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# Determinants of Household-Level Water Treatment Practices in Southern Ethiopia

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## ABSTRACT

**BACKGROUND:** Household water treatment and handling is an important component of a global strategy to provide safe water to millions of people who live without adequate water currently. Household water treatment at the point of use also helps to improve drinking water quality for millions who suffer due to contamination of their drinking water. This study aims to assess household-level water treatment practices and associated factors in Southern Ethiopia.

**METHODS:** A community-based cross-sectional study was conducted among selected households using a systematical random sampling technique in Bule town. Data was collected using a pretested, structured questionnaire and analyzed using STATA version 16. A variable with a *P*-value ⩽ .25 in bi-variable regression was entered into multivariable regression and then a variable with a *P*-value ⩽ .05 was taken as statistically significant.

**RESULTS:** The study found that only 29.9% (with a 95% CI: 25.3-34.6) of households have good water treatment practices for drinking purposes. Regarding predictors of household-level water treatment practices, respondents who had good knowledge were 5 times (AOR = 6.98, 95% CI = 4.01-11.9) more likely to practice household-level water treatment than their counterparts. In addition, respondents who earn more than 3000 ETB per month are twofold more likely to practice household water treatment than those with an average monthly income of less than 1000 ETB (AOR = 2.37, 95% CI = 1.22-4.60).

**CONCLUSIONS:** Household-level water treatment was less common in Bule town. The household's monthly income and their knowledge status were found to be the determinants of household-level water treatment practices in the study area.

**KEYWORDS:** Household-level, water treatment practices, southern Ethiopia

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## Introduction

The sixth Sustainable Development Goals (SDGs) aim to ensure the availability and sustainable management of water and sanitation for all. The SDGs Target 6.1 and 6.2 are particularly planned to achieve the goal of universal and equitable access to safe and affordable drinking water for all access to adequate and equitable sanitation and hygiene for all by 2030.[1] It's also a top goal of Ethiopia's current national drinking water quality monitoring strategic direction, which is carried out through health extension program packages.[2]

Coverage of safely managed drinking water at home is 74% globally, 30% in Sub-Saharan Africa, and 13% In Ethiopia in 2020.[3] The EDHS 2016 (Ethiopian demography and health survey) indicates that improved drinking water is available to 97% of urban households and 57% of rural households in Ethiopia.[4] Despite progress toward house coverage of properly managed drinking water, 844 million people in the world still lack access to even basic water services, and over 2.1 billion people lack access to safely managed drinking water on-premises.[5]

For communities without reliable access to safe drinking water, household water treatment (HWT) provides a means of reducing contamination to lower microbiological risk levels by treating water that has been contaminated both at the source and through domestic handling.[4,6] Chlorination, flocculation, filtration, solar disinfection, and boiling are point-of-use water treatment technologies which are simple and inexpensive technologies, that exist for treating drinking water in the home and storing it in safe containers.[7] It dramatically improves microbial water quality and significantly reduces the incidence of diarrhea.[6,8]

Waterborne diseases are the major health burden that is caused by the consumption of unhygienic drinking water in most of the developing countries in the world.[6] Untreated water consumption is a global problem that causes 3.2% of deaths (1.8 million) worldwide, of which over 99.8% occur in developing countries, and 90% are children.[9] Plenty of evidence underscores the importance of household water treatment and safe storage to enhance the quality of drinking water and avoid water-borne infections. When effective methods are used correctly and consistently, they can reduce diarrheal disease by as much as 45%.[10] Similarly, improvements in drinking water quality by domestic water treatment, such as point-of-use chlorination and adequate storage, have been shown to minimize diarrhea occurrences in several studies.[1,11-14]

According to a 2015 national survey on household water treatment in 70 countries, household water treatment practices ranged from 66.8% in the Western Pacific to 18.2% in Africa.[15,16] In Ethiopia, in addition to extremely limited access to safe drinking water, the rate of water purification in the home is still very low, with only 5% to 10% of Ethiopia's population using it.[13,17,18] According to the EDHS (2016) report, only 7% of Ethiopian households use proper household water treatment methods such as boiling, adding bleach/chlorine, straining through a cloth, filtering, solar disinfection, and letting it stand and settle.[4] In Ethiopian studies, the sex of the household head, education level, knowledge of water treatment, and water source were identified as factors in consuming untreated water.[13,19]

Even though different studies were conducted in different parts of Ethiopia on household water treatment, a community in the study area is still suffering from water-borne diseases like diarrhea that are related to untreated water that can be easily prevented by a small means of treating water at the household-level. In the context of the study area, little is known about level point-of-use water treatment approaches and the factors that influence water treatment decisions and practices. As a result, the goal of this study is to fill this gap by identifying the level of household water treatment practice and associated factors among households in Southern Ethiopia, which will enrich existing works on household water treatment practice and may inspire other researchers to conduct similar studies in different parts of the country. By giving a clear picture of water treatment practices, the result of this study could help residents of the study area, health facilities, and governmental and non-governmental organizations work on water treatment practices to reduce waterborne diseases.

## Methods

### *Study design and setting*

A quantitative community-based cross-sectional study design was employed to determine the magnitude of household-level water treatment practice and associated factors among households in Bule town, Southern Ethiopia. The town is 387 km from Addis Ababa and 27 km from the Dilla town administrative center (zonal capital). According to a 2007 census projection, the town has 3 urban kebeles (the smallest administrative unit) with a total of 8873 households.[20] The study was conducted during the period of October 15 to November 5, 2021 G.C. All households in the town were the source population, and all households selected using systematic random samplings were considered as the study population. The study included respondents who were 18 years or older (preferably female) and had lived in the town for at least 6 months, and excluded participants who were critically ill and unable to communicate in order to submit information (Figure 1).


**Figure 1.** Map of the study area.

### *Sample size and sampling procedure*

A single population proportion formula was used to determine the required sample size using the following assumptions: proportion of household-level water treatment practices from the study done in Burie Zuria district[21] which is 44.8%, $Z\alpha/2$ = the standard score for 95% confidence level, and $d$ = margin of error (0.05). Considering a 10% non-response rate, the final sample size was 418.

A systematic random sampling technique was used to reach the total sample size, using the total number of households in the town as a sampling frame. The k interval was calculated using the total number of households in the town, which was 1610 (the data from the town administrative office) divided by the study sample size (N = 418), which was 1610/418 = 4. After the first household was selected using the lottery method, every fourth household was selected to be included in the study.

### *Variables*

**Dependent variable**:-Household-level water treatment practice

**Independent variables**:- Socio-demographic factors (sex, educational status, occupational status, monthly income of household head, family size); Knowledge of HWTs; water source types; Water storage and handling factors (type of storage container, cover material, water drawing, technique) and hygienic factors (hand washing before water collection and cleansing water storage container).

### *Data collection procedures*

Face-to-face interviews were used to collect data, with a structured and pretested questionnaire adapted and modified from similar previous literature.[21-23] The adapted questionnaires were changed and contextualized to fit the local situation and study goals. The questionnaire was divided into 4 sections: socio-demographic and economic characterizes (10 items);

water source, storage, and hygiene (17 items); knowledge of household water treatment (6 items), and Household-level water treatment practices (2 items). The questionnaires were initially prepared in English and translated into Amharic, then back into English to check their original meaning. It was then pretested on 5% of households outside the study area and modified depending on the results before the actual data was collected. Data was collected by 14 public health student data collectors and 1 supervisor.

### *Data quality control*

Data quality was ensured by the proper design and pre-testing of the questionnaire. 2 days of training were given to the data collectors and supervisors on the data collection process. The supervisors supervised the data collection on a daily basis, and they also checked the completeness of the filled questionnaires. Furthermore, the principal investigator and supervisor gave feedback and corrections on a daily basis to the data collectors before they deployed to the field the next day, and the completeness, accuracy, and clarity of the collected data were checked carefully. All of the data was double entered to ensure the validity of the data.

### *Operational definitions*

- **Household water treatment practice**: Households who used at least one of the following common HWT methods: boiling, adding bleach/chlorine, Filtration, solar disinfection, and settling down during past 2 weeks were considered as "practice HWT" while households who were not used any alternative method of the above HWTs were considered as "not practice HWT."[4]
- **Knowledge of respondents**: For the knowledge assessment, each correct response was given a score of 1, while a wrong response was scored as 0. Respondents who scored knowledge questions above the mean were considered to have "good knowledge," and those who scored below the mean were considered to have "poor knowledge."
- **Improved water sources:** include piped water and public tap water.[24]

### *Data process and analysis*

Before being exported to STATA version 16 for data processing and analysis, the collected data were validated and entered into Epi Data version 3.4 (Odense, Denmark, EpiData Association, 2000-2008).[25] Descriptive statistics such as mean, frequency, and standard deviation were computed. Binary logistic regression was done to identify candidate variables for multivariable logistic regression. The independent and dependent variables' crude odds ratios and 95% confidence intervals were calculated, and variables with a *P*-value of .25 in binary logistic regression were considered as candidates for the final model.[26] Multivariable logistic regression analysis was used to control possible confounders and to determine factors associated with household water treatment practice. Model fitness was checked by using the Hosmer-Lemeshow goodness of fit test. At this step, the interaction between different independent variables was checked, and collinearity diagnostic was done by checking the standard error of less than 2. All statistical analysis was set at a 5% level of significance (ie, $P < .05$).

## Results

### *Socio-demographic characteristics*

A total of 418 respondents, with a response rate of 100%, participated. The age of the respondents ranged from 20 to 65 years (mean age, 35.65 years). All respondents were female, with an average family size of 6, and 168 (40%) of the respondents' monthly average income was 1001 to 3000 ETB (Table 1).

### *Water source, storage, and handling practices of respondents*

Among the total study participants, the majority (59.57%) of them were getting water from improved water sources, and 284 (67.94%) had taken less than 30 minutes to fetch water and come back. About half of the total participants had water-storing experience, out of which 167 (79.15%) were stored in a jerry can. From the observation findings, 205 (97.15%) of households covered their water containers, and 79.9% of households used a pouring method to withdraw water from their containers. The majority of respondents clean their water storage vessel within a week, and their water storage vessel is not accessible to children (Table 2).

### *Respondents' knowledge of household-level water treatment*

Among the total study participants, 223 (53.3%) had good knowledge of household-level water treatment (Figure 2).

### *Respondents' household-level water treatment practices*

Household-level water treatment is practiced by 125 (29.9%) with (95% CI 25.3-34.6), with 85 (68%) using chlorination (Wu ha-Agar), 30 (24%) boiling, and 6(4.8%) filtration using cloth, sand and gravel (Table 3).

### *Factors associated with household-level water treatment practices*

In bi-variable analysis, 6 variables (head of household, educational status, average monthly income, source of water, time taken to fetch water, and knowledge) were found to have a *P*-value $< .25$, for which these variables were taken to multivariable logistic regression analysis. In multivariable logistic

**Table 1.** Socio-demographic characteristics of respondents in Bule town, southern Ethiopia (N = 418).

| VARIABLES | CATEGORIES | FREQUENCY | PERCENT (%) |
|---|---|---|---|
| Gender of head household | Male | 269 | 64.35 |
| | Female | 149 | 35.65 |
| Age | 18-30 | 173 | 40.67 |
| | 31-45 | 180 | 43.06 |
| | >45 | 65 | 16.27 |
| | Mean of age (in years) | 35.6 (mean) | |
| Type of respondent | Wife of household | 328 | 78.47 |
| | Other female* | 90 | 21.53 |
| Educational status | No formal education | 138 | 33.01 |
| | Have formal education | 280 | 66.99 |
| Occupation | Farmer | 110 | 26.32 |
| | Government employ | 55 | 13.16 |
| | Merchant | 154 | 36.84 |
| | Daily laborer | 20 | 4.78 |
| | Others | 79 | 18.90 |
| Family size | <5 | 133 | 31.82 |
| | ⩾5 | 285 | 68.18 |
| | Mean of family size | 6.1 (mean) | |
| Monthly income (ETB) | ⩽1000 ETB** | 138 | 33.01 |
| | 1001-3000 ETB | 168 | 40.20 |
| | >3000 ETB | 112 | 26.80 |
| | Median (mean) | 2000 (median) | 2509.12 (mean) |

*Other female: ⩾18 years old females other than the wife of the household; **1 USD = 37.143 ETB during data collection time.

regression analysis, 2 variables (knowledge and monthly income) were significantly associated with household water treatment practice. In this analysis, the odds of having good knowledge about household-level water treatment practice are 6.98 times more likely to practice household water treatment than those with poor knowledge (AOR = 6.98, 95% CI = 4.01-11.90). The results of the multivariable model also show households who have an average monthly income of 3000 ETB are 2-fold more likely to practice household water treatment than those with an average monthly income of less than 1000 ETB (AOR = 2.37, 95% CI = 1.22-4.60) (Table 4).

## Discussion

The findings of this study showed that 29.9% (95% CI: 25.3-34.6) have good household-level water treatment practices. This finding is slightly lower than the Ethiopian Health Transformation Plan's target to increase HWTS use to 35% by 2020.[19] The finding (29.9%) is much lower than studies conducted in India (53%), Zambia (50%), Nigeria (54%), Kenya (69%), and Uganda (76%), respectively.[27-31] The difference might be due to a difference in clean water coverage that may vary as well as the accessibility of information about HWT among the countries. When compared to the studies conducted in Ethiopia, the finding is slightly lower than the previous studies, particularly in Burie, Northwest Ethiopia (44.8%), Gibe (34.3%), and Bahir Dar, Northwest Ethiopia (34%).[21,32,33] Whereas the current finding was slightly greater than a study conducted in Dabat, Northwest Ethiopia, 23.1%; Degadamot, North West Ethiopia (14.2%); and Harar, Eastern Ethiopia (16.5%).[23,34,35] This slight difference might be due to a difference in the time period and sample size and a variation in the level of community awareness of household-level water treatment. The finding of this study shows that among respondents who practice household-level water treatment,

**Table 2.** Respondents' water source, storage, and handling in Bule, southern Ethiopia (N = 418).

| VARIABLES | CATEGORIES | FREQUENCY | PERCENT (%) |
|---|---|---|---|
| Source of water | Improved | 249 | 59.57 |
| | Unimproved | 169 | 40.43 |
| Time taken to fetch the water (min) | <30 min | 284 | 67.94 |
| | ⩾30 min | 134 | 32.06 |
| Water collector | Adult women | 251 | 60.05 |
| | Other | 167 | 39.95 |
| Store water in the house | Yes | 211 | 50.48 |
| | No | 207 | 49.52 |
| Type of water storage vessel | Jerry can | 167 | 79.15 |
| | Bucket | 40 | 18.96 |
| | Clay pot | 1 | 0.4 |
| | Others | 3 | 1.42 |
| Wash water storage vessel before storing water | Yes | 205 | 97.16 |
| | No | 6 | 2.84 |
| Frequency of cleaning water storage vessels | Daily | 76 | 36.71 |
| | Within a week | 120 | 57.97 |
| | Above a week | 15 | 5.31 |
| Cover water storage vessel | Yes | 205 | 97.16 |
| | No | 6 | 2.84 |
| Water storage container protected from children | No | 53 | 25 |
| | Yes | 158 | 75 |
| Method of withdrawing water from water container | Pouring | 334 | 79.9 |
| | Dipping | 84 | 20.1 |
| For dipping, use a handled mug/cup to draw out water from the container | Yes | 61 | 72.62 |
| | No | 23 | 27.38 |

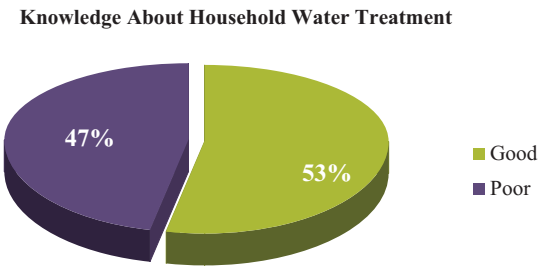


**Figure 2.** Respondents' knowledge of household-level water treatment practices in Bule town, southern Ethiopia (N = 418).

the majority (68%) of them use chlorination water treatment methods using chemicals called "Wuha Agar" in Amharic, which means water guard. The finding is in line with the study conducted in Harar, eastern Ethiopia, which shows 70% use of chlorination.[35] In contrast, the finding is higher than the study conducted in Burie, northwest Ethiopia (19.6%), Bahir Dar, northwest Ethiopia (20%), and northwestern Nigeria (16.6%).[21,33,36] The disparity could be due to the availability of wuha agar in the local market and distribution from the study zonal health office for water treatment purposes and the ease of use of the chlorination method.[31,33] The second dominant household water treatment method is boiling, which accounts for 24% of total households that use household-level water treatment. This is lower than the study conducted in Uganda shows boiling (67%), Burie, Northwest Ethiopia (59.7%). The difference could be due to the variety of access to electricity, fuel, or firewood because the study area has intermittent electricity access, which leads them to use other cost-effective options.

**Table 3.** Respondents' household-level water treatment practices in Bule town, southern Ethiopia (N = 418).

| VARIABLE | CATEGORIES | FREQUENCY | PERCENT (%) |
|---|---|---|---|
| Have you practiced HWT before using for drinking? | Yes | 125 | 29.9 |
| | No | 293 | 70.1 |
| If yes, which Methods do you use? | Boiling | 30 | 24 |
| | Chlorination (wuha agar in Amharic language) | 85 | 68 |
| | Filtration | 6 | 4.8 |
| | Settling down | 4 | |

**Table 4.** Bi-variable and multi-variable logistic regression analysis of factors associated with household-level water treatment practice in Bule town, Southern Ethiopia (N = 418).

| VARIABLE CATEGORIES | WATER TREATMENT PRACTICES | | COR (95% CI) | *P*-VALUE | AOR (95% CI) | *P*-VALUE |
|---|---|---|---|---|---|---|
| | PRACTICE HWT N = 125 | NOT PRACTICE HWT N = 293 | | | | |
| Head of household | | | | | | |
| Female | 39 | 110 | 0.75 (0.48-1.18) | .216 | 1.01 (0.61-1.68) | .965 |
| Male | 86 | 183 | 1 | | 1 | |
| Educational status | | | | | | |
| Have formal education | 95 | 185 | 1.85 (1.15-2.97) | .011 | 1.12 (0.68-2.10) | .525 |
| No formal education | 30 | 108 | 1 | | 1 | |
| Monthly income | | | | | | |
| ⩽1000 ETB | 31 | 107 | 1 | .048 | 1 | .057 |
| 1001-3000 ETB | 55 | 113 | 1.67 (1.00-2.80) | .031 | 1.75 (0.98-3.11) | .011* |
| >3000 ETB | 39 | 73 | 1.84 (1.05-3.22) | | 2.37 (1.22-4.60) | |
| Source of water | | | | | | |
| Improved | 87 | 162 | 1 | .007 | 1 | .365 |
| Unimproved | 38 | 131 | 0.54 (0.34-0.84) | | 0.77 (0.44-1.34) | |
| Time taken to fetch water | | | | | | |
| <30 min | 90 | 194 | 1 | .246 | 1 | .980 |
| ⩾30 min | 35 | 99 | 0.76 (0.48-1.21) | | 1.01 (0.56-1.78) | |
| Knowledge | | | | | | |
| Good | 103 | 120 | 6.75 (4.03-11.31) | .001 | 6.93 (4.01-11.90) | .001* |
| Poor | 22 | 173 | 1 | | 1 | |

Abbreviations: AOR, adjusted odd ratio; CI = confidence interval; COR, odd ratio; ETB = Ethiopian Birr; *= *P*-value < 0.05.

Regarding knowledge of household-level water treatment, one-half of respondents have good knowledge of HWTS. This is supported by the study conducted in Bahir Dar, northwest Ethiopia (75.7%), Harar, eastern Ethiopia (79.3%), and India (60%).[33,35,37] Concerning factors affecting household-level water treatment, respondents with good knowledge are 6.98 times (AOR = 6.98, 95% CI = 4.01-11.9) more likely to practice household water treatment than those who have poor knowledge. This result is supported by study results done in Bahir Dar, Ethiopia; Degadamot, northwest Ethiopia; and Patan, India.[23,33,38] This might be due to those with good knowledge of household water treatment methods and also

the consequences of water contamination being more likely to implement HWT.

Another factor that affects the household water treatment of respondents is the average monthly income. Those who earn more than 3000 ETB per month are two-fold more likely to practice household water treatment than those with an average monthly income of less than 1000 ETB (AOR = 2.37, 95% CI = 1.22-4.60). This study is in line with a study done in Dar es Salaam, Tanzania[39]; Degadamot, northwest Ethiopia[23]; and Bahir Dar, northwest Ethiopia[33] which explained that the more the households earn income, the more they can afford to avail materials needed for treatment. This could be because low-income households in developing countries like Ethiopia strive to fulfill food requirements for their families and may do not focus on treating water at home. The study's limitation was that it could not assess the effect of household-level water treatment practices on water-borne diseases among households implementing HWT and households implementing non-HWT.

## Conclusion

Although there is improved water-storing experience and handling practices in the study area, there is a low level of household water treatment practices in the study area. Monthly income and knowledge about household-level water treatment were factors that influenced household-level water treatment practices in the study area. Based on the findings, health facilities and governmental and non-governmental organizations should strengthen health education on household-level treatment practices to increase community knowledge and availability of necessary supplies, especially for low-income households, which can improve community HWT practices.

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## Author Contributions

DS conceived the study, developed data collection tools, performed the analysis and interpretation of data, and drafted the paper. DS, BGD, HAE, and HEH were involved in the development, approval of the proposal, and revision of drafts of the paper. The final manuscript was read and approved by all authors.

## Ethical Considerations

Ethical approval and clearance were obtained from the institutional review board of Dilla University, College of Health Sciences and Medicine. Permission was also obtained from the concerned bodies of Bule town offices. Verbal informed consent was secured from each participant during the data collection period. Participants' right to refuse participation was kept. All study participants who were found to have poor household-level water treatment had a detailed assessment, and appropriate intervention was offered. The confidentiality of respondents was maintained.

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## Supplemental Material

Supplemental material for this article is available online.

## REFERENCES

1. WHO. *Drinking-Water, Sanitation and Hygiene in the Western Pacific Region: Opportunities and Challenges in the SDG Era*. World Health Organization; 2018.
2. FDRE. *National Drinking Water Quality Monitoring and Surveillance Strategy*. Ministry of Health. 2011. https://www.cmpethiopia.org/content/download/473/2750/file/Final%20Report%20of%20WQMS%20strategy-19%20May%202011.pdf [Accessed 20 March 2022].
3. WHO. *Progress on Household Drinking Water, Sanitation and Hygiene 2000-2020: Five Years Into the SDGs*. World Health Organization; 2021.
4. Central Statistical Agency (CSA) [Ethiopia] and ICF. *Ethiopia Demographic and Health Survey, Addis Ababa. 2016*. CSA and ICF; 2017.
5. UN. *Sustainable Development Goal 6. Synthesis Report on Water and Sanitation*. United Nations; 2018.
6. WHO. *Meeting the MDG Drinking Water and Sanitation Target: A Mid-term Assessment of Progress*. World Health Organization; 2004.
7. WHO. *Combating Waterborne Disease at the Household Level*. World Health Organization; 2007.
8. Cotruvo JA, Sobsey MD. Point-of-use water treatment for home and travel. *Water Health*. 2009;2:103.
9. WHO. *The Global Burden of Disease: 2004 Update*. World Health Organization; 2008.
10. WHO. *Preventing Diarrhoea Through Better Water, Sanitation and Hygiene: Exposures and Impacts in Low-and Middle-Income Countries*. World Health Organization; 2014.
11. WHO. *Household Water Treatment and Safe Storage: Manual for the Participant*. World Health Organization; 2013.
12. UNICEF/WHO. *Assessing the Affordability of Water, Sanitation and Hygiene: Ghana Country Case Study*. UNICEF/WHO; 2021.
13. Rosa G, Clasen T. Estimating the scope of household water treatment in low-and medium-income countries. *Am J Trop Med Hyg*. 2010;82:289-300.
14. Cumming O, Arnold BF, Ban R, et al. The implications of three major new trials for the effect of water, sanitation and hygiene on childhood diarrhea and stunting: a consensus statement. *BMC Med*. 2019;17:173.
15. Fewtrell L, Kaufmann RB, Kay D, Enanoria W, Haller L, Colford JM Jr. Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis. *Lancet Infect Dis*. 2005;5:42-52.
16. Santé mdl. *Weekly Epidemiological Record= Relevé épidémiologique hebdomadaire*. World Health Organization; 2019:561-568.
17. Bain R, Cronk R, Hossain R, et al. Global assessment of exposure to faecal contamination through drinking water based on a systematic review. *Trop Med Int Health*. 2014;19:917-927.
18. African Development Bank and UNICEF. *Water Supply and Sanitation in Nigeria: Turning Finance Into Services for 2015 and Beyond – An AMCOW Country Status Overview*. Water and Sanitation Program (WSP); 2011.
19. FDRE. *Health Sector Transformation Plan, 2016-2020*. Federal Democratic Republic of Ethiopia, Ministry of Health; 2015.
20. Gedeo Zone Finance and Economy Office. *Population Projection Based on 2007 Population Census*. Gedeo Zone Finance and Economy Office; 2020.
21. Belay H, Dagnew Z, Abebe N. Small scale water treatment practice and associated factors at Burie Zuria Woreda rural households, Northwest Ethiopia, 2015: cross sectional study. *BMC Public Health*. 2016;16:887.
22. CSA. *Ethiopia Demographic and Health Survey*. Cenral saiscical Agency; 2016.
23. Tsegaye D, Aniley Y, Negese B, Mengesha Z. Assessment of knowledge and practice of house hold water treatment and associated factors in rural kebeles of degadamot woreda, north-West Ethiopia, 2020. *J Bacteriol Parasitol*. 2021;12:403.
24. CDC. *Global Water, Sanitation, & Hygiene (WASH)*. Centers for Disease Control and Prevention; 2021.

25. StataCorp. *Stata Statistical Software: Release 16*. StataCorp LLC; 2019.
26. Soboksa NE, Hailu AB, Gari SR, Alemu BM. Water supply, sanitation and hygiene interventions and childhood diarrhea in Kersa and Omo Nada districts of Jimma Zone, Ethiopia: a comparative cross-sectional study. *J Health Popul Nutr*. 2019;38:45.
27. Kuberan A, Singh AK, Kasav JB, et al. Water and sanitation hygiene knowledge, attitude, and practices among household members living in rural setting of India. *J Nat Sci Biol Med*. 2015;6:S69-S74.
28. Rosa G, Kelly P, Clasen T. Consistency of use and effectiveness of household water treatment practices among urban and rural populations claiming to treat their drinking water at home: a case study in Zambia. *Am J Trop Med Hyg*. 2016;94:445-55.
29. Raimi M, Vivien OT, Odipe OE, Owobi OE. *The Sources of Water Supply, Sanitation Facilities and Hygiene Practices in Oil Producing Communities in Central Senatorial District of Bayelsa State, Nigeria*. Vol. 7. MOJ Public Health; 2018:337-345.
30. SNV. *Understanding the Effects of Poor Sanitation on Public Health, the Environment and Well-Being Report of a Study Conducted in Homa Bay, Elgeyo Marakwet and Kericho Counties in Kenya*. 2018. http://www.snv.org/assets/explore/download/180008_snv_homa_bay_county_report_lr.pdf. [Accessed 15 February 2022].
31. Saturday A, Makokha GL, Macharia A. Performance of household water treatment methods for microbial removal under household conditions in Kabale district, Uganda. *J Environ Health Sci*. 2016;2: 1-9.
32. Tafesse B, Gobena T, Baraki N, Alemeshet Asefa Y, Adare Mengistu D. Household water treatment practice and associated factors in Gibe district southern Ethiopia: A community based cross-sectional study. *Environ Health Insights*. 2021;15:11786302211060150.
33. Abera B, Mulu W, Yizengaw E, Hailu T, Kibret M. Water safety, sanitation and hygiene related knowledge, attitudes and practices among household residents in peri-urban areas in northwest Ethiopia. *Ethiopian Journal of Health Development*. 2018;32:00-000.
34. Bitew BD, Gete YK, Biks GA, Adafrie TT. Knowledge, attitude, and practice of mothers/caregivers on household water treatment methods in northwest Ethiopia: a community-based cross-sectional study. *Am J Trop Med Hyg*. 2017;97:914-922.
35. Alemeshet Asefa Y, Alemu BM, Baraki N, Mekbib D, Mengistu DA. Bacteriological quality of drinking water from source and point of use and associated factors among households in eastern Ethiopia. *PLoS One*. 2021;16:e0258806.
36. Sridhar MKC, Okareh OT, Mustapha M. Assessment of knowledge, attitudes, and practices on water, sanitation, and hygiene in some selected LGAs in Kaduna State, Northwestern Nigeria. *J Environ Public Health*. 2020;6532512.
37. Reed R, Singh IB, Mani S, Kanjur R. Small-scale solar disinfection systems for household-level water treatment in rural India. XII World Water Congress "Water for Sustainable Development - Towards Innovative Solutions". 2005:64-79.
38. Solanki NV, Amaliyar J. Study on knowledge, attitude and practice about purification of household water among 210 individuals of urban area of Patan District. *Religion*. 2019;45:8.
39. Jenkins MW, Cumming O, Scott B, Cairncross S. Beyond 'improved' towards 'safe and sustainable' urban sanitation: assessing the design, management and functionality of sanitation in poor communities of dar es Salaam, Tanzania. *J Water Sanit Hyg Dev*. 2014;4:131-141.