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Research Paper

Household water treatment practice and associated factors among households dependent on unimproved water sources in Ameya district, Oromia, Ethiopia

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ABSTRACT

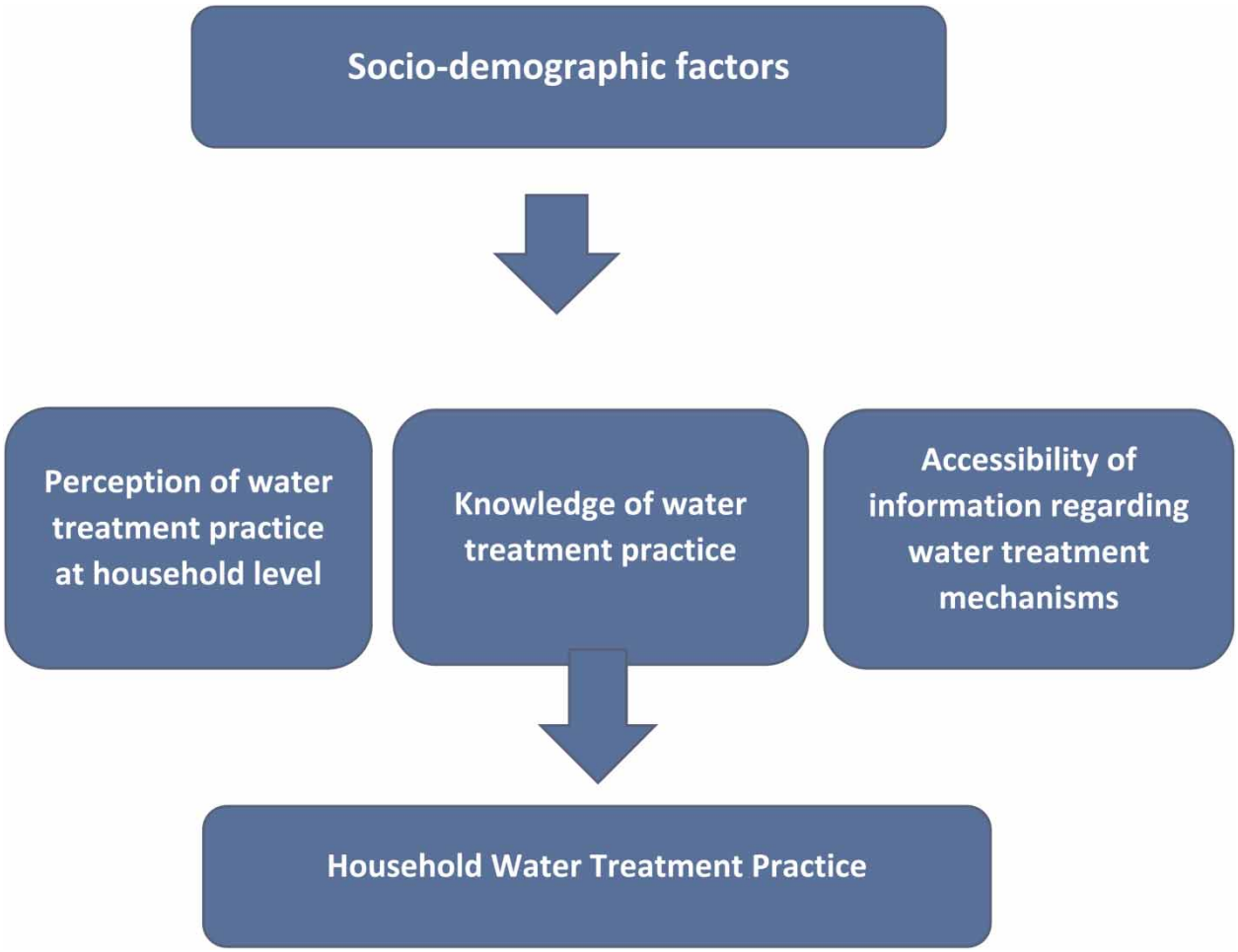
Globally, about 435 million people depend on unimproved drinking water sources, and 144 million people still rely on surface water. Specifically, a significant part of the population in Ethiopia depends on unimproved water sources. Studies have examined household water treatment practices in the country, but there is limited research regarding the population that depends on unimproved water sources. Therefore, this study aims to evaluate household water treatment practices and related factors for the households that depend on unimproved water sources in the Ameya district of the Oromia Regional State in Southwest Ethiopia. A community-based, cross-sectional study was used to assess the water treatment practices and related factors for the households that use an unimproved water source in the Ameya district of the Oromia Regional State in Ethiopia. The study used a multistage sampling technique and included a total of 413 households. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) 26 statistical package. A multivariable logistic regression was applied to identify the factors related to household water treatment practices at a 95% confidence interval (CI). Variables with a *p*-value of less than 0.05 in the multivariable regression were considered to be significantly related to the water treatment practice. The current study showed that 125 (30.3%) of the households that used unimproved water sources practiced household water treatment at the household level. These water treatment methods include boiling (60.8%) the water or using cloth filters (23.2%) or chlorine-based products (13.6%). When considering the training and formal education of the respondents, the water treatment practices were significantly related to the respondents' water treatment training (adjusted odds ratio (AOR) = 2.99; 95% CI 1.97–4.94) and educational status, specifically secondary education (AOR = 1.61; 95% CI 1.02–2.93). Less than one-third of the households that depend on unimproved water sources treated their water prior to drinking. Providing training to teach individuals how to treat household water is essential to improving water treatment practices.

Key words: Ameya district, household water treatment, rural Ethiopia, small-scale water treatment, unimproved water sources

HIGHLIGHTS

- About 30.3% of households practiced water treatment at the household level.
- Factors associated with the household level water treatment practice include educational status (being in secondary school) and training in water treatment.
- Improving access to information and increasing public awareness of unsafe water through the health extension worker is essential.

GRAPHICAL ABSTRACT



1. INTRODUCTION

The 2019 Joint Monitoring Program (JMP) report estimated that approximately 206 million people in the world use limited water services and 435 million people obtain drinking water from unimproved sources. People who live in rural areas are the most vulnerable population as eight of 10 people lack basic water services (JMP 2019). The disaggregated data of 90 countries indicated that basic water coverage for the richest quintile was at least twice as high as coverage for the poorest quintile (WHO 2019a, 2021; CDC 2021).

Contaminated drinking water is one of the main health challenges that children and families face in the developing world. Annually, impure water contributes to the deaths from diarrheal disease of 1.8–2.5 million children under the age of 5 years (Geremew & Damtew 2020). Treating household water is recommended to reduce diarrhea in the sub-Saharan countries, where a significant number of people depend on unsafe water. However, the treatment of household water in the region is low. In fact, 29% use unimproved water for drinking purposes, but only 22% of the households treat their water, and only 18% use adequate treatment methods (Bitew *et al.* 2017; Melese *et al.* 2019; Alemayehu *et al.* 2021).

Ethiopia is the water tower of East Africa, but water is still inaccessible in most parts of the country. Moreover, the water is of a poor quality and is often contaminated by human and animal feces. Because of the limited water availability, most of the rural population relies on unimproved water sources (Belay *et al.* 2016; Usman *et al.* 2016). According to a report by the central statistical agency of Ethiopia, 14% of the population gets drinking water from low-risk sources (no detectable *Escherichia coli*), while 37% gets it from high-risk sources (detectable *E. coli* of more than 100 CFU/100 mL). Similarly, the household water quality in terms of *E. coli* is poor: only 5.6% of the population has access to low-risk household drinking water,

while 48% of them have very high-risk drinking water in their homes. The deterioration in water quality is greater in rural areas, accounting for 55% of the very high-risk, and almost all (98%) of households with piped water had low chlorine residuals, indicating untreated water (CSA 2017).

People use unprotected springs, shallow wells, rivers as well as irrigation water from canals as water sources for domestic uses, but human and animal feces easily pollute these sources. Furthermore, unimproved sanitation habits and open defecation practices exacerbate the problem (Baidya *et al.* 2019).

When used correctly and consistently, household water treatment and safe storage (HWTS) provides an efficient solution for managing water safety at home. Different studies show household water treatment is an effective method specifically for pathogen removal and inactivation in populations where continuous access to safe piped-in water is not available (WHO 2019b). However, the use of these water treatment methods at the household level is low globally (Ojomo *et al.* 2015; Bipin Dangol 2020).

According to a 2016 survey, only 7% of the households in Ethiopia (11% in urban areas and 6% in rural areas) use an appropriate household water treatment method, such as boiling, adding bleach, or chlorine, straining through a cloth, filtering, solar disinfecting, or allowing the water to stand and settle (EDHS 2017). Different research showed various factors impact water treatment practices, but the primary factors are the financial status, educational status, and family size of the household (Bamou Tankoua 2021).

Research indicates that households that depend on unimproved water sources are the most at-risk group for contracting water-associated diseases and that the household water treatment can effectively address this issue (Lantagne & Clasen 2012). However, evidence regarding the use of treatment practices is lacking. Efforts have been made to improve the use of household water treatment practices in the country. Non-governmental organizations (NGOs), governments, and other entities have promoted various practices, but boiling is the most frequently used treatment method. Therefore, this study aims to determine household water treatment practices and related factors for households dependent on unimproved water sources in the Ameya district of the Oromia Regional State in Southwest Ethiopia.

2. METHODS

2.1. Study area and period

The study was conducted in the Amaya district of the Oromia Regional State, which is 144 km from Addis Ababa, the capital of Ethiopia. The district water coverage (i.e., the availability of water within 30 min round trip or 1.5 km from households) is 50%, and the district water access (i.e., the ability to use the available water) is 60%. The district has 16 water sources that government agencies, NGOs, and communities have constructed (bureau 2020). The coverage of the improved water source was only 40%. Each year, the list of the top 10 diseases in the district includes diarrheal disease (i.e., dysentery) and intestinal parasites (BUREAU 2020; DISTRICT 2020). The study was conducted from 1 March 2021 to 30 April 2021.

2.2. Study design

A community-based, cross-sectional study was conducted to determine household water treatment practices and related factors.

2.3. Study population

The study population consisted of households that are dependent on unimproved water sources in the Ameya district in the selected kebeles. A kebele is the smallest administrative division in Ethiopia.

2.4. Inclusion criteria

The households lived for more than 6 months in the selected kebeles included in the study.

2.5. Sample size determination

The sample size was calculated using a single population proportion formula with consideration of the following assumptions: prevalence (P) of 44.8% (the proportion of households that practice water treatment at the household level) (Belay *et al.* 2016), confidence interval (CI) of 95%, a margin of error (d) of 5%, and a non-response rate of 10%. Thus, the final sample size consisted of 418 households.

2.6. Sampling method and procedure

Of the 16 rural kebeles in the study area, eight were selected using simple random sampling. The total sample size was proportionally allocated to each of the kebeles based on their household's size (HHS) (Ajo Gidu (446 HHS), Alibabo (545 HHS), Kechema Giren (671 HHS), Bero Salan (746 HHS), Ashute (937 HHS), Denkeka (1,011 HHS), Bere (1,138 HHS), and Gute Eteya (1,157 HHS)). Also, the households were selected using systematic random sampling (Figure 1).

2.7. Data collection tools and procedures

Data were collected by interviewing the study participants. The questionnaire was adapted from previous research conducted on similar research topics (Geremew *et al.* 2018; Damtew & Geremew 2020; Geremew & Damtew 2020) and rearranged accordingly. It was prepared in English, translated into the local language (Afaan Oromoo), and then back-translated into English to ensure accuracy. The questionnaire was composed of sociodemographic characteristics, household water treatment practice, household perception and knowledge of household water treatment practice, and accessibility to information on how to treat water at the household level. Data collectors and supervisors were recruited and trained on data collection tools, consent, and ethical issues during data collection.

2.8. Ethical approval and informed consent

Ethical approval for this study was obtained from the Institutional Health Research Ethics Review Committee of the Faculty of Health and Medical Sciences, Haramaya University. Informed verbal consent was obtained from all the individuals included in this study.

2.9. Data processing and analysis

The questionnaire was visually checked for completeness, and a code was assigned. Data were entered into Epi-Data v3.02 and exported to SPSS v26 for analysis. Frequency tables were used to summarize the participants' sociodemographic characteristics and the magnitude of household water treatment practice. Next, bivariate logistic regression was performed for each independent variable with the outcome variable, and variables with $p < 0.25$ were included in the multivariable logistic

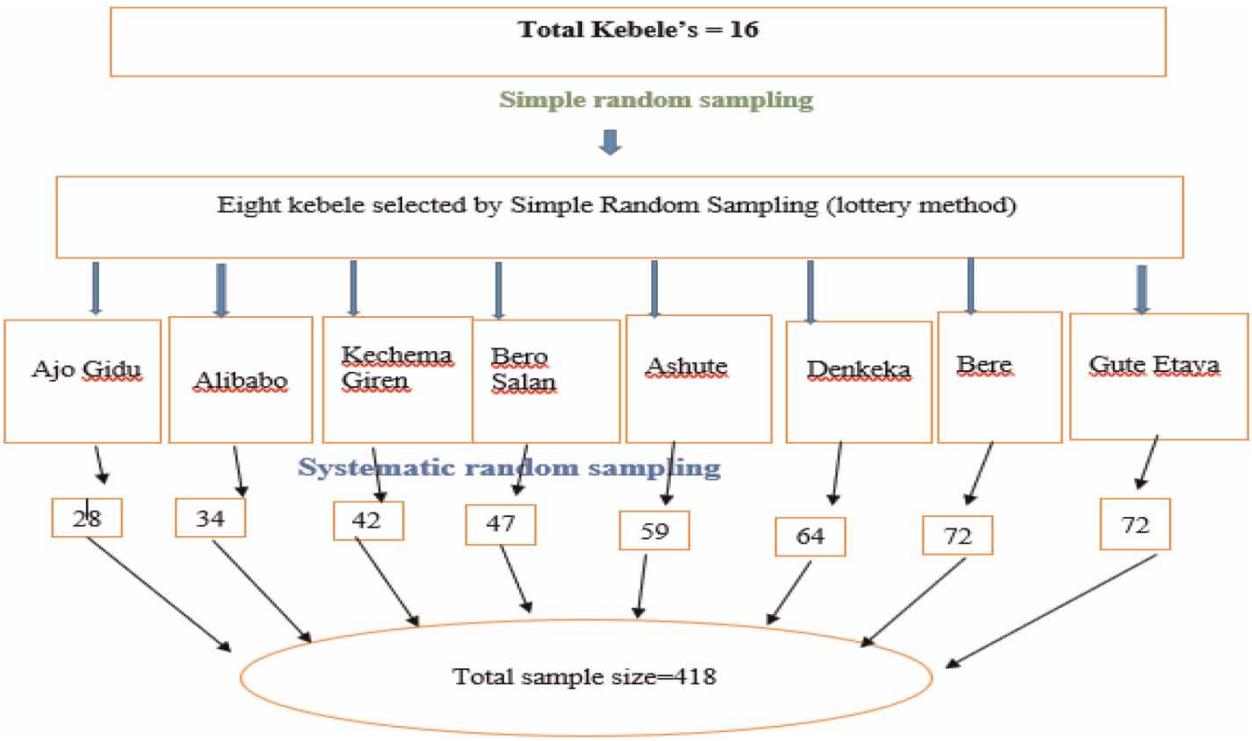


Figure 1 | Diagrammatical presentation of the proportional allocation of samples.

regression analysis (final model). Finally, variables with $p < 0.05$ were considered statistically significant. Multicollinearity was checked using the variance inflation factor cutoff of 10; no multicollinearity was observed between variables.

3. RESULTS

3.1. Characteristics of study households

Of the proposed sample households, 413 participated in the study (response rate: 98.8%). Approximately 242 (58.6%) of the participants were men, and the age of the respondents ranged from 19 to 80 years (mean: 40.5 ± 13.6). More than half of the respondents had not received a formal education, and 330 (79.9%) of the participants were farmers (Table 1).

3.2. Magnitude of household water treatment practices

Fewer than one-third ($n = 125$, 30.3%) of households practiced household water treatment, mainly by boiling (25.6%), using a cloth filter (23.2%), or using chlorine-based products (13.6%). Among these 125 households, 58.4% of the participants stated the effectiveness of household water treatment as the main reason (Table 2).

3.3. Household perception and knowledge of water treatment at the household level

Approximately three-fourths of the households perceived that their drinking water quality was not safe, and 81.1% believed that the water from the source was contaminated (Table 3).

3.4. Access to information and environmental characteristics of water treatment practice at the household level

Assessment of the access to information on household water treatment practice revealed that most households were provided training/advice on how to treat water at the household level. The training/advice was provided by health extension workers, other health professionals, and NGOs (Table 4).

3.5. Factors associated with household water treatment practice

The bivariate analysis revealed that the respondents' educational level, knowledge about the quality of the water, monthly income, the perception that the water is contaminated at the source, belief that drinking untreated water causes diarrheal

Table 1 | Sociodemographic characteristics of study participants in the Ameya district, Oromia region, Southwest Ethiopia, 2021

Characteristics	Category	Frequency	Percent
Respondent	Mother	238	57.6
	Father	154	37.3
	Others	21	5.2
Sex	Female	242	58.6
	Male	171	41.4
Marital status	Married	375	90.8
	Unmarried	20	4.8
	Divorced	9	2.2
	Others	9	2.2
Educational level	No formal education	207	50.1
	Elementary	173	41.9
	Secondary	17	4.1
	College and above	16	3.9
Occupation	Farmer	330	79.9
	House wife	43	10.4
	Merchant	18	4.4
	Government employ	15	3.6
	Other	7	1.7
Number of under-five children	None	37	9.0
	1	124	30.0
	≥2	252	61.0

Table 2 | Magnitude of the household water treatment practice of study participants, Ameya district, Oromia region, Southwest Ethiopia, 2021

Characteristics	Category	Frequency	Percent
Household water treatment practice	Practice	125	30.3
	Not practice	288	69.7
Method of water treatment used ($n = 125$)	Ceramic filter	44	10.7
	Boiling	32	7.7
	Filter with cloth	29	7.0
	Use chlorine	17	4.1
	Let it stand and settle	3	0.7
Reason to use the method ($n = 125$)	Method is effective	73	58.4
	I don't know other method	34	27.2
	Cost-effective	18	14.4
Enjoyed the taste and smell of treated water ($n = 125$)	Yes	92	73.6
	No	33	26.4
Reason for not practicing water treatment at HH level ($n = 288$)	Unavailability of treatment materials/products	111	38.5
	Believe drinking water source is clean	123	42.7
	Believe drinking untreated water has no effect	27	9.4
	Cost is expensive	16	5.6
	I don't know	9	3.1
	Others	7	2.4

HH, households; *n*, sample size.

Table 3 | Perception of the respondent about the water treatment practice in Ameya district, Oromia, Ethiopia, 2021

Characteristics	Options	Frequency	Percent
How is the quality of water you drink	Not clean	297	71.9
	Very clean	100	24.2
	I don't know	11	2.7
	Others	5	1.2
How important is it to treat water	Very important	384	93.0
	Not important	28	6.8
	Do not know	1	0.2
How safe to drink water from the source	Not safe	379	91.8
	Safe	33	8.0
	I don't know	1	0.2
Do you believe water from source is contaminated	Yes	335	81.1
	No	78	18.9
Do have a plan to treat your drinking water	Yes	371	89.8
	No	42	10.2
Reason to use water treatment practice	Health benefit and cost-effective	179	43.3
	Health benefit and effective for sanitation and hygiene	154	37.3
	Others	6	1.5
The causes of diarrheal diseases	Drinking untreated water	294	71.2
	Drinking water from source	100	24.2
	I don't know	19	4.6

diseases, and method of cleaning the container, as well as having a radio, having a mobile, and being advised on how to treat water at the household level, affected the practice of household water treatment.

After controlling for confounding factors in the multivariate logistic regression analysis, the respondents' educational level, their belief that the water from the source is contaminated, having a radio, and being advised on how to treat water at the household level were significantly associated with household water treatment practices (Table 5).

Table 4 | Access to information and environmental characteristics on water treatment practice of respondents in the Ameya district, Oromia, Ethiopia, 2021

Characteristics ($n = 413$)	Options	Frequency	Percent
Does your household have Electricity ($n = 413$)	Yes	117	28.3
	No	296	71.7
Does your household have Radio ($n = 413$)	Yes	240	58.1
	No	173	41.9
Does your household have Television ($n = 413$)	Yes	13	3.1
	No	400	96.9
Does your household have Mobile ($n = 413$)	Yes	208	50.4
	No	205	49.6
Does your household have Landline ($n = 413$)	Yes	17	4.1
	No	396	95.9
Do you advised to treat water at household ($n = 413$)	Yes	228	55.2
	No	185	44.8
Main source of drinking water ($n = 413$)	Protected well	7	1.7
	Unprotected well/borehole	49	11.9
	Surface water	353	85.5
	Others	4	1.0
Who is providing water at source ($n = 413$)	Water authority	8	1.9
	From open well	7	1.7
	CBO/NGO	363	87.9
	Private operator	35	8.5
Do you store water for drinking separately ($n = 413$)	Yes	132	32.0
	No	281	68.0
Which container do you use to store water for drinking ($n = 132$)	Bucket	5	3.8
	Bucket without lid	9	6.8
	Small pans	5	3.8
	Jerrican	112	84.8
	Others	1	0.8
Do you clean container you use to store water ($n = 132$)	Yes	131	99.1
	No	1	0.9
How often do you clean the container ($n = 132$)	Daily	101	76.5
	Every 2 weeks	10	13.2
	Once a week	6	4.5
	No program	15	11.3
How do you clean the container ($n = 129$)	With water only	89	21.5
	With water and detergent	14	4.1
	Mopping with leaves	24	5.8
	Others	2	0.5
Do you use drinking water for other purposes ($n = 413$)	Yes	225	54.5
	No	188	45.5
How you draw water from your container ($n = 413$)	Using small pan	156	37.8
	Pour from container directly	91	22.0
	Use small cup	165	40.0
	Others	1	0.2

NGO, non-governmental organizations; CBO, community-based organizations.

4. DISCUSSION

The overall prevalence of household water treatment practices in the rural Ameya district among unimproved water sources was 30.3% (95% CI 26.3–32.5%). The respondents' educational level, knowledge of water quality, monthly income, perception that the water is contaminated at the source, belief that drinking untreated water causes diarrheal diseases, and method

Table 5 | Factors associated with the household water treatment practice at the household level in the district of Ameya, Oromia region, Southwest Ethiopia, 2021 ($n = 413$)

Variables	Category	Practice water treatment		COR (95% CI)	AOR (95% CI)
		Practice	Not practice		
Educational level	No formal education	56	151	Ref	Ref
	Secondary school	66	124	1.4 (0.92, 2.21)*	1.6 (1.02, 2.93)**
	Above secondary school	3	13	0.6 (0.17, 2.26)	0.36 (0.04–3.07)
Marital status	Unmarried	6	12	Ref	Ref
	Married	119	256	1.08 (0.40, 2.89)*	0.66 (0.13–3.35)
	Other	0	18	1.23 (0.35, 4.34)	0.79 (0.45–3.75)
Occupation of respondents	Other	12	71	Ref	Ref
	Farmer	113	217	1.28 (0.39, 4.12)*	
Sex of respondents	Female	75	167	Ref	Ref
	Male	50	121	0.92 (0.60, 1.41)*	0.94 (0.49, 1.81)
How is the quality of water?	Very clean	73	27	Ref	Ref
	Not clean	50	247	0.07 (0.04, 0.12)	0.34 (0.27, 3.54)
	I don't know	2	14	0.08 (0.01, 0.40)*	0.45 (0.13, 2.57)
How important is it to treat water?	Very important	112	272	2.1 (0.97, 4.56)	0.78 (0.47, 4.01)
	Have no important	13	15	Ref	Ref
Believe water from source is contaminated?	Yes	111	224	2.26 (1.21, 4.21)*	2.99 (1.97, 4.94)*
	No	14	64	Ref	Ref
Have electricity?	Yes	36	81	1.03 (0.65, 1.64)*	1.19 (0.59, 2.40)
	No	89	207	Ref	Ref
Have radio?	Yes	75	165	1.14 (0.72, 1.7)*	2.80 (2.21, 3.32)*
	No	50	123	Ref	Ref
Does your house hold have a mobile?	Yes	54	154	1.51 (0.99, 2.30)*	0.61 (0.35, 1.31)
	No	71	134	Ref	Ref
Do you advised to treat water in the home?	Yes	90	138	2.79 (1.77, 4.4)*	3.01 (1.97, 7.18)*
	No	35	150	Ref	Ref
By whom do you advised to use treat water?	Health professionals	21	50	Ref	Ref
	Health extension	29	71	1.75 (0.99, 3.08)*	0.43 (0.31, 1.89)
	NGOs and public media	3	12	1.07 (0.28, 4)	0.32 (0.14,5.80)
	By all sources	37	25	6.15 (3.22, 11.74)	2.43 (0.89, 5.43)
How do you clean container?	With water only	23	66	Ref	Ref
	With water and detergent	1	16	5.26 (1.8, 15.39)*	0.08 (0.01, 0.69)*
	Mopping with leaves	1	23	2.19 (0.1, 35.4)*	3.53 (0.17, 71.49)

COR, crude odd ratio; AOR, adjusted odd ratio; CI, confidence interval.
*$p < 0.05$; **$p < 0.025$.

of cleaning the container, as well as having radio, having mobile, and being advised to treat water were significantly associated with water treatment practice.

Amaya district households with an unimproved water source have a low household water treatment practice, putting them at risk of contracting waterborne diseases. It is less than the expected goal of the Sustainable Development Goal, to achieve universal and equitable access to safe and affordable drinking water for all by 2030, the WHO estimate of middle- and low-income countries of 33% was less than the study conducted in the northwest of Ethiopia in the Burie Zuria district 44.8% (WHO 2013; Assembly 2015; Belay *et al.* 2016). But the finding of this study is higher than the findings from the WHO estimate of China (20%) and Zambia (25.2%) (Quick *et al.* 2002; WHO 2013). The possible explanations for this finding being lower than the WHO estimate for middle- and lower-income countries could be related to sample size and study design, but for that the study being higher could be related to differences in the year of study.

The results of this study, which show a higher practice of household water treatment than that of a related survey conducted in Ethiopia, indicated that the number of households that reported treating water with appropriate water treatment methods was 3.0, 8.2, and 6.5% in 2005, 2011, and 2016, respectively (Geremew *et al.* 2018). A similar study conducted in Northern Ethiopia indicated a lower rate of household water treatment practice (Azage *et al.* 2021). The differences may be due to differences in study design, socioeconomic differences, and sample size.

The results reveal that the household practices of boiling water and letting it stand to account for 25.6 and 2.5%, respectively, which are lower than those from Tanzania (43.6 and 40.3%, respectively) (Kakulu 2012). However, the finding is in line with a previous study in Colombia in which an average of 31% of the participants had the option of boiling their household water boiling treatment option (Brown & Sobsey 2012). Of the treatment methods, most households' preference for using boiling could be because the method is easy to practice, most households have the required material to do so, and there is water boiling practice for other purposes, like for coffee or washing heavily soiled utensils.

The household head with at least secondary education had higher odds of treating his/her water prior to drinking than the household head who had no formal education. This result is supported by a previous study in which households with education had a higher odds of treating their water than those who were not educated (Geremew *et al.* 2018).

The belief of study participants in the contamination of water sources is also one of the factors associated with the household water practice. Accordingly, those who believed that water from the source was contaminated had a higher odds ratio than those who did not believe that water from the source was contaminated. In addition to this, those who were advised to treat water at the household level had higher odds of household water treatment than those who were not ever advised. In the current study, health extension workers provided the majority of advice on how to treat water in households, indicating that health extension workers have a significant influence in the promotion and provision of preventive interventions, including water treatment practices.

The lack of knowledge about how to use household water treatment methods also affects the practice, and households that have been advised on household water treatment methods show better practice than those that have not advised, in addition to having radio as a source of information. This finding is consistent with the findings of a previous study conducted in Bahir Dar City (Birara *et al.* 2018). The possible explanation for this finding might be due to the fact that households advised have a good awareness of the treatment mechanism as well as the effects of using untreated water on health.

5. CONCLUSIONS AND RECOMMENDATIONS

The findings of this study revealed that the prevalence of household water treatment practices is very low in the Ameya district, Southwest Ethiopia. Being in secondary school, believing water from a source is contaminated, having a radio, and being advised on how to treat water at the household level were the factors that had a statistically significant association with the household water treatment practice at the household level. Improving access to information through radio and mass media and increasing public awareness of the causes and effects of unsafe water through health extension workers and other health workers are essential.

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DECLARATION OF CONFLICTING INTERESTS

The authors declare that there is no conflict of interest.

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AUTHOR CONTRIBUTIONS

M.E. conceived the idea, collected the data, and played a major role in this research. The authors (M.E., G.D., H.G., K.B., D.A., and A.G.) contributed to data analysis, writing, and editing the document. M.E., G.D., H.G., K.B., D.A., and A.G.

gave valuable ideas for the manuscript and revised it. Finally, all the authors (M.E., G.D., H.G., K.B., D.A., and A.G.) read and approved the final version to be published and agreed on all aspects of this work.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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