Household Water Treatment Practice and Associated Factors in Rural Households of Sodo Zuria District, Southern Ethiopia: Community-Based Cross-Sectional Study

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ABSTRACT

INTRODUCTION: In Ethiopia, access to safe drinking water is very low, and even safe water at the point of distribution is subjected to frequent and substantial contamination during collection, transport, and storage. The purpose of this study was to assess the level of household water treatment practices and associated factors in rural households of the Sodo Zuria district, southern Ethiopia.

METHODS: A community-based cross-sectional study was conducted in 836 households using a multistage sampling technique. A structured and pre-tested questionnaire was used. Binary and multivariate logistic regression analysis was used.

RESULTS: The household water treatment practice was 44.1%. Households having a higher estimated monthly income, AOR = 1.5 (1.23, 3.47), older age greater than 45 years, AOR = 1.69 (1.08, 2.64), fetching water twice a day, AOR = 2.8 (1.21, 9.17), weekly washing of the water storage container, AOR = 0.3 (0.11, 0.83), and using the dipping technique to draw water from the collection jar, AOR = 1.67 (1.14, 2.42) were significant factors in the practice of household water treatment in the study.

CONCLUSIONS: The household water treatment practice was low. Higher estimated monthly income, older household heads, fetching water twice per day, washing the water storage container weekly, and dipping techniques to draw water from water storage containers were significant factors of household water treatment practices. Thus, proper hygiene of water storage, and engaging the community in income-generating activities were recommended.

KEYWORDS: Ethiopia, household water treatment practices, rural households

Introduction

Globally, the common household water treatment technologies are chlorination, filtration, solar disinfection and boiling,[1,2] and boiling is the most frequently used method.[2,3] Household water treatment and safe storage is the term used to describe the process of treating and safely storing water in the home.[4] In general, it is a way of lowering disease-causing pathogens[5] and improving the quality of drinking water at the household level.[6] Worldwide, more than 1 billion people lack access to drinking water, which is equal to 17% of the global population.[4]

It is estimated that globally every day, the diarrheal disease kills 2195 children, outnumbering AIDS, malaria, and measles combined which makes it the second leading cause of death in children under 5 years of age.[7] A significant proportion of diarrheal disease can be prevented through safe drinking and adequate water sanitation and hygiene (WASH).[8,9]

Copious studies from low-income and middle-income populations throughout the world have reported that indicators of household-level WASH are significant predictors of linear growth of children after adjusting for a wide array of other covariates including birth weight, gestational age at birth, maternal height, maternal education, and household wealth.[10] However, a wide range of studies indicated that HWTS can improve drinking water quality prior to consumption and it has been found as a cost-effective method that can reduce the risk of diarrhea significantly.[11-14] Even though the benefit of household water treatment practice to decrease the risk of enteric infection is well understood in different studies, there are different hurdles that prevent consistent practice; which include psychosocial, contextual, and technology-related factors.[15,16]

Although tens of millions of people rely on improved community water supplies, water supply authorities may not deliver microbiologically qualified water, so water needs to be treated at the household level.[17,18] In low-income countries, numerous household water treatments (HWT) have been confirmed to significantly improve drinking water quality in field trials.[19] It was reported that there was more than 25% reduction in diarrheal disease among children <2 years of age using flocculent disinfectant compared to untreated water handling methods.[20] Waterborne diseases have a harmful effect on public health

when drinking water is of poor quality[21] and due to a problem in the universal provision of treated and piped water, and HWT technology is lacking.[6,22,23] Common sources of drinking water in low-income countries are shallow wells, ponds, streams, rivers, and lakes, which are extremely contaminated with fecal pathogens needs HWT.[24]

Evidence from the Demographic and Health Survey of sub-Saharan Africa also showed that only 18% of households treat their drinking water appropriately.[25] In Ethiopia, various studies found that efforts to minimize water-borne diseases by treating drinking water at the source were insufficient to reduce water-borne diseases in the country unless drinking water was treated and sanitary handling is practiced at home.[26]

In Ethiopia, access to safe drinking water is very low, and even safe water at the point of distribution is subjected to frequent and substantial contamination during collection, transport, and storage. Meanwhile, conventional water treatment plants are scarce, and even existing plants are vulnerable to frequent interruptions and technical malfunctions.[22] Even improved water sources often fail to provide safe drinking water due to an infusion of fecal contamination in the course of the distribution system and mode of use.[27-29] Treatment of point of use water at the household level, such as boiling and chlorination, is the most cost-effective intervention to prevent diarrheal disease. The effect of chlorine-treated household water treatment on the reduction of diarrhea episodes is variable, ranging from no protective effect to 85% reduction.[4] However, household water treatment is widespread throughout the world but in Ethiopia a maximum of 6% and below it of the households practiced HWT.[30,31]

The United Nation as program set the SDG 6.1 universal and equitable access to safe and affordable drinking water for all by the end of 2030.[32] Despite increasing efforts to promote household water treatment in Ethiopia through routine health extension program, the reasons for the low practice are not yet clear. In addition to the limited research done on this regard, there is no conclusive and consistent evidence on factors that determine the practice of household water treatment among rural households. It will also enrich literatures available on household water treatment practice and may trigger other researcher to conduct related studies in various parts of the globe. Therefore, the main objective of this study was to evaluate the current status of household water treatment practices and associated factors in rural households in Sodo Zuria District, South Ethiopia.

Methods

Study setting: The study was carried out in rural households in the Sodo Zuria district, southern Ethiopia, from August 1st to September 30, 2018. The Sodo Zuria district is located in the Wolaita zone 329 kilometers south of Addis Ababa, the capital of Ethiopia. The district has 36 Kebeles (sub-districts/lowest administrative unit in Ethiopian context) and 35 231 households. The district had also about a total of 172 632 populations.

The common sources of household water supply in the district are unimproved water sources such as a river, well, and spring water.[33]

Study design and population: A community-based cross-sectional study design was used. All households in the district were the source population and all randomly selected households from the selected kebeles were the study population. Respondents whose age is 18 years and above (preferably female), and who have been living for at least 6 months in the district were included in the study. Whereas, respondents who were seriously ill and could not communicate to give information were excluded from the study.

Sample size: A single population proportion formula was used considering the proportion of HWT practices from a study conducted in north-west Ethiopia which is 44.8%.[5] With an assumption of 95% confidence level, 5% margin of error, design effect of 2 and an anticipated nonresponse of 10% were considered. Based on the above assumptions, using the single proportion formula, the total sample size was found to be 836.

Sampling procedure: A multistage sampling procedure was used by first selecting 8 Kebeles from 36 Kebeles using the simple random sampling method. Based on the proportional allocation, households were distributed in each Kebele. The households of study participants were selected using systematic sampling techniques after calculating the sampling interval from the 8 kebeles number of household divided by the number of study sample size households which was 6688/836 = 8. Then the data were collected every eighth household.

Variables

Outcome variable: The outcome variable for this study was household water treatment practice (Yes/No) which is dictated as "Yes" if at least one of the following options is practiced at the household; such as boil, add bleach/chlorine, strain through a cloth, use water filter, solar disinfection, let it stand and settle, and it is measured by self-report.[4,34]

Explanatory variables: The explanatory variables included socio-demographic (Age, sex, educational status, and religion, marital status, occupational status, family size, head of a household, and monthly income), water supply, storage, and hygiene factors.

Data collection tool and procedure: Data were collected using a pretested and structured questionnaire in a face-to-face interview of household heads. The questionnaire was adapted based on the available literature. The questionnaire was originally prepared in English and then translated into Amharic. Finally, it was translated back to English to check for consistency. Training was given to 5 data collectors and 1 supervisor for 2 days. A pre-test was conducted on 5% of the sample size in Kebeles which were not included in the actual data collection. Following the pre-test result, the tool and procedures were modified for ease of convenience and to ensure data quality. Data collection procedures were genuinely supervised to check

the consistency, clarity, and completeness of the questionnaires filled daily during data collection.

Operational definitions

Household water treatment practices: Households who used at least one of the following household water treatment methods before drinking: boiling, adding bleach/chlorine, letting the water pass through a clean cloth (filtering), solar disinfection (SODIS), and settling in the last 2 weeks at least once before drinking.[4]

Data management and analysis procedure: First, the questionnaires were checked for completeness, then coded and entered into the computer using the Epidata3.1 statistical software, then cleaned and exported to SPSS 20 statistical software for analysis. Data were presented in descriptive statistics, tables, and charts. Binary logistic regression analysis was used to screen the eligible independent variables effect on the outcome variable at P-values <.25. The necessary assumption of logistic regression was checked using Hosmer and Lemeshow goodness-of-fit-test statistics to assess the fitness of the model. Collinearity was checked using a cutoff point based on the variance inflation factor (VIF) <10 or the tolerance test >0.1. To control for confounding variables in the bivariate analysis, a multivariate analysis was run. In the final model, the level of significance of the variables was determined at *P*-value <.05.

Results

Socio–demographic characteristics of the respondents

Eight hundred and thirty-three respondents had participated in the study with a response rate of 99.6%. The mean age of the respondents was 38.22 and (SD ± 8.2) years. Among the total of the respondents, 625 (75%) were women and 702 (84.3%) were married. Regarding educational status, 403 (44.8%) of them had no formal education and the majority 626 (75.2%) of the subjects were farmers in occupation (Table 1).

Water handling practices. About 344 (41%) participants had reported that they stored water in 2 containers and 378 (45.4%) of the household containers had a capacity of <20 L. The majority (774 (90.9%)) of the respondents used covered water containers for water storage. Two-third, 116 (65%) of the respondents reported that the government water supply system was interrupted. Regarding water sources, more than half of the household, 524 (62.9%) had an unimproved source (Table 2).

Household water treatment practice. About 367 (44.1%) of the respondents had used different household water treatment methods to treat water before drinking. Concerning the mode of water withdrawal from the storage container, approximately 449 (53.9%) had drawn water by dipping (during data collection) from the storage container and the majority 757 (90.9%) of them had washed their water storage container. The water

Table 1. Socio-demographic characteristics of respondents, Sodo Zuria district, South, Ethiopia, 2018 (n = 833).

VARIABLES	RESPONSES	FREQUENCY	PERCENT
Sex	Female	625	75
	Male	208	25
Age	18-35 y	323	38.8
	36-45 y	351	42.1
	>45 y	159	19.1
Educational status	No formal education	403	48.4
	Literate	430	51.6
Occupation	Farmer	626	75.2
	Housewife	73	8.8
	Merchant	80	9.6
	Daily laborer	53	6.4
Marital status	Single	64	7.7
	Married	702	84.3
	Divorced/widowed	67	8.0
Family size	≤5	583	70.0
	>5	240	30.0
Monthly income (ETB)	≤500	327	39.2
	501-999	382	45.9
	≥1000	124	14.9

treatment practice reported by the study respondents 245 (29.5%) had used boiling as their water treatment option prior to drinking. About 84 (10.1%) and 38 (4.5%) had practiced adding chlorine/bleach and settling, respectively. More than half of the 466 households (54.9%) had never used any method to have safe drinking water (Table 3).

Factors associated with household water treatment practice. During bivariate logistic regression analysis, sex, age, education, occupation, monthly income, frequency of fetching water per day, ways of drawing water, and frequency of washing the water storage container were screened as candidate independent variables for multivariable logistic regression analysis with HWT practice with *P*-value <.25. During multivariate analysis, monthly income, age, the frequency of fetching water, the frequency of washing water containers, and mode of drawing water maintain their significant association with HWT practice at *P*-value <.05.

Households with estimated income greater than 1000.00 ETB are 1.5 times more likely to practice HWT than those

Table 2. Water handling practices in Sodo Zuria district Southern, Ethiopia, 2018 (n = 833).

VARIABLES	RESPONSES	FREQUENCY	PERCENT
Number of containers used to store water	1	224	26.6
	2	344	41.3
	3 and more	265	32.1
A capacity of the container in liters	≤20 L	259	31.1
	>20 L	574	69.9
Do your water container have a cover	Yes	757	90.9
	No	76	9.1
A material used to wash the container (n = 806)	Water with soap	377	46.8
	Water only	429	53.2
A container used to fetch water	Jerry can	581	69.9
	Pot	212	25.5
	Plastic container	38	4.6
A frequency of fetching water per day	1	576	69.1
	2 or more	257	30.9
Nature of government water supply (n = 176)	Continuous	60	34.1
	Intermittent	116	65.9
Water sources	Unimproved	524	62.9
	Improved	309	37.1

Table 3. Household water treatment practices in rural households of Sodo Zuria district, Southern, Ethiopia, 2018 (n = 833).

VARIABLES	RESPONSE	FREQUENCY	PERCENT
Methods of water drawing from storage container	Dipping	604	72.5
	Pouring	229	27.5
Do you wash water storage container?	Yes	757	90.9
	No	76	9.1
A frequency of washing the container (n = 757)	Daily	385	50.9
	2-3 d interval	244	32.2
	Weekly	128	16.9
Do you store water for more than 3 d?	Yes	450	54
	No	383	46
Type of water storage container	Jerry can	536	64.3
	Pot	246	29.5
	Plastic container	40	4.8
	Iron container	11	1.4
Do you treat water prior to drinking?	Yes	367	43.9
	No	466	56.1
Time taken to fetch water from water sources	<30 min	669	80.4
	≥30 min	164	19.6
HWT methods	Boiling	245	29.5
	Chlorine bleach	84	10.1
	Settling	38	4.5
	Never used	466	55.9

with income <500 ETB, AOR = 1.5 (95% CI = 1.23-3.47). Those who had an age greater than 45 years were 1.69 times more likely to practice HWT than 18 to 35 years, AOR = 1.69 (95% CI = 1.08, 2.64). Households who collected water twice a day were 2.8 times more likely to practice HWT than households who drank more than twice, AOR = 2.8 (95% CI = 1.21-9.17). The weekly washing of the container has 30% higher odds of HWT practice than those who washed their water storage container daily, AOR = 0.3 (95% CI = 0.11, 0.83). Using a dip method to draw water from the collection jar was 1.67 times more likely to practice HWT than who used pouring, AOR = 1.67 (95% CI = 1.14, 2.42) (Table 4).

Discussion

According to the current study, 44.1% of study participants practiced HWT at least once during 2 weeks before the data collection. Even though the current finding showed that 44.7% and 50.9% of drinking water sources in the region were contaminated with Escherichia coli and enterococci respectively[35] the level of household water treatment practice was found to be 44.1%. This finding is consistent with the study done Northwest Ethiopia (44.8%),[5] Nigeria (45%)[36] whereas it was lower than

studies revealed from Zambia (72.6%), Peru 70.9%,[37] and a study in Western Pacific region (66.8%).[27] But it was higher than the findings from Ethiopian demographic health survey 2016 which is 7%,[34] Southern Ethiopia Gibe district revealed 34.3%,[26] northern Ethiopia Degadamot district 14%,[38] and in developing countries 33.3%.[39] It was also higher than studies revealed from outside Ethiopia such as in Biye community, Kaduna State of Nigeria 32.4%, in Eastern Mediterranean region 13.6%,[27] and in African region 18.2%.[37] The possible explanations for this difference might be related with households' perception difference across different contexts. The discrepancy from these reports might be explained that the report included all regional states with different socio-demographic, socioeconomic background, related to sample size, study design, and study period variations.

Households with higher income were 1.5 times more likely to practice HWT than those with low income. This finding is in line with the finding of Maria Elena Figueroa

Table 4. Factors associated with household water treatment practices in rural households of Sodo Zuria district, southern, Ethiopia, 2018 (n = 833).

VARIABLES		HWT PRACTICE		COR (95% CI)	AOR (95% CI)
		YES	NO		
Sex	Male	107	101	1.49 (1.09, 2.04)	1.16 (0.8, 1.68)
	Female	260	365	Reference value	Reference value
Age in years	18-35	129	194	Reference value	Reference value
	36-45	160	191	1.26 (0.93, 1.71)	1.44 (0.9, 2.03)
	>45	78	81	1.45 (0.99, 2.12)	1.69 (1.08, 2.64)
Educational	Literate	197	233	1.16 (0.88, 1.52)	1.35 (0.98, 1.87)
	Illiterate	170	233	Reference value	Reference value
Occupation	Merchant	112	118	Reference value	Reference value
	Farmer	87	86	1.07 (0.72, 1.58)	1.4 (0.89, 2.18)
	House wife	107	141	0.8 (.56, 1.15)	1.07 (0.71, 1.62)
	Daily labor	61	121	0.53 (0.35, 0.79)	0.76 (0.49, 1.19)
Estimated income	≤500 ETB	128	199	Reference value	Reference value
	501-999 ETB	168	214	1.22 (0.90, 1.65)	1.2 (0.87, 1.64)
	≥1000 ETB	53	71	2.08 (1.37, 3.17)	1.5 (1.23, 3.47)
Frequency of fetching water per day	Once	275	301	4.72 (1.94, 11.49)	3.33 (0.01, 7.84)
	Twice	134	85	3.28 (1.31, 8.12)	2.8 (1.21, 9.17)
	Above 2	6	31	Reference value	Reference value
Water storage (>3 d)	Yes	182	267	1.36 (1.04, 1.80)	1.3 (0.96, 1.77)
	No	185	199	Reference value	Reference value
Frequency of washing water storage containers	Daily	204	197	Reference value	Reference value
	2-3 d	113	160	0.68 (0.50, 0.93)	0.65 (0.46, 0.91)
	Weekly	39	93	0.41 (0.27, 0.62)	0.3 (0.11, 0.83)
Methods of water drawing	Dipping	293	311	1.97 (1.45, 2.76)	1.67 (1.14, 2.42)
	Pouring	74	155	Reference value	Reference value

and D. Lawrence Kincaid.[40,41] This study was confirmed with the evidence revealed from Mexico groups the lowest family income households compared together the highest income households distribution shows that water consumption is favorable to a larger extent to the households with the highest income.[42] This was also consistent a study revealed in China[43] and Nigeria.[36]

Respondents with higher age were 1.69 times more likely to practice HWT than household heads of lower age. A similar finding was reported by Maria Elena Figueroa.[40] The possible explanation for this finding might also be that older age participants may have understood through exposure the need for household water treatment to reduce diarrheal disease, and their educational level[38] may also encourage practice.

This study revealed that participants who draw their water from storage vessel by dipping were 1.67 times more likely to practice household water treatment than those who draw their water by pouring. This finding is in line with the study done in Northern and southern Ethiopia.[5,26] The possible explanation might be due to the fact that those who withdraw water from the storage container by dipping thought that dipping the container for drawing water increases the risk of contamination, and they might get information from health professionals on the possible ways of water contamination. Since hands can enter the jar, causing water contamination and to avoid those contaminants, respondents may employ either of the methods for HWT. Apparently, those who pour water and store it in narrow-neck containers may be more protective against contamination.[37]

Households who fetched water twice per day were 2.8 times more likely to practice HWT than households who fetched water more than twice per day. This is in agreement with a study from north-west Ethiopia[5,26] and Nigeria.[36] The possible explanation might be due to the fact that those who were fetching water more frequently might have higher tendency to store their water, which in turn empowers them to treat their water, by storing.

Respondents who washed their container weekly have 30% lowered odds of HWT practice than those who washed their container daily. The reason may be that the person who washed daily may think that for a daily washed water storage container, contaminants are less likely in the water contamination. But the CDC report revealed that only washing the water storage container is not guaranteed for the absence of disease-causing organisms in water.[44] Generally household water treatment practice has a range of multilevel influences. Beyond the model of providing on-going safe water education by health extension workers, potential initiatives could be improved by community mobilization activities that include community leaders, women's groups, etc., in promoting water treatment at community engagements. This is confirmed by a qualitative analysis of factors influencing household water treatment practices among consumers of self-supplied water in rural Ethiopia.[45]

Limitation of the Study

The current study used a large sample size compared to previous studies. As a limitation, since the information for this study was collected mainly through interviews and self-reports, there is a possibility that some of the responses might suffer from social desirability bias and to avoid this we add an observation method as a method of data collection besides the interview. Moreover, since the study employed cross sectional study design, it may be difficult to establish temporal relationship between the outcome and response variables. In addition, it could have been better if the water bacteriological analysis were considered in the method.

Conclusion

The HWT practice was low. Having a higher estimated monthly income, being of older age, fetching water twice per day, washing water storage container weekly, and using dipping method to draw water from the container were determinant factors of HWT practice. Therefore, dipping method drawing water, water storage hygienic practice, and strengthening income generating activities are highly recommended. Further scientific studies through qualitative methods were also recommended.

Acknowledgements

Author Contributions

Availability of Data and Materials

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Considerations

Ethical approval and clearance was obtained from the Institutional Ethics Review Committee (IRC) of Wolaita Sodo University, School of Health Sciences and Medicine, School of Public Health. Permission was also obtained from the concerned bodies of Sodo Zuria district offices. Written and verbal consent was obtained from the study participants. Privacy and confidentiality were maintained. Participants were told that they have the right to participate and/or withdraw any time they feel uncomfortable by the interview.

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