to the point of use in their homes or storage. These findings disagree with a community based cross sectional study conducted in India (Fernandes& Chakkarwar, 2018).

CONCLUSION

Practice of hygienic water handling practices among participants was poor. Socio demographic profile of participants has an impact on water handling practices and also on prevalence of water borne diseases. Literacy rate plays a major role in safe drinking water and handling practices. Also safe water handling practices have significant association with prevalence of water borne diseases. The educational level of the household along with the economic status was equally correlated with high incidence of diarrhoea.

Participants with high household income and education levels were more likely to use home water treatment. The prevalence of water borne diseases was 79% and diarrhoeal disease was the most prevalent water borne disease among households in all selected villages accounting for 52.1% followed by typhoid fever at 38%. Source of drinking water, socioeconomic status, and as well as the adoption of measures to treat water were the major factors responsible for the occurrence of waterborne/diarrheal disease.

RECOMMENDATIONS

Awareness programs through rigorous, frequent and effective implementation of well-designed health education programs with the full and active participation of Ministry of health, organizations working on safe water programs and different partners at the community level to promote safe drinking water handling practices and water quality should be applied across the study area. In these programs households should be encouraged to clean transport vessels, store drinking water in covered containers, clean storage containers with water and soap before storing water, practice hand washing with soap and water before handling, practice regular treatment of water and understand different methods of water treatment. Such programs are crucial to prevent contamination across the villages, to improve the status of public health and also to reduce diarrhoeal morbidity. Improved construction design to artesian well can be introduced to prevent bacteriological contamination of water and protective fences for human water sources should be installed. Quality assessment of the water source should be conducted regularly to assure that safe drinking water with national quality standards is available to everyone. Finally ideally a safe water network should be established in all villages.

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