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Knowledge, Attitude, and Practice of Mothers/Caregivers on Household Water Treatment Methods in Northwest Ethiopia: A Community-Based Cross-Sectional Study

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Abstract. In Ethiopia, ensuring safe drinking water remains a big challenge where waterborne diseases, including diarrhea cause a great harm in many rural communities. Limited knowledge, misinformation, negative attitude, and lack of experience toward best practices of alternative water treatment technologies were among the leading challenges. A community-based cross-sectional study was conducted from June 23 to 30, 2015, in Dabat District. The study participants were selected by using simple random sampling method. Questionnaire-based face-to-face interview technique of data collection was used by 20 data collectors under close supervision with six supervisors. From the total of 845 participants with mother–child paired 49.3%, 95% confidence interval [CI] (45.8, 52.5%) had good knowledge, and 54.8%, 95% CI (51.6, 58.3%) had favorable-attitude toward household water treatment. Only 23.1%, 95%CI (20, 26%) of the study participants had practiced household water treatment. Being an urban resident (adjusted odds ratio [AOR]: 2.58, 95% CI: [1.62, 4.11]), having good-knowledge (AOR: 2.62, 95% CI: [1.81, 3.79]), favorable attitude (AOR: 1.45, 95% CI: [1.01, 2.08]), and used unimproved water source (AOR: 1.67, 95% CI: [1.11, 2.50]) were factors associated with household water treatment practices in the district. Despite mothers/caregivers having a fairly good knowledge and positive attitude, their practice of treating drinking water at household level was quite low. Thus, well designed strategy for health education on effective water treatment methods through the national health extension program is recommended.

INTRODUCTION

Good public health requires not just access to an ample quantity of drinking water, but also that this water be safe to drink. Safe drinking water is defined by World Health Organization (WHO) as, "water that does not represent any significant risk to health over a lifetime of consumption."[1] For communities without reliable access to safe drinking water, household water treatment (HWT) provides a means of improving water quality and preventing waterborne diseases.[2–4]

HWT, which includes boiling, sedimentation, filtration, chlorination, and solar disinfection (SODIS), is among the seven points of strategic areas announced by World Health Organization (WHO) and United Nations Children's Fund (UNICEF) for prevention of diarrhea and other waterborne diseases through community full participation.[5,6] It is also a priority area of a current national drinking water quality monitoring strategic direction at country level which is implemented through the health extension program packages.[7] Though, the health policy of Ethiopia aimed to improve water quality through source improvements, drinking water might be compromised by post collection contamination due to poor knowledge of sanitary household water handling practices.[8]

The problem of access to safe water handling practice is not only hampered by the gap between knowledge and action, but also by wrong knowledge and attitude.[9] Particularly, in rural areas of many developing countries, the knowledge level regarding the direct link between unsafe water consumption and diarrheal diseases is very low.[10] Despite a quarter of households in this region having a history of diarrheal episodes, similar situation has been reported in rural India and Zimbabwe, where 72.7% and 73% households failed to practice any method of water treatment.[11,12]

In Kenya, most of the respondents had knowledge about ideal methods of water collection, treatment, and storage. However, they did not practice the methods appropriately. Attitudes among the respondents also hindered safe drinking water practices. For instance, many households perceived their drinking water source as safe and did not treat it, even when obtained from surface water sources.[13] In addition, the deficient knowledge of respondents leads to a wrong perception on the pathways of water contamination. For example, in western Kenya about 41% of respondents perceived clear river water as safe to drink without any treatment.[13] A study in Cambodia also found that when there was a mismatch between cultural concepts of good water and the method of water treatment, people did not trust it. In this case, Cambodians distrusted water filters, because to them water had to be boiled to be good water.[14]

Water quality problems in rural Ethiopia exist due to poor knowledge and the malpractice of water handling at the source and point of use. This indicates that 60–100% of water samples from protected water sources (springs/wells fitted with hand pumps) are positive for fecal coliforms which is water quality indicators,[15] leading to hundreds of millions people with an improved water source not having access to microbiologically safe water for drinking.[16] However, almost 90% of the rural population of Ethiopia did not practice any alternative water treatment methods,[17] which would pose them to high public health risks unless prompt intervention like alternative HWT methods with safe water storage is undertaken.

Ensuring safe drinking water remains a big challenge where waterborne diseases cause a great harm to public health. Limited knowledge, misinformation, negative attitude, and lack of experience toward best practices of alternative water treatment technologies were among the leading challenges.[13]

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Furthermore, in Ethiopia, epidemiologic evidences pertaining to knowledge, attitude, and practices among community toward HWT were not clearly known. Although before implementing water treatment at household level, taking a first-step assessment to determine the status of knowledge, attitude, and practice of mothers/caregivers on HWT was a prerequisite issue. Therefore, the findings of this study could be helpful as a springboard for implementing water quality intervention strategies through promoting community's knowledge, attitude, and practice on alternative HWT technologies.

METHODS

Study area. The study was conducted in Dabat Health and Demographic Surveillance System (HDSS) site which is located in Dabat District, northwest Ethiopia. It covers13 Kebeles (the lowest local administration in Ethiopian context), of which four are urban. According to the HDSS site survey in 2013/14, it has a total population of about 70,611, of which nearly 7,918 are children under 5 years. The total number of households that have at least one under five children is 7,574. Because of the nonexistence of conventional water treatment in the district, almost all households collect water from wells, springs, or rivers, and they often store in 20-L-size Jerry cans.[18]

Study design. A community-based cross-sectional study was conducted in Dabat District from June 23–30, 2015.

Sample size. The sample size was determined using the formula for a single population proportion with the assumptions that 50% proportion (*P*) of knowledge, attitude or practices of mothers/caregivers on HWT (due to absence of previous study in Ethiopia or similar countries), 5% margin of error (*d*), 95% CI (*Z* = 1.96), design effect (*D*) of 2 and 10 nonresponse rate. Thus, the sample size $(n) = [Z^2_{\alpha/2}P(1\text{-}P)/d^2] \times D$[19]

$$n = \left[1.96^2 \times 0.5(1\text{-}0.5) \Big/ (0.05)^2\right] \times 2 = 768$$

Therefore, the calculated sample size after adding 10% nonresponse rate was 845 households with mother–child paired.

Sampling procedure. Two step sampling technique was used to select the study participants. First, 13 kebeles were selected randomly from a total of 30 kebeles encompassed under HDSS site. Then, households that consisted mother–child pair were selected using the OpenEpi random program (http://www.openepi.com/Random/Random.htm) based on simple random sampling technique with sampling frame accessed from Dabat research center database.

Measurement of variables. *Measurement of knowledge.* To measure knowledge of the respondents on HWT a scoring system was used. Each correct response was scored as 1 and incorrect response was scored as 0. Variables in the questionnaire were given a total score range from 0 to *n* (*n* is the number of knowledge questions, which is scored 0–30). Using a frequency distribution, poor knowledge was defined as a score of < 50%(responding to less than 15 questions correctly), whereas a score of ≥ 50% (responding to ≥ 15 questions correctly) was considered as good knowledge.[20]

Measurement of attitude. The attitude of study participants toward HWT was measured based on a Likert scale 1–5 scoring system (strongly disagree to strongly agree). A positive attitude is considered when a mother/caregiver agreed to a favorable outcome or disagreed with behavior which has a negative impact on adoption of HWT. Thus, both agreements to favorable outcomes and disagreement with negative behavior about statements of 31 questions were considered as the correct response. Using a frequency distribution which showed normal distribution, unfavorable attitude was defined as a score of < 50%(responding to less than 16 questions correctly), whereas a score of ≥ 50% was considered as having favorable attitude.[20]

The rating of Likert scale was measured as follows

Positive statement		Negative statement	
Choices	Score	Choices	Score
Strongly disagree	1	Strongly disagree	5
Disagree	2	Disagree	4
Neither agree nor disagree	3	Neither agree nor disagree	3
Agree	4	Agree	2
Strongly agree	5	Strongly agree	1

Measurement of practices. Mothers/caregivers used at least one alternative method of HWT was considered as good practices with a score of 1, otherwise poor practices as 0 scores.

Data collection tool. Structured questionnaire encompassing 83 questions divided into the following four sections was used:

Section 1: gathered personal and sociodemographic information on the participant characteristics to establish if there would be any correlation between these variables and the participant's knowledge, attitude, and practice regarding HWT (13 questions).
Section 2: gathered information on participant's knowledge and source of information about HWT and cause of diarrheal disease among the alternatives (30 questions).
Section 3: gathered information on participant's attitude about HWT methods (31 questions).
Section 4: collected information on the participant's practices about application of alternative HWT, common type of water sources, and proper water handling practices (9 questions).

Data quality. The questionnaire was prepared in English after reviewing literature. Then, it was contextually modified based on the concepts of WHO and UNICEF Core questions on drinking water and sanitation for household surveys,[21] which consists a set of harmonized questions widely used by nations in their surveys to make data accurate and comparable across the globe. To maintain data quality, the questionnaire was pretested to mothers who have similar characteristics with the study participants and residing nearby the study area. Translation of questionnaire from English to local language "Amharic" for data collection purpose and from Amharic to English during the data entry was done by independent language experts. After they received 2 days training, 20 experienced data collectors involved in the data collection processes under the close supervision of six personnel. Reinterviewing 5% of the households, rechecking, and data edition were done.

Validity. Content validity was assured by taking the pretest of questionnaires with the involvement of 20 data collectors and six supervisors. Comments were collected from each

participant and the questionnaire was amended based on their suggestions.

Reliability. To ensure reliability, the questionnaire was pretested before the actual data collection began with uniform households. The internal consistency was analyzed by using Cronbach's α coefficient.[22] On analysis, the Cronbach's α result was 0.859 for knowledge part among 30 items, 0.770 for attitude part among 31 items, and 0.312 for practice of better handling of drinking water among six items. The overall Cronbach's α Coefficient value was 0.831 which included 67 items. George and Mallery in 2003 provide the following rules of thumb: > 0.9, excellent; > 0.8, good; and > 0.7, acceptable.[23] This indicates the internal consistency of the questionnaire was acceptable where the test result of Cronbach's α coefficient was highest, that is, more than 0.7.

Data management and analysis. The data entry and cleaning were performed using EPI Info, version 3.5.3 statistical software (Centers for Disease Control, Atlanta, GA) and exported to SPSS, version 20.0 (SPSS Inc., Chicago, IL) for analysis of descriptive statistics (frequency, percentage, median, mean, and standard deviation [SD]) and logistic regression model. Both bivariate and multivariate logistic regression analysis were done to determine the relative effect of explanatory variables on the outcome variable after controlling the effect of possible confounders. The strength and direction of association between variables were determined using odds ratio, with 95% confidence interval [CI], and P value < 0.05. To confirm the fitness of statistical model, Hosmer and Lemeshow test was done and to avoid multicollinearity problems, variance inflation factor was also tested.

Ethical consideration. Ethical clearance was obtained from the Institutional Review Board of the University of Gondar with the Ref. No: R/C/S/V/P/05/541/2015. Permission letter was also received from Amhara Regional Administrative State Health Bureau and then official letters were submitted to local district administrators and health departments. Complete informed written consent, including thumb print for illiterate guardians was secured from all mothers/caregivers of the study participants. Participants were ensured the confidentiality of the information they gave. No identifiers were included in the data collection tools. The participants were informed that they have the right to withdraw from the study at any time if they want to do so.

RESULTS

Sociodemographic characteristics of participants. A total of 845 households with mother–child paired participated in this study, forming a response rate of 100%. The majority households 674 (79.8%) were from rural area. Nearly 60% of the study participants reside in highland (cold climate zone), whereas a quarter of respondents reside in lowland (hot climate zone). Almost all respondents 825 (97.6%) were biological mothers. The mean (±SD) age of mothers was 30.6 (±7.4) years and most of them (93.5%) were married and housewives (92.3%). About 72% were illiterate and nearly all of them (99%) were Christians. All of the respondents belong to Amhara ethnic group. The average family size was 5.6 (±1.8). Nearly half of the households had earned less than 600 Ethiopian Birr (ETB) monthly incomes (Table 1).

Knowledge of participants. Almost half of the participants 417 (49.3%) had a good knowledge toward various methods of HWT. Even to the sort of a single question to identify the knowledge level of participants, which directly forwarded, like "do you know the types of water treatment methods at household level?", "Yes" answer was given by 388 (45.9%) respondents. Among these, 276 (71.1%) participants knew about plain sedimentation, boiling 267 (68.8%), filtration with clean cloth 105 (27.1%), chlorination 50 (12.9%), straining with local sieve 17 (4.4%), and sunlight and heat only 5 (1.3%). The main sources of knowledge information were health extension workers (HEWs) 145 (37.4%) followed by health professionals in the health institutions 83 (21.4%) (Table 2).

The knowledge of participants about the health consequences of drinking dirty water without any treatment was substantially accounted 746 (88.3%). Among these, knowledge related to the types of disease outcomes directly linked to drinking dirty water without any treatment was cited more of intestinal parasite 363 (48.7%) followed by diarrheal disease 257 (34.5%). The knowledge regarding the various causes of childhood diarrhea with multiple responses, majority of participants 543 (64.3%) responded contaminated water, nearly half of participants 415 (49.1%) replied the growing of milk teeth, followed by eating stale foods 384 (45.4%) and eating with dirty hands 360 (42.6%) (Table 2).

Attitude of participants. More than half of respondents 463 (54.8%) had a favorable attitude, whereas the remaining respondents 382 (45.2%) had an unfavorable attitude toward HWT. According to the three most effective methods of HWTs such as SODIS, boiling, and chlorination was measured separately by multiple answers of related questions and then in both methods more than half of the respondents had a favorable attitude when results were rendered 445 (52.7%), 450 (53.3%), and 462 (54.7%), respectively (Table 3).

Practices of HWT and handling of water. More than half of the respondents 431 (51%) had obtained their water from an unimproved water source (largely unprotected spring, 39.3% and stream/river water 10.3%). The remaining 414 (49%) had obtained water from improved water sources, mainly from protected spring 16.2%, protected hand-dug well 12.5%, or piped water 14.4%.

Just nearly a quarter of households had used at least one of the water treatment alternative methods, of which 102 (52.3%), 49 (25.1%), 40 (20.5%), and four (2.1%) had used plain sedimentation, boiling, straining with clean cloth/ local sieves, and chlorine solution, respectively. None of the household yet implemented the practice of SODIS water treatment method. However, more than half of the households 455 (53.8%) had poor management of water quality at household level (Table 4).

Factors associated with knowledge, attitude, and practice of HWT. From the sociodemographic variables included in the multivariate analysis, educational status, types of water source, and household income level were found to have a statistically significant association with knowledge. Literate mothers/caregivers are 3.46 times more likely to have good knowledge on HWT (adjusted odds ratio [AOR]: 3.46, 95% CI: [2.47, 4.85]). Those who collect their water from improved water source (AOR: 1.52, 95% CI: [1.13, 2.04]).and had ≥ 600 ETB monthly income (AOR: 1.78, 95% CI: [1.33, 2.37]) are found to be more likely to have good knowledge (Table 5).

Residence, occupation, and knowledge of mother/caregiver about HWT had statistically significant associations with mothers'/caregivers' attitude toward HWT. Mothers/caregivers

TABLE 1
Selected sociodemographic characteristics of the respondents in Dabat District, Northwest Ethiopia, June 2015 (N = 845)

Characteristics		Number	Percent (%)
Residence	Rural	674	79.8
	Urban	171	20.2
No. of HHs in climatic zone	Lowland	219	25.9
	Midland	131	15.5
	Highland	495	58.6
Age of respondents (year)	18–24	183	21.7
	25–34	381	45.1
	35–44	245	29.0
	≥ 45	36	4.2
Marital status	Married	790	93.5
	Single	10	1.2
	Divorced	30	3.5
	Widowed	15	1.8
Education	Illiterate	606	71.7
	Read and write	23	2.7
	Primary school	102	12.1
	Secondary school	95	11.2
	Certificate and above	19	2.3
Occupation	Housewife	780	92.3
	Government employee	17	2.0
	Private gainful work	26	3.1
	Other*	22	2.6
HHs monthly income (ETB)	< 600	408	48.3
	≥ 600	437	51.7
Family size (number)	≤ 5	415	49
	> 5	430	51
Number of U5C per HHs	One	626	74.1
	Two	215	25.4
	Three	4	0.5

ETB = Ethiopian Birr; HHs = households; U5C = under five children.
* Mainly daily laborer followed by merchant.

who had good knowledge about HWT are more likely to have a favorable attitude toward HWT compared with their counterparts (AOR: 4.05, 95% CI: [2.96, 5.54]). Being resident in urban area lowers the likelihood of a favorable attitude toward HWT (AOR: 0.33, 95% CI: [0.21, 0.54]). Similarly, being a daily laborer decreases the likelihood of having a favorable attitude compared with housewives (AOR: 0.24, 95% CI: [0.08, 0.74]) (Table 6).

Among the eight predictor variables included in the multivariate logistic regression analysis residence, knowledge about HWT, attitude toward HWT, and water sources were found to have statistically significant associations with HWT practices. Mothers/caregivers who lived in urban area (AOR: 2.58, 95% CI: [1.62, 4.11]), who had good knowledge about HWT (AOR: 2.62, 95% CI: [1.81, 3.79]), had favorable attitudes toward HWT methods (AOR: 1.45, 95% CI: [1.01, 2.08]) and households who were collecting drinking water from an unimproved water sources (AOR: 1.67, 95% CI: [1.11, 2.50]) were found to be more likely to treat water at household level (Table7).

DISCUSSION

In this study, nearly half (49.3%) of mothers/caregivers had good knowledge level on HWT methods which is higher than the findings in Nigeria (26.1%),[24] rural Haryana(33.5%),[10] and rural community of Madhya Pradesh, in India (20%).[11] The percentage of mothers/caregivers in this study who had knowledge on boiling (68.8%) is a little bit higher than those in rural Haryana (64.3%),[10] but less than the subjects in Myanmar (83.3%).[25] In spite of percentage variations, most mothers/caregivers either in Dabat, Ethiopia, or in rural Haryana, India, or in Myanmar, southeast Asia, had the knowledge that boiling is a common method of HWT. The reason for this could be that boiling is the oldest method of HWT which has been promoted in many developing countries.[26]

Likewise, 71.1% of the mothers/caregivers in this study knew about plain sedimentation as HWT method which is higher than twice the findings in Madhya Pradesh (28%).[11] On the other hand, the knowledge of mothers/caregivers in this study about filtration was much lower (27.1%) when compared with another study in Myanmar 70% of the subjects had the knowledge of filtering water through cloths.[25] In current study, the level of knowledge on chlorination was also comparable (12.9%) with that of the Myanmar study (10%).[25] Only 1.3% of mothers/caregivers in this study knew about SODIS method. Lower level of knowledge on SODIS was also reported in a study conducted in Myanmar (0.6%).[25] This may indicate that the effort exerted to promote SODIS in Ethiopia and Myanmar is minimal. Moreover, the knowledge level of mothers/caregivers on SODIS method was 10 times lower than in the findings from Bolivia (13%).[27] Such a high difference might be due to wider dissemination of the SODIS information to the Bolivian community using different strategies.[28]

In the current study, 64.3% of the mothers/caregivers had the knowledge that the consumption of contaminated water without any treatment at household level can cause diarrheal disease. This finding is more than four times higher than a study done in rural community of Madhya Pradesh, India (14.4%).[11] It is also higher than in Zambia that among households treated their water, 48% of women knew that consumption of water is unsafe without proper treatment and 34% reported the advantage of treating water to improve health.[29] In Pakistan, only 30% of the respondents which is less than twice from current study, knew the link of diarrheal diseases with ingestion of contaminated water.[30]

Mothers/caregivers who used an improved water source had 1.5 times more knowledge on HWT methods than those who did not use the improved water source. This may be due to the awareness gained by the mothers/caregivers from the on-site health education programs about the advantage of HWT to maintain the quality of water both in the source and at home. Education level and household incomes are also statistically associated factors to determine the knowledge level of mothers/caregivers on HWT. Being literate (AOR = 3.46) and earning a better household income (AOR = 1.78) had more knowledge on HWT than their counterparts. These findings are supported by a study done in Malawi which reported that educated mothers/caregivers and those who have better income level had more knowledge toward HWT methods.[31]

However, mothers/caregivers had a limited knowledge and exposure about SODIS method; they had a favorable attitude to accept the role of SODIS. This is because mothers/caregivers had the interest to provide clean water for children and perceived that SODIS is as equally important as to common HWT methods like boiling if SODIS produces safe water. Overall, about 55% of mothers/caregivers had a favorable attitude toward HWT. The attitudes of mothers/caregivers were independently analyzed in terms of three

TABLE 2
Knowledge level of the respondents on HWT in Dabat District, Northwest Ethiopia, June 2015 (N = 845)

Characteristics		Number	Percent (%)
Overall Knowledge on HWT	Poor knowledge	428	50.7
	Good knowledge	417	49.3
	Mean = 12.3	Median = 12.0	SD = ±4.3
Knowledge of respondents about HWT methods			
	No	457	54.1
	Yes	388	45.9
Knowledge about the types of HWT methods (N = 388)*			
	Sedimentation	276	71.1
	Boiling	267	68.8
	Filtration with cloth/ sand	105	27.1
	Chlorination	50	12.9
	Straining with local sieve	17	4.4
	Sunlight and heat (SODIS)	5	1.3
Knowledge's about clear water is safe to drink.	No	301	35.6
	Yes	544	64.4
Knowledge's about the causes of any disease to drink dirty water	No	99	11.7
	Yes	746	88.3
Knowledge's about the negative outcome of drinking dirty water (N = 746)			
	Intestinal parasite	363	48.7
	Diarrheal disease	257	34.5
	Amoeba and *Giardia*	126	16.8
Knowledge's about waterborne disease			
	No	405	47.9
	Yes	440	52.1
Knowledge of the purpose of HWT			
	No	300	35.5
	Yes	545	64.5
Source of Knowledge about HWT (N = 388)			
	Health extension workers	145	37.4
	Health professionals in the health institution	83	21.4
	Self-experiences	63	16.0
	Teachers at schools	49	12.9
	Friends/neighbors	42	10.8
	Radio/TV	6	1.5

HWT = household water treatment; SD = standard deviation; SODIS = solar disinfection.
* Summation of frequency and percentage could be greater than 388 and 100, respectively due to multiple responses.

TABLE 3
Attitudes of the respondents on HWT in Dabat district, Northwest Ethiopia, June 2015 (N = 845)

	Attitude of participants	
Category of water treatment	Favorable n (%)	Unfavorable n (%)
Comprehensive HWT	463 (54.8)	382 (45.2)
Boiling of drinking water	450 (53.3)	395 (46.7)
SODIS	445 (52.7)	400 (47.3)
Addition of chlorine solution	462 (54.7)	383 (45.3)
Attitude: mean = 108	Median = 109	SD = ±9.9

HWT = household water treatment; SD = standard deviation; SODIS = solar water disinfection.

domains of effective HWT methods which revealed that more than half of participants had favorable attitudes toward the three domains in the ascending order namely SODIS (52.7%), boiling (53.3%), and chlorination (54.7%). In addition, a high proportion of respondents (62.5%) showed their willingness to accept SODIS treated water. This indicates that SODIS may be considered as an alternative to other water treatment methods like boiling or chlorination in rural communities; and such an acceptability of SODIS is consistent with that of the rural communities of other countries. For example, McGuigan and others indicated that SODIS is a culturally acceptable HWT method in rural Cambodia.[14] Murinda and Kraemer in peri-urban community of Zimbabwe also reported that 61% of the participants said SODIS was convenient (less laborious, does not require firewood, and easy to operate), 36% of participants told SODIS prevented diseases (kills the germs, promotes good health) and the participants also interviewed about the SODIS were very positive and reported a high likelihood of using SODIS in the near future.[12]

In this study, participants in the urban residences had shown a less positive attitude toward the role of HWT. The possible reason may be that the perception of the urban people is the water supplied by the piped water systems is safer though the supply is inadequate and irregular.

Although most of the households (51%) obtained their water from unprotected water sources (spring, well, and river water) which were prone to contamination, HWT practice was uncommon in majority (77%) households which was less than the national figure (90%) of the Ethiopian demographic and health surveillance 2011 report,[17] but it is almost comparable to the findings of other country studies. Approximately 72% of population of some rural India and 73% in Zimbabwe did not use any method of water treatment.[10,11] This may be due to low awareness and less recognition of the link between consumption of untreated water and negative health impact in developing countries.

The present study revealed that only 23.1%, 95% CI (20, 26%) of households used at least one of the alternative methods for HWT. This result was comparable with that a study that was done in 22 African countries like Ghana and Egypt (18.2%), but less than in other low and medium income countries where a third of households (33%) treated their drinking water at household level as assessed by Rosa and Clasen.[32] In this study, the majority (64.4%) of respondents consider the water is safe to drink if it is clear and sparkling to naked eye. This finding is supported by a study in western Kenya which revealed that 41% of respondents perceived that clear river water is safe to drink.[13] This can be one of the possible reasons for lower levels of HWT practice in the study area.

The participants' practice of HWT in this study (23.1%) was nearly half of that in Nigeria (54.1%). However, coverage of water treatment with sedimentation methods by study subjects (52.3%) was 5-folds higher than in Nigeria (10.5%), whereas the findings for other HWT practices were almost consistent with those of the Nigerian study (boiling 25.1% versus 24.9%, straining with clean cloth 20.5% versus 21.4%, and chlorination 2.1% versus 3.6%).[24] The percentage of households found practicing boiling in this study was higher (25.1%) than in Zambia (7%)[29] or Zimbabwe (15%).[12] However, very few households (2.1%) in current study reported chlorinating the water which is nearly similar to the finding of the study in Zimbabwe (5%),[12] and greatly lower than the study finding in Zambia (42%).[29] The difference might be the choice of HWT methods to be implemented at household level may vary from country to country

TABLE 4

Households' water treatment practices in Dabat District, Northwest Ethiopia, June 2015 (N = 845)

Characteristics		Number	Percent (%)
Category of water sources	Unimproved water source	431	51.0
	Improved water source	414	49.0
Water sources in the community			
	Unprotected spring	332	39.3
	Protected spring	137	16.2
	Protected dug well	106	12.5
	Unprotected dug well	12	1.5
	Piped water	122	14.4
	Public tab/stand pipe	49	5.8
	Rivers/streams	87	10.3
Practice of water treatment at household level			
	No	650	76.9
	Yes	195	23.1
Commonly used water treatment methods (N = 195)			
	Plain sedimentation	102	52.3
	Boiling	49	25.1
	Straining with clean cloth/ local sieve	40	20.5
	Add chlorine solution	4	2.1
Water quality improvement practice			
	Poor	455	53.8
	Good	390	46.2
Children who drunk household treated water (N = 195)			
	No	43	22.1
	Yes	152	77.9

depending on indigenous knowledge, accessibility, and raw water quality.

SODIS method was not familiar practice within the Ethiopian community in spite of the fact that the rural community in this study area had some knowledge about the advantage of treated water to improve public health. As well, more than half of mothers/caregivers had a positive attitude toward SODIS but none of them practiced it. The main reason might be SODIS method is unknown at community level in the study area which accounted 98.7%. Moreover, no any effort has been made to address the relevant information either through promotion or regular health education as SODIS is one of the alternative methods to treat water at household level and access also did not too.[33] Whereas at least in Zambia, 1% of the study households practiced SODIS[29] but it was better in Zimbabwe 15%[12] and in Bolivia 60% of participants used SODIS technology.[27] Such variations in the level of practicing SODIS, for instance 1.3% in Ethiopian and 13% in Bolivian rural communities, may be due to their knowledge gaps. Therefore, this indicates that enhancing the knowledge level of the community about SODIS is one of the strategies to implement this potential HWT method in developing countries.

Regarding predictors of HWT, in this study, urban mothers/caregivers were practiced HWT approximately three times more likely to rural mothers/caregivers (AOR = 2.58). Households that accessed water from unimproved water sources which are not protected from external source of contamination, particularly fecal matter,[16] were more than one and half times more likely to treat their drinking water relative to the households who accessed water from improved water sources (AOR = 1.67). This may be attributable to the differences between the urban and rural residents in terms of their better literacy status, accessibility of information, and being an unimproved water source which can expose to different source of contaminants might give a highlight of aesthetic conditions to inspire the users to apply HWT. This concept is also supported by a study in Pakistan where turbidity was the sole indicator of water quality which is unhealthy to drink.[30]

Mothers/caregivers who had good-knowledge were more than two and half times more likely to use HWT methods compared with mothers/caregivers who had poor knowledge (AOR = 2.62). This difference may be due to the literacy level of mothers/caregivers on HWT. Mothers/caregivers who were at least able to read and write had better knowledge than the illiterate mothers/caregivers toward the HWT methods. This finding is more or less in agreement with the findings of a study conducted by Miner and others in Nigeria in which knowledge was found to be significantly associated with water treatment

TABLE 5

Bivariate and multivariate analysis of factors associated with knowledge on household water treatment among mothers/caregivers in Dabat District, Northwest Ethiopia, June 2015

Predictor variables		Knowledge level		COR (95% CI)	AOR (95% CI)
		Good	Poor		
Residence:	Rural	300	374	1.0	
	Urban	117	54	2.7 (1.89, 3.86)***	
Respondents age category (year)	18–24	91	92	1.0	
	25–34	199	182	1.11 (0.78, 1.57)	
	35–44	109	136	0.81 (0.55, 1.19)	
	≥ 45	18	18	1.01 (0.50, 2.07)	
Marital status	Married	387	403	1.0	
	Not married†	30	25	1.25 (0.72, 2.16)	
Educational status	Illiterate	244	362	1.0	1.0
	Literate	173	66	3.89 (2.81, 5.39)***	3.46 (2.47, 4.85)***
Occupational status	Housewife	373	407	1.0	
	Employed	31	12	2.82 (1.43, 5.57)***	
	Daily laborer	13	9	1.58 (0.67, 3.73)	
Water source	Unimproved	257	174	1.0	1.0
	Improved	171	243	2.10 (1.60, 2.76)***	1.52 (1.13, 2.04)**
Household	< 600	166	242	1.0	1.0
Income (ETB)	≥ 600	251	186	1.97 (1.50, 2.59)***	1.78 (1.33, 2.37)***

AOR = adjusted odds ratio; CI = confidence interval; COR = crude odds ratio; ETB = Ethiopian Birr. Hosmer and Lemeshow test for the final step was 0.97 (i.e., $P > 0.05$) and the test result of VIF was < 10 for each independent variable in the final model. Therefore, the actual test result is confirmed that no multi co-linearity was observed.

Statistically significant at $^{**}P < 0.01$ and $^{***}P < 0.001$.

† Including single + divorced + widowed.

TABLE 6

Bivariate and multivariate analysis of factors associated with attitude on household water treatment among mothers/ caregivers in Dabat District, Northwest Ethiopia, June 2015

Predictor variables		Level of attitude		COR (95% CI)	AOR (95% CI)
		Favorable	Unfavorable		
Residence:	Rural	387	287	1.0	1.0
	Urban	76	95	0.59 (0.42, 0.83)**	0.33 (0.21, 0.54)***
Respondents age category (year)	18–24	94	89	1.0	
	25–34	205	174	1.1 (0.76, 1.57)	
	35–44	143	102	1.33 (0.90, 1.95)	
	≥ 45	21	15	1.33 (0.64, 2.73)	
Marital status	Married	432	358	1.0	
	Not married†	31	24	1.07 (0.62, 1.86)	
Educational status:	Illiterate	320	286	1.0	
	Literate	143	96	1.33 (0.98, 1.80)	
Occupational status	Housewife	436	344	1.0	1.0
	Employed	22	21	0.83 (0.45, 1.53)	0.98 (0.46, 2.11)
	Daily laborer	5	17	0.23 (0.09, 0.64)**	0.24 (0.08, 0.74)*
Knowledge	Poor	171	257	1.0	1.0
	Good	292	125	3.51 (2.64, 4.67)***	4.05 (2.96, 5.54)***
Household income (ETB)	< 600	207	201	1.0	
	≥ 600	256	181	1.37 (1.05, 1.80)*	

ETB = Ethiopian Birr. Hosmer and Lemeshow test for the final step is 0.71 (i.e., $P > 0.05$) and attitude like knowledge, the actual test result confirmed that no multicollinearity was observed.
Statistically significant at *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
† Including single + divorced +widowed.

at household level.[24] Education level was also found to be positively associated with home water treatment a study was done in rural Arizona community.[34] Likewise, mothers/ caregivers who had a favorable attitude were almost one and half times more likely to practice water treatment at their homes as compared with mothers/caregivers who had an unfavorable attitude (AOR = 1.45). The link between knowledge, attitude, and practice has shown positive correlation which indicated that favorable attitude may be the result of a good knowledge of the positive health impact of good water quality as there was a 4-fold improvement in attitudes toward HWT when good knowledge (AOR = 4.05) was possessed. This finding was supported a study was done in Pakistan by Noman and others who explained that adequate knowledge can lead to a positive attitude and resulting in good practices.[35]

Even though there was a substantial level of knowledge and positive attitude toward HWT among mothers/caregivers in the community, HWT practice was very low. A similar finding was reported by Kioko and others in western Kenya in which the participants of the peri-urban households in the study had significant knowledge on drinking water safety, but their practice of safe handling and treatment of water was very poor.[13]

Limitation. The results about HWT practice and attitude were based on self-reports of participants. Participants may answer either due to courtesy or social desirability that leads to a bias that may result in over or under estimates.

TABLE 7

Bivariate and multivariate analysis of factors associated with practices on HWT among mothers/ caregivers in Dabat district, Northwest Ethiopia, June 2015

Predictor variables		Practice of HWT		COR (95% CI)	AOR (95% CI)
		Yes	No		
Residence	Rural	135	539	1.0	1.0
	Urban	60	111	2.16 (1.5, 3.1)***	2.58 (1.62, 4.11)***
Marital status	Married	182	608	1.0	
	Not married†	13	42	1.03 (0.54, 1.97)	
Education	Illiterate	116	490	1.0	
	Literate	79	160	2.07 (1.49, 2.92)***	
Occupation	Housewife	174	606	1.0	
	Employed	13	30	1.51 (0.77, 2.96)	
	Daily laborer	8	14	1.99 (0.82, 4.82)	
Knowledge on HWT	Poor	59	369	1.0	1.0
	Good	136	281	3.03 (2.15, 4.26)***	2.62 (1.81, 3.79)***
Attitude on HWT	Unfavorable	69	313	1.0	1.0
	Favorable	126	337	1.70 (1.22, 2.36)***	1.45 (1.01, 2.08)*
Water source	Unimproved	96	335	0.91 (0.66, 1.26)	1.67 (1.11, 2.50)*
	Improved	99	315	1.0	1.0
Household income (ETB)	< 600	87	321	1.0	
	≥ 600	108	329	1.21 (0.88, 1.67)	

AOR = adjusted odds ratio; CI = confidence interval; HWT = household water treatment. Hosmer and Lemeshow test of the final step was 0.74 (i.e., $P > 0.05$) and the test result of variance inflation factor was < 10. Therefore, the actual test result confirmed that no multi colinearity was observed.
Statistically significant at *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
† Including single + divorced + widowed.

CONCLUSION

The level of knowledge and attitude of mothers/caregivers on HWT was fairly good while their practice of treating drinking water with either of alternative methods was quite poor. However, the knowledge of mothers/caregivers on chlorination and SODIS which are more effective method was inadequate. Statistically significant predictor factors to determine the mothers' knowledge level where educational status, household income, and type of water sources, whereas attitude was influenced by type of residence, type of occupation, and knowledge level. Factors associated with HWT practices were education, knowledge level, attitude, and the type of water sources. Thus, the deficiency of knowledge, poor attitude, and lack of practice of HWT continue to be the causes of substantial burden on the provision of safe drinking water in rural communities. Therefore, there is a need to improve HWT through rigorous, frequent, and effective implementation of well-designed health education and awareness programs by the full and active participation of HEWs, organizations working on safe water program and different partners at the community level. Finally, conduct further studies on the effectiveness of various HWT methods and the associated cost–benefit analyses to adopt feasible technologies to implement in rural communities.

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