Prevalence of and factors associated with acute diarrhea among children under five in rural areas in Ethiopia with and without implementation of community-led total sanitation and hygiene

Gezahegn Mernie1, Helmut Kloos2 and Metadel Adane3*

Abstract

Background: Since Ethiopia has been implemented the Community-Led Total Sanitation and Hygiene (CLTSH) approach to control incidence of diarrhea, few studies have compared the prevalence of diarrhea and associated factors in rural areas that have implemented this approach with those that have not implemented it, and none have examined it in the district of Menz Gera Midir in the Amhara Region of Ethiopia. This study addressed this gap.

Method: A community-based comparative cross-sectional study was conducted among 224 children under five in three randomly selected rural kebeles (the smallest administrative units in Ethiopia) where CLTSH had been implemented and 448 similar children in three other randomly selected rural kebeles where CLTSH had not been implemented during February and March, 2020. Data were collected using a structured questionnaire and an on-the-spot observational checklist. Data were analyzed using three different binary logistic regression models with 95% confidence interval (CI): the first model (Model I) was used for CLTSH-implementing kebeles, the second model (Model II) for non-CLTSH-implementing kebeles, and the third model (Model III) for pooled analysis of CLTSH-implementing and non-implementing kebeles. To control confounders, each multivariable logistic regression model was built by retained variables with \( p < 0.25 \) from the bi-variable logistic regression analysis. From the adjusted multivariable analysis of each model, variables with \( p \)-values < 0.05 were declared factors significantly associated with acute diarrhea.

Results: The prevalence of acute diarrhea among children under five from households in kebeles that had implemented CLTSH was 10.6% (95% CI:6.6–14.7%) and among those that had not implemented CLTSH 18.3% (95%CI:14.8–22.2%). In CLTSH-implementing areas, use of only water to wash hands (AOR: 3.28; 95% CI:1.13–9.58) and having a mother/caregiver who did not wash their hands at critical times (AOR: 3.02; 95% CI:1.12–8.12) were factors significantly associated with acute diarrhea. In non-CLTSH-implementing areas, unimproved water source (adjusted odds ratio [AOR]: 2.81; 95% CI:1.65–4.78), unsafe disposal of child feces (AOR: 2.10; 95% CI:1.13–3.89), improper solid waste disposal (AOR: 1.95; 95% CI:1.12–3.38), and untreated drinking water (AOR: 2.33; 95% CI:1.21–4.49) were factors significantly associated with acute diarrhea. From the pooled analysis, not washing hands at critical times (AOR: 2.54; 95%
Introduction
Diarrhea is defined as three or more loose or watery stools in a 24-h period [1]. It may be caused by a number of bacterial, viral, protozoan, or parasitic organisms. In developed and developing countries, rotavirus and Escherichia coli are the most common etiological agents of diarrheal disease. Diarrheal diseases are more common in communities with poor sanitation, poor hygiene practices, a lack of safe water for drinking, improper child feeding practices, and poor housing conditions [2].

Globally, diarrhea kills more children than AIDS, malaria, and measles combined [3]. Annually, 1.9 million children die from diarrheal diseases. About 78% of children who die from diarrhea live in Africa and Southeast Asia [4]. The major contributors to diarrheal disease are poor sanitation, lack of hygiene, and lack of safe drinking water [5].

In Africa's sub-Saharan countries including Ethiopia, where hygiene and sanitation are poor, the incidence of diarrheal diseases is highest. Diarrhea is the leading cause of morbidity and mortality in children under five years of age in Africa. African children experience, on average, five episodes of diarrhea every year, and an estimated 800,000 die from diarrhea and dehydration [6]. About 80% of the rural population and 20% of the urban population of sub-Saharan Africa lack access to safe drinking water and sanitation [7].

In Ethiopia, childhood diarrhoeal disease is most common among 6- to 11-month-old children; the percentage of children under five years old who had diarrhea in a two week period decreased from 24% in 2000 to 18% in 2005 [8], 13% in 2011 [9], and 12% in 2016 [5]. Acute diarrhea is a common problem in Menz Gera Midir District, Amhara Region, Ethiopia. In its 2018/19 annual performance report, the district health office listed diarrhea as the leading cause of under-five morbidity. Out of 12,631 children under five, 2,023 (16.02%) sought treatment for diarrhea at a health institution [10].

One strategy for the prevention of diarrhea in Ethiopia is the implementation of Community-Led Total Sanitation (CLTS), now known as Community-Led Total Sanitation and Hygiene (CLTSH) [11]. The 2011 Ethiopian Hygiene and Sanitation Strategic Action Plan indicated that CLTSH had reached all nine regions of Ethiopia, but had not been implemented in some rural areas [12]. The CLTSH approach is one of the most cost-effective ways to improve water, sanitation, and hygiene, especially in low-income countries and rural settings, where it can mobilize and sensitize communities to discontinue open defecation [11, 13], and serve as an important tool for changing the collective behavior of communities [11].

Since Ethiopia has been using the CLTSH approach to control incidence of diarrhea, few studies have compared the prevalence of diarrhea and associated factors in rural areas that have implemented this approach with those that have not implemented it. Thus, this study compared the prevalence of acute diarrhea and associated factors among rural children under five living in kebeles that had implemented CLTSH with similar children in kebeles that had not implemented CLTSH within Menz Gera Midir District, North Shoa Zone, Amhara Region, Ethiopia.

Method
Study area description and study design
A comparative cross-sectional study was conducted during February and March 2020 in Menz Gera Midir District, one of the 27 districts in North Shoa Zone of Amhara Region, Ethiopia. Children under five years of age in 2020 in the district was 13,422 [10]. The district consists of four urban kebeles (the smallest administrative units in Ethiopia) in Mehal Meda Town and 20 rural kebeles. Mehal Meda Town is the capital of the Menz Gera Midir District, which is located about 284 km north of Addis Ababa. Of the 20 rural kebeles in Menz Gera Midir District, 11 (55%) had implemented a CLTSH program and 9 (45%) did not employ the CLTSH approach in 2018 [10].

Conclusion: The prevalence of acute diarrhea among under-five children in Menz Gera Midir District was lower in kebeles where CLTSH had been implemented than in kebeles where CLTSH had not been implemented. Therefore, we recommend that governmental and non-governmental sectors increase implementation of CLTSH programs, including improving handwashing at critical times, promoting safe disposal of child feces and enhancing the availability of improved water sources.

Keywords: Acute diarrhea, Children under five, Community-Led Total Sanitation and Hygiene, Rural areas, Ethiopia
Source and study population
The source population was all children under five in all rural kebeles in Menz Gera Midir District, whereas the study population was the selected under-five children in three CLTSH implementing and three non-implementing rural kebeles in Menz Gera Midir District. Children with bloody diarrhea or persistent diarrhea were excluded from the study.

Sample size determination and sampling techniques
The sample size was calculated by the double proportion formula with the assumptions that a two-week prevalence of diarrhea among children under five in CLTSH-implementing kebeles was 9.9% [14] and non-implementing kebeles 22.22% [15] taken from studies in Dangla District and Kersa District, respectively; 80% power, ratio between CLTSH-implementing and non-implementing kebeles taken as 1:2, design effect of 1.5 and 10% non-response. The final sample size was 672, of which 224 were in CLTSH-implementing kebeles and 448 in non-implementing kebeles.

A two-stage sampling technique was used to select the study participants. In the first stage, six kebeles (three in CLTSH-implemented and another three in non-implemented kebeles) were selected by simple random sampling using the lottery method. Then, the sampling frame was prepared for each kebele by using the households with at least one child under five years of age. Then, based on the total study population of the selected kebeles, a sample size of 224 households was proportionally allocated to the three selected kebeles where CLTSH had been implemented. Similarly, a sample size of 448 households was proportionally allocated to the three selected kebeles where CLTSH had not been implemented.

In the second stage, a systematic random sampling technique was used to select specific households for inclusion in the study. A lottery method was used based on the respective K-value (5 for implementing and 10 for non-implementing kebeles) to select the first household in each kebele. In households with more than one child under five, one child was chosen using the lottery method to estimate the prevalence of diarrhea in the study population. Households in which the study participants were not present during data collection were revisited the same day. If they were again not available, another visit was made the next day in order to minimize the non-response rate. If not available after the third visit, they were considered as non-respondents.

Acute diarrhea measurement
The outcome variable of this study was acute diarrhea, denoted as yes (1) or no (0), where yes indicated the presence of acute diarrhea and no indicated the absence of acute diarrhea during the two weeks prior to the survey. Diarrhea among children under five in CLTSH-implementing kebeles and non-implementing kebeles was identified by asking the participants’ mothers/caregivers questions based on WHO-defined signs and symptoms of diarrhea [16] that had occurred during the previous two weeks. The WHO protocol [16] does not specify the recall period and the type of diarrhea. Because our study focused on acute diarrhea, we adopted a two-week recall period as specified in the World Gastroenterology Organization’s Global Guidelines for acute diarrhea surveys [17]. We excluded bloody and persistent diarrhea since bloody diarrhea is frequently caused by dysentery and persistent diarrhea lasts more than 14 days [16, 17].

Operational definitions
Definitions of independent variables are available in Table 1.

Data collection and quality assurance
Data were collected using a pre-tested questionnaire and an on-the-spot observation checklist. The questionnaire was developed after a review of the published literature. To ensure the quality and consistency of the data, the questionnaire was prepared

---

Table 1: Operational definitions of some independent variables

| Variables                                      | Operational definitions                                                                 |
|------------------------------------------------|----------------------------------------------------------------------------------------|
| Community-Led Total Sanitation and Hygiene (CLTSH) | An approach to changing sanitation and hygiene behavior rather than making physical changes in the community [18] |
| Caregiver                                      | Any person who provides care for the child other than the mother [19]                  |
| Unimproved water sources                       | Unprotected dug well, unprotected spring, or surface water (river, dam, lake, pond, or stream) from which water was fetched [20] |
| Handwashing at critical times                  | Handwashing with soap after visiting latrine, after cleaning the bottom of a child, before preparing food, before eating, and before feeding a child [21] |
| Proper refuse disposal                         | Disposal of refuse by burning, burying in a pit, storing in a container or at a designated site [21] |
| Safe child feces disposal                      | Disposal of child feces in a latrine                                                  |
in English, translated to Amharic and then back to English. During data collection, the data collector administered the questionnaire orally to the study participants using the Amharic language. The questionnaire and observation checklist consisted of socioeconomic, environmental, and behavioral information. The questionnaire was objective and logically sequenced. Before the actual data collection, the questionnaire was pre-tested on a sample 5% the size of the study sample in one CLTSH-implementing kebele and one non-implementing kebele near the study area to validate the data collection tool. The results of the pre-test were used to ensure clarity of language and verify skip patterns of the questions.

The questionnaire was administered by six nurses and two supervisors who had been trained by the principal investigator for two days on the data collection tools and procedures, including the aim of the study, content of the questionnaire, and how to approach study subjects. Supervisors oversaw interviewers daily during the whole period of data collection and checked questionnaires for completeness and consistency. During administration of the survey, the collected data were checked daily by the principal investigator and supervisors for completeness, and houses providing incomplete data were revisited once to obtain additional data.

Inter-observer reliability was ensured by providing clear definitions of the dependent and independent variables and events to be recorded, by training the data collectors, and by providing feedback about discrepancies during daily supervision, as explained elsewhere [22]. We re-interviewed 5% of the study participants using a different interviewer to check reliability of the information entered by different interviewers.

In order to verify the accuracy of data entries, two generic data verification strategies were employed [23]. As the first step, a randomly selected 10% of the questionnaires were thoroughly checked and then as the second step, the data were exported to the Statistical Package for the Social Sciences (SPSS) version 25.0 for data cleaning. To identify missing values and assess overall distributions, descriptive statistics of frequency distributions were examined. Basic data quality assurance measures were taken according to the study by Keleb et al., including data cleaning using browsing of data tables after sorting, graphical exploration of distributions using box plots, histograms, and scatter plots, frequency distributions and cross tabulations, summary statistics and statistical outlier detection using sorting [24].

Data analysis
During data analysis, for normally distributed continuous variables, mean and standard deviation (SD) (mean±SD) were calculated for continuous variables, whereas descriptive statistics such as frequencies (n) and percentage (%) were calculated for categorical data. Using the outcome variable of presence of acute diarrhea, we estimated the prevalence of acute diarrhea among the participating children for both CLTSH-implementing and non-implementing kebeles.

Data were analyzed using three different binary logistic regression models: the first model (Model 1) was used only for CLTSH-implementing kebeles, the second model (Model II) for non-CLTSH-implementing kebeles, and the third model (Model III) for pooled analysis of CLTSH-implementing and non-implementing kebeles’ data. For each model, bi-variable and multivariable analysis were estimated and variables with $p < 0.25$ in bi-variable logistic regression were retained into multivariable analysis of each model for CLTSH-implementing and non-implementing kebeles.

From the adjusted multivariable logistic regression analysis, variables with $p$-value $< 0.05$ and adjusted odds ratio (AOR) at 95% CI (confidence interval) were declared significantly associated with acute diarrhea. A multicollinearity test was performed to assess the existence of correlation between the independent variables using a cut-point of standard error of 2; it showed that there was no multicollinearity, with a maximum standard error of 1.68. The Hosmer–Lemeshow goodness-of-fit test [25] with $p$-value greater than 0.05 was used for each model, finding the $p$-value of Model 1, Model 2 and Model 3 was 0.885, 0.932 and 0.971, respectively.

Results
Socio-demographic characteristics of study participants
A total of 654 households, 218 (33.3%) in CLTSH-implementing kebeles and 436 (66.7%) in non-implementing kebeles, were interviewed. The response rate was 97.3%. Most of the respondents ($n = 505, 77.2%) were biological mothers and 149 (22.8%) were caregivers. Two-thirds of the respondents ($n = 430, 65.7%) were in the age group 26–40 years, and 574 (87.7%) were married. Most mothers/caregivers ($n = 356, 54.4%) reported having attended primary school. All participants were Orthodox Christians. Children’s ages ranged from 6 to 59 months, with a mean age of 29.4 months with SD±14.9. The family size of two-thirds of the participants ($n = 432, 66.1%) was smaller than five persons (Table 2).

Environmental characteristics
One hundred forty-eight (67.9%) of the households in CLTSH-implementing kebeles and 295 (67.7%) households in non-CLTSH-implementing kebeles used
improved water sources. A latrine was available to 191 participants (87.6%) in CLTSH-implementing and 306 (70.2%) in non-implementing kebeles. Nine (4.1%) of the households in CLTSH-implementing and 23 (5.3%) households in the non-CLTSH-implementing kebeles shared latrines with another household. One hundred twenty-two (56.0%) and 131 (30%) of households in CLTSH-implementing and non-implementing kebeles,

| Variable                                      | Category       | CLTSH status | Implemented | Not implemented |
|-----------------------------------------------|----------------|--------------|-------------|-----------------|
| Relation of respondent to child              | Caregiver      | 37 (17.0)    | 112 (25.7)  |
|                                               | Mother         | 181 (83.0)   | 324 (74.3)  |
| Age of respondent (years)                    | 18–25          | 43 (19.7)    | 68 (15.6)   |
|                                               | 26–40          | 148 (67.9)   | 282 (64.7)  |
|                                               | > 40           | 27 (12.4)    | 86 (19.7)   |
| Sex of respondent                             | Female         | 195 (89.4)   | 367 (84.5)  |
|                                               | Male           | 23 (10.6)    | 69 (15.8)   |
| Marital status of respondent                  | Single         | 12 (5.5)     | 18 (4.1)    |
|                                               | Divorced       | 10 (4.6)     | 27 (6.2)    |
|                                               | Widowed        | 2 (0.9)      | 11 (2.5)    |
|                                               | Married        | 194 (89.0)   | 380 (87.2)  |
| Educational status of mother/caregiver        | Illiterate     | 36 (16.5)    | 71 (16.3)   |
|                                               | Read & write   | 9 (4.1)      | 15 (3.4)    |
|                                               | Primary (1–8)  | 104 (47.7)   | 252 (57.8)  |
|                                               | Secondary or above | 69 (31.7)   | 98 (22.5)   |
| Educational status of father                  | Illiterate     | 21 (9.6)     | 50 (11.5)   |
|                                               | Read & write   | 9 (4.1)      | 6 (1.4)     |
|                                               | Primary (1–8)  | 85 (39.0)    | 181 (41.5)  |
|                                               | Secondary or above | 79 (36.2)   | 143 (32.8)  |
| Occupation of mother/caregiver                | Housewife      | 183 (83.9)   | 376 (86.2)  |
|                                               | Farmer         | 33 (15.1)    | 58 (13.3)   |
|                                               | Merchant       | 2 (0.9)      | 2 (0.5)     |
| Sex of child                                  | Female         | 120 (55.0)   | 214 (49.1)  |
|                                               | Male           | 98 (45.0)    | 222 (50.9)  |
| Family size (persons)                         | > 5            | 71 (32.6)    | 151 (34.6)  |
|                                               | 1–5            | 147 (67.4)   | 285 (65.4)  |
| Age of child (months)                         | < 11           | 23 (10.6)    | 48 (11.0)   |
|                                               | 12–23          | 44 (20.2)    | 92 (21.1)   |
|                                               | 24–35          | 51 (23.4)    | 114 (26.1)  |
|                                               | 36–47          | 50 (22.9)    | 85 (19.5)   |
|                                               | 48–59          | 50 (22.9)    | 97 (22.2)   |
| Number of children under five in household    | Two or more    | 22 (10.1)    | 73 (16.7)   |
|                                               | One            | 196 (89.9)   | 363 (83.3)  |
| Birth order of child                          | First          | 94 (43.1)    | 116 (26.6)  |
|                                               | Second         | 61 (28.0)    | 155 (35.6)  |
|                                               | Third or above | 63 (28.9)    | 165 (37.8)  |
| Monthly household income ($ USD)               | < 15.0         | 169 (77.6)   | 341 (78.2)  |
|                                               | 15.0–22.7      | 28 (12.8)    | 68 (15.6)   |
|                                               | > 22.7         | 21 (9.6)     | 27 (6.2)    |
respectively, had handwashing facilities near the toilet (Table 3).

Child feces were properly disposed of in latrines among 158 (72.5%) households in kebeles that had implemented CLTSH and 172 (39.4%) households in kebeles that had not. One hundred sixty-two (74.3%) households in CLTSH-implementing kebeles and 241 (55.3%) in non-CLTSH-implementing kebeles disposed of their solid waste properly. Seventy-nine (36.2%) households in CLTSH-implementing kebeles and 168 (38.5%) households in non-CLTSH-implementing kebeles disposed of liquid waste improperly (Table 3).

**Behavioral characteristics**

One hundred eighty-two (83.5%) mothers/caregivers in CLTSH-implementing kebeles and 359 (82.3%) in the non-implementing kebeles started supplementary feeding of infants at the age of six months. Two hundred

---

**Table 3** Environmental conditions of study participants in CLTSH-implementing and non-implementing kebeles, Menz Gera Midir District, North Shoa Zone, Amhara Region, Ethiopia, February and March 2020

| Variable                          | Category | CLTSH-implementing kebeles | Non-CLTSH-implementing kebeles |
|-----------------------------------|----------|----------------------------|-------------------------------|
| Source of drinking water          | Unimproved | 70(32.1)                 | 141(32.3)                     |
|                                   | Improved  | 148(67.9)                | 295(67.7)                     |
| Time walking to fetch water (minutes) | > 30    | 148(67.9)                | 337(77.3)                     |
|                                   | ≤ 30      | 70(67.9)                 | 99(22.7)                      |
| Average daily water consumption per person (liters) | < 20    | 172(78.9)                | 354(81.2)                     |
|                                   | ≥ 20      | 46(21.1)                 | 82(18.8)                      |
| Water supply interruption         | Yes       | 10(4.6)                  | 37(8.5)                       |
|                                   | No        | 208(95.4)                | 399(91.5)                     |
| Latrine availability              | No        | 27(12.4)                 | 130(29.8)                     |
|                                   | Yes       | 191(87.6)                | 306(70.2)                     |
| Ownership of latrine              | Shared    | 9(4.1)                   | 23(5.3)                       |
|                                   | Private   | 182(83.4)                | 287(65.8)                     |
| Type of latrine                   | Traditional | 81(37.2)                | 279(64.0)                     |
|                                   | Improved  | 111(50.9)                | 31(7.1)                       |
| Latrine has seat cover            | No        | 99(45.4)                 | 169(38.8)                     |
|                                   | Yes       | 92(42.2)                 | 141(32.3)                     |
| Number of households sharing latrine | > 2 households | 62(28.8)               | 143(32.3)                     |
|                                   | 2 households | 3(1.4)                  | 9(2.1)                        |
| Child feces disposal              | Outside the latrine | 60(27.5)                | 264(60.6)                     |
|                                   | Inside the latrine | 158(72.5)              | 172(39.4)                     |
| Frequency of latrine cleaning     | Never     | 44(22.0)                 | 78(17.9)                      |
|                                   | Sometimes | 86(39.4)                 | 187(42.9)                     |
|                                   | Daily     | 61(27.9)                 | 45(10.3)                      |
| Distance of latrine from kitchen (meters) | ≤ 6    | 48(22.0)                 | 55(12.6)                      |
|                                   | > 6       | 143(65.6)                | 255(58.5)                     |
| Handwashing facility near toilet  | No        | 69(31.7)                 | 179(41.1)                     |
|                                   | Yes       | 122(56.0)                | 131(30.0)                     |
| Refuse disposal                   | Improper  | 56(25.7)                 | 195(44.7)                     |
|                                   | Proper    | 162(74.3)                | 241(55.3)                     |
| Wastewater disposal               | Improper  | 79(36.2)                 | 168(38.5)                     |
|                                   | Proper    | 139(63.8)                | 268(61.5)                     |
| Livestock kept in the house       | Yes       | 53(24.3)                 | 86(19.7)                      |
|                                   | No        | 165(75.7)                | 350(80.3)                     |
seventeen (99.5%) children in the CLTSH-implementing kebeles and 427 (97.9%) in non-implementing kebeles had been vaccinated for rotavirus. More than half of the households in both the CLTSH-implementing (n = 125, 57.3%) and non-implementing (n = 303, 69.5%) kebeles did not treat drinking water at home. Sixty-three (28.9%) and 47 (10.8%) households in the implementing and non-implementing kebeles, respectively, treated drinking water by boiling. One hundred thirteen (51.8%) households in CLTSH-implementing and 242 (55.5%) households in non-implementing kebeles washed their hands at all the critical times, and 98 (45.0%) and 237 (54.4%) households in CLTSH-implementing kebeles and non-implementing kebeles, respectively, used water and soap for handwashing (Table 4).

Prevalence of acute diarrhea
The overall two-week acute diarrhea prevalence in the study was 15.7% (95%, CI: 13.1–18.7). The prevalence of acute diarrhea during the two weeks prior to the survey among children under five living in CLTSH-implementing kebeles was 10.6% (95% CI: 6.6–14.7) and in non-CLTSH-implementing kebeles 18.3% (95%, CI:14.8–22.2).

Factors associated with acute diarrhea in CLTSH-implementing kebeles
In this study, some variables were found in the bi-variable analysis to be significantly associated with acute diarrhea; those with p-values < 0.25 were analyzed in the multivariable analysis to determine the related effects of the independent variables on the occurrence of acute diarrhea (Table 5).

We found that implementing the CLTSH program was a protective factor for acute diarrhea (AOR: 0.24; 95% CI: 0.20–0.6). In the kebeles where CLTSH had been implemented, the odds of developing acute diarrhea among children of mothers/caregivers who did not wash their hands at critical times were 3.02 times (AOR: 3.02; 95% CI: 1.36–3.53) more likely to develop acute diarrhea than children whose mothers/caregivers practiced safe disposal of child feces (Table 6).

In the non-implementing kebeles, children whose mothers/caregivers disposed of solid waste improperly were 2.19 times (AOR: 2.19; 95% CI: 1.36–3.53) more likely to develop acute diarrhea than children whose mothers/caregivers disposed of solid waste properly. The occurrence of acute diarrhea was 2.33 times (AOR: 2.33; 95% CI: 1.21–4.49) higher among children whose households did not treat drinking water compared to children whose households did treat drinking water. In non-implementing kebeles, the odds of developing acute diarrhea were 2.57 times (AOR: 2.57; 95% CI: 1.49–4.42) higher among children whose mothers/caregivers didn't wash their hands at critical times than among those whose mothers/caregivers did wash their hands at critical times (Table 6).

Factors associated with acute diarrhea in non-CLTSH-implementing kebeles
In kebeles where CLTSH had not been implemented, the odds of acute diarrhea were 2.81 times (AOR: 2.81; 95% CI: 1.65–4.78) higher among children of mothers/caregivers who fetched water from an unimproved drinking water source than among those whose mothers/caregivers fetched water from an improved water source. In the non-implementing kebeles, the odds of developing acute diarrhea among under-five children whose mothers/caregivers practiced unsafe disposal of child feces were 2.1 times (AOR: 2.10; 95% CI:1.13–3.89) higher than among those children whose mothers/caregivers practiced safe disposal of child feces (Table 6).
Discussion

We conducted a comparative cross-sectional study in CLTSH-implementing and non-implementing kebeles to investigate the prevalence of diarrhea and associated factors among children under five. We found the prevalence of acute diarrhea among children under five living in
### Table 5  
Bi-variable logistic regression analysis of association of variables with under-five acute diarrhea among CLTSH-implementing, non-implementing kebeles and pooled estimate in Menz Gera Midir District, North Shoa Zone, and Amhara Region, Ethiopia, February and March 2020

| Variable                              | Category         | Model 1: CLTSH‑implementing |           | Model 2: Non‑CLTSH‑implementing |           | Model 3 (Pooled Analysis) |           |
|---------------------------------------|------------------|-----------------------------|-----------|----------------------------------|-----------|---------------------------|-----------|
|                                       |                  | Acute diarrhea              | COR       | P-value                          | Acute diarrhea | COR       | P-value                          | Acute diarrhea | COR       | P-value                          |
|                                       |                  | No                          | Yes       |                                  | No               | Yes       |                                  | No               | Yes       |                                  |
| Relation to child                     | Caregiver        | 31                          | 6         | 1.86(0.68–5.11)                 | 0.220             | 88        | 24                                 | 1.30(0.76–2.22) | 0.330     | 119                                 | 30               | 1.49(0.93–2.38) | 0.091           |
|                                       | Mother           | 164                         | 17 Ref    |                                  | 268               | 56 Ref    |                                  | 432               | 73 Ref    |                                  |
| Mother’s education                    | Illiterate       | 31                          | 5         | 1.69(0.47–5.98)                 | 0.410             | 55        | 16                                 | 1.00(0.48–2.08) | 0.981     | 86                                 | 21               | 1.21(0.64–2.26) | 0.541           |
|                                       | Read and write   | 7                           | 2         | 3.00(0.50–17.80)                | 0.221             | 14        | 1                                  | 0.24(0.03–1.98) | 0.182     | 21                                 | 3                | 0.70(0.19–2.54) | 0.593           |
|                                       | Primary school   | 94                          | 10        | 1.11(0.38–3.22)                 | 0.831             | 211       | 41                                 | 0.67(0.37–1.20) | 0.173     | 305                                 | 51               | 0.83(0.50–1.37) | 0.464           |
|                                       | Secondary or above| 63                          | 6 Ref     |                                  | 76                | 22 Ref    |                                  | 139               | 28 Ref    |                                  |
| Household size (persons)              | > 5              | 61                          | 10        | 1.69(0.70–4.06)                 | 0.243             | 127       | 24                                 | 0.77(0.45–1.30) | 0.336     | 188                                 | 34               | 0.95(0.60–1.48) | 0.828           |
|                                       | 1–5              | 134                         | 13 Ref    |                                  | 229               | 56 Ref    |                                  | 363               | 69 Ref    |                                  |
| Sex of child                          | Female           | 110                         | 10        | 0.59(0.24–1.42)                 | 0.244             | 181       | 33                                 | 0.67(0.41–1.10) | 0.121     | 291                                 | 43               | 0.64(0.41–0.98) | 0.043           |
|                                       | Male             | 85                          | 13 Ref    |                                  | 175               | 47 Ref    |                                  | 260               | 60 Ref    |                                  |
| Age of child (months)                 | 6–11             | 20                          | 3         | 2.35(0.43–12.65)                | 0.325             | 39        | 9                                  | 0.94(0.39–2.8)  | 0.901     | 59                                 | 12               | 1.15(0.53–2.49) | 0.710           |
|                                       | 12–23            | 37                          | 7         | 2.96(0.71–12.25)                | 0.136             | 76        | 16                                 | 0.86(0.41–1.80) | 0.692     | 113                                 | 23               | 1.15(0.61–2.18) | 0.650           |
|                                       | 24–35            | 47                          | 4         | 1.33(0.28–6.28)                 | 0.717             | 93        | 21                                 | 0.92(0.46–1.84) | 0.823     | 140                                 | 25               | 1.01(0.54–1.88) | 0.964           |
|                                       | 36–47            | 44                          | 6         | 2.13(0.50–9.06)                 | 0.308             | 70        | 15                                 | 0.88(0.41–1.86) | 0.738     | 114                                 | 21               | 1.04(0.54–2.00) | 0.891           |
|                                       | 48–59            | 47                          | 3 Ref     |                                  | 78                | 19 Ref    |                                  | 125               | 22 Ref    |                                  |
| Number of under-five children per household | Two or more | 18                          | 4         | 2.07(0.63–6.75)                 | 0.229             | 56        | 17                                 | 1.44(0.78–2.65) | 0.231     | 74                                 | 21               | 1.65(0.96–2.82) | 0.061           |
|                                       | One              | 177                         | 19 Ref    |                                  | 300               | 63 Ref    |                                  | 477               | 82 Ref    |                                  |
| Monthly household income ($) USD      | < 15.0           | 152                         | 17        | 0.47(0.14–1.57)                 | 0.221             | 285       | 56                                 | 0.56(0.22–1.39) | 0.213     | 437                                 | 73               | 0.56(0.27–1.15) | 0.111           |
|                                       | 15.0–22.7        | 26                          | 2         | 0.32(0.05–1.98)                 | 0.224             | 51        | 17                                 | 0.95(0.34–2.64) | 0.924     | 77                                 | 19               | 0.83(0.35–192) | 0.661           |
|                                       | > 22.7           | 17                          | 4         | Ref                               | 20                | 7 Ref     |                                  | 37                | 11 Ref    |                                  |
| Source of drinking water              | Unimproved       | 60                          | 10        | 1.73(0.71–4.16)                 | 0.223             | 96        | 45                                 | 3.48(2.11–5.74) | <0.001    | 156                                 | 55               | 2.90(1.88–4.45) | <0.001          |
|                                       | Improved         | 135                         | 13 Ref    |                                  | 260               | 63 Ref    |                                  | 395               | 48 Ref    |                                  |
| Walking distance to water source (minutes) | > 30     | 128                         | 20        | 3.49(0.01–12.16)                | 0.054             | 279       | 58                                 | 0.72(0.41–1.26) | 0.251     | 407                                 | 78               | 1.10(0.67–1.80) | 0.690           |
|                                       | ≤ 30             | 67                          | 3 Ref     |                                  | 77                | 22 Ref    |                                  | 144               | 25 Ref    |                                  |
| Latrine availability                  | No               | 26                          | 1         | 0.29(0.03–2.28)                 | 0.245             | 97        | 33                                 | 1.87(1.13–3.09) | 0.011     | 123                                 | 34               | 1.71(1.08–2.70) | 0.028           |
|                                       | Yes              | 169                         | 22 Ref    |                                  | 259               | 47 Ref    |                                  | 428               | 69 Ref    |                                  |
| Average daily water consumption per person (liters) | <20   | 153                         | 19        | 1.30(0.42–4.04)                 | 0.641             | 293       | 61                                 | 0.69(0.38–1.23) | 0.212     | 446                                 | 80               | 0.81(0.49–1.36) | 0.045           |
|                                       | ≥ 20             | 42                          | 4 Ref     |                                  | 63                | 19 Ref    |                                  | 105               | 23 Ref    |                                  |
| Child feces disposal                  | Outside latrine  | 50                          | 10        | 2.23(0.92–5.40)                 | 0.072             | 202       | 62                                 | 2.62(1.49–4.62) | <0.001    | 252                                 | 72               | 2.75(1.75–4.33) | <0.001          |
|                                       | Inside latrine   | 145                         | 13 Ref    |                                  | 154               | 18 Ref    |                                  | 299               | 31 Ref    |                                  |
Table 5 (continued)

| Variable                          | Category   | Model 1: CLTH-implementing | Model 2: Non-CLTHS-implementing | Model 3 (Pooled Analysis) |
|----------------------------------|------------|----------------------------|---------------------------------|---------------------------|
|                                  |            | Acute diarrhea  | COR                    | Acute diarrhea  | COR                    | Acute diarrhea  | COR                    |                 |
|                                  |            | No          | Yes                  | P-value        | No          | Yes                  | P-value        | No          | Yes                  | P-value        |
| Solid waste disposal             | Improper   | 46          | 10                   | 2.49(1.02–6.05) | 0.043       | 144        | 51                    | 2.58(1.56–4.28) | 0.001       | 190        | 61                    | 2.76(1.79–4.24) | 0.001       |
|                                  | Proper     | 149         | 13                   | Ref            | 212         | 29                    | Ref            | 361         | 42                    | Ref            |
| Liquid waste disposal            | Improper   | 68          | 11                   | 1.71(0.71–4.08) | 0.227       | 120        | 40                    | 1.78(1.09–2.90) | 0.021       | 196        | 51                    | 1.77(1.16–2.71) | 0.008       |
|                                  | Proper     | 127         | 12                   | Ref            | 228         | 40                    | Ref            | 355         | 52                    | Ref            |
| Livestock kept in house          | Yes        | 45          | 8                    | 1.77(0.70–4.46) | 0.225       | 71         | 15                    | 0.92(0.49–1.72) | 0.801       | 116        | 23                    | 1.07(0.64–1.79) | 0.770       |
|                                  | No         | 150         | 15                   | Ref            | 285         | 65                    | Ref            | 435         | 80                    | Ref            |
| Currently breastfeeding          | No         | 79          | 6                    | 0.51(0.19–1.37) | 0.184       | 132        | 24                    | 0.72(0.43–1.22) | 0.231       | 211        | 30                    | 0.66(0.41–1.04) | 0.071       |
|                                  | Yes        | 116         | 17                   | Ref            | 224         | 56                    | Ref            | 340         | 73                    | Ref            |
| Home water treatment             | No         | 107         | 18                   | 2.96(1.05–8.29) | 0.038       | 237        | 66                    | 2.36(1.27–4.38) | 0.001       | 344        | 84                    | 2.66(1.57–4.50) | <0.001      |
|                                  | Yes        | 88          | 5                    | Ref            | 119         | 14                    | Ref            | 207         | 19                    | Ref            |
| Water drawing method             | Pouring    | 96          | 13                   | Ref            | 163         | 31                    | Ref            | 259         | 44                    | Ref            |
|                                  | Dipping    | 61          | 7                    | 0.84(0.32–2.24) | 0.588       | 189        | 46                    | 1.28(0.77–2.11) | 0.330       | 250        | 53                    | 1.24(0.80–1.93) | 0.310       |
|                                  | Both       | 38          | 3                    | 0.58(0.15–2.16) | 0.083       | 4          | 3                     | 3.94(0.84–18.49)| 0.081       | 42         | 6                     | 0.84(0.33–2.09)| 0.71        |
| Handwashing at critical times per day | 1–2         | 89          | 16                   | 2.72(1.07–6.91) | 0.034       | 142        | 52                    | 2.79(1.68–4.64) | <0.001      | 231        | 68                    | 2.69(1.73–4.18) | <0.001      |
|                                  | 3–5        | 106         | 7                    | Ref            | 214         | 28                    | Ref            | 320         | 35                    | Ref            |
| Handwashing material             | Water only  | 102         | 18                   | 3.28(1.17–9.19) | 0.025       | 157        | 42                    | 1.40(0.86–2.27) | 0.174       | 259        | 60                    | 1.57(1.02–2.40) | 0.031       |
|                                  | Water and soap/ash | 93 | 5 | Ref | 199 | 38 | Ref | 292 | 43 | Ref |
| Feces seen in compound           | Yes        | 28          | 6                    | 2.10(0.76–5.79) | 0.151       | 133        | 36                    | 1.37(0.84–2.23) | 0.201       | 161        | 42                    | 1.66(1.08–2.57) | 0.029       |
|                                  | No         | 167         | 17                   | Ref            | 223         | 44                    | Ref            | 390         | 61                    | Ref            |
| CLTSH status of kebele           | Implemented| 195         | 23                   | 0.32(0.23–0.86) | <0.001      | 195        | 23                    | 0.32(0.23–0.86) | <0.001      | 356        | 80                    | Ref            |

Ref, reference category
Table 6 Multivariable regression analysis of association of variables with under-five acute diarrhea among CLTSH-implementing, non-implementing kebeles and pooled estimate in Menz Gera Midir District, North Shoa Zone Amhara Region, Ethiopia, February and March 2020

| Variable                          | Category              | Model 1: CLTSH-implemented | Model 2: Non-CLTHS-implemented | Model 3 (Pooled analysis) |
|----------------------------------|-----------------------|-----------------------------|-------------------------------|--------------------------|
|                                  |                       | Acute diarrhea | AOR (95% CI) | P-value | Acute diarrhea | AOR (95% CI) | P-value | Acute diarrhea | AOR (95% CI) | P-value |
|                                  |                       | No | Yes | AOR | P-value | No | Yes | AOR | P-value | No | Yes | AOR | P-value |
| Relation to child                | Caregiver             | 31 | 6  | 2.28 (0.64–8.09) | 0.200 | 88 | 24 | 1.47 (0.81–2.68) | 0.200 | 119 | 30 | 142 (0.84–2.41) | 0.180 |
|                                 | Mother                | 164 | 17 | Ref |          | 268 | 56 | Ref |          | 432 | 73 | Ref |          |
| Mother's education               | Illiterate            | 31 | 5  | 1.65 (0.30–9.00) | 0.560 | 55 | 16 | 0.87 (0.38–1.98) | 0.740 | 86 | 21 | - |          |
|                                 | Read & write          | 7  | 2  | 2.29 (0.21–24.01) | 0.480 | 14 | 1  | 0.22 (0.02–1.94) | 0.170 | 21 | 3  | - |          |
|                                 | Primary school        | 94 | 10 | 0.83 (0.22–3.09) | 0.790 | 211 | 41 | 0.60 (0.31–1.15) | 0.130 | 305 | 51 | - |          |
|                                 | Secondary or above    | 63 | 6  | Ref |          | 76 | 22 | Ref |          | 139 | 28 | - |          |
| Household size (persons)         | > 5                   | 61 | 10 | 1.78 (0.69–4.63) | 0.230 | 127 | 24 | 0.51 (0.27–0.94) | 0.140 | 188 | 34 | - |          |
|                                 | 1–5                   | 134 | 13 | Ref |          | 229 | 56 | Ref |          | 363 | 69 | - |          |
| Sex of child                     | Female                | 110 | 10 | 1.12 (0.33–3.75) | 0.850 | 181 | 33 | 0.67 (0.39–1.14) | 0.140 | 291 | 43 | 0.64 (0.40–1.01) | 0.060 |
|                                 | Male                  | 85  | 13 | Ref |          | 175 | 47 | Ref |          | 260 | 60 | Ref |          |
| Age of child (months)            | 6–11                  | 20  | 3  | 5.32 (0.69–40.93) | 0.100 | 39  | 9  | - |          | 59  | 12 | - |          |
|                                 | 12–23                 | 37  | 7  | 2.38 (0.44–12.87) | 0.310 | 76  | 16 | - |          | 113 | 23 | - |          |
|                                 | 24–35                 | 47  | 4  | 1.31 (0.22–7.60) | 0.750 | 93  | 21 | - |          | 140 | 25 | - |          |
|                                 | 36–47                 | 44  | 6  | 4.84 (0.85–27.46) | 0.070 | 70  | 15 | - |          | 114 | 21 | - |          |
|                                 | 48–59                 | 47  | 3  | 78  | 19 | - |          | 125 | 22 |          |          |          |          |
| Number of under-five children per household | Two or more | 18  | 4  | 2.23 (0.44–11.22) | 0.320 | 56  | 17 | 1.65 (0.83–3.24) | 0.140 | 74  | 21 | 1.69 (0.93–3.08) | 0.080 |
|                                 | One                   | 177 | 19 | Ref |          | 300 | 63 | Ref |          | 477 | 82 | Ref |          |
| Monthly household income ($) USD | < 15                  | 152 | 17 | 0.39 (0.09–1.74) | 0.220 | 285 | 56 | 0.53 (0.18–1.52) | 0.230 | 437 | 73 | 0.46 (0.20–1.04) | 0.060 |
|                                 | 15–22.7               | 26  | 2  | 0.21 (0.02–192) | 0.160 | 51  | 17 | 0.95 (0.29–3.09) | 0.930 | 77  | 19 | 0.60 (0.23–1.56) | 0.300 |
|                                 | > 22.7                | 17  | 4  | 1 | 20  | 7  | 1 |          | 37  | 11 | 1 |          |
| Source of drinking water         | Unimproved            | 60  | 10 | 1.98 (0.75–5.22) | 0.166 | 96  | 45 | 2.81 (1.65–4.78) | <0.001 | 156 | 55 | 2.56 (1.62–4.05) | <0.001 |
|                                 | Improved              | 135 | 13 | Ref |          | 260 | 35 | Ref |          | 395 | 48 | Ref |          |
| Walking distance to water source (minutes) | > 30 | 128  | 20 | 3.31 (0.91–12.07) | 0.060 | 279 | 58 | - |          | 407 | 78 | - |          |
|                                 | ≤ 30                  | 67  | 3  | Ref |          | 77  | 22 | - |          | 144 | 25 | - |          |
| Latrine availability             | No                    | 26  | 1  | 0.26 (0.03–2.28) | 0.220 | 97  | 33 | 1.66 (0.96–2.89) | 0.069 | 123 | 34 | 1.71 (0.43–1.20) | 0.200 |
|                                 | Yes                   | 169 | 22 | Ref |          | 259 | 47 | Ref |          | 428 | 69 | Ref |          |
| Average daily water consumption per person (liters) | < 20 | 153 | 19 | - |          | 293 | 61 | 0.84 (0.43–1.63) | 0.610 | 446 | 80 | - |          |
|                                 | ≥ 20                  | 42  | 4  | - |          | 63  | 19 | 1 |          | 105 | 23 | - |          |
| Child feces disposal             | Outside latrine       | 50  | 10 | 1.85 (0.64–5.27) | 0.240 | 202 | 62 | 2.10 (1.13–3.89) | 0.010 | 252 | 72 | 2.20 (1.34–3.60) | <0.001 |
|                                 | Inside latrine        | 145 | 13 | Ref |          | 154 | 18 | Ref |          | 299 | 31 | Ref |          |
| Variable                        | Category  | Model 1: CLTSH-implemented | Model 2: Non-CLTHS-implemented | Model 3 (Pooled analysis) |
|--------------------------------|-----------|----------------------------|--------------------------------|--------------------------|
|                                |           | Acute diarrhea              |                                |                          |
|                                |           | AOR                        | P-value                        | AOR                      | P-value                  | AOR                      | P-value                  |
|                                |           | No | Yes | AOR (95% CI) | P-value | No | Yes | AOR (95% CI) | P-value | No | Yes | AOR (95% CI) | P-value |
| Solid waste disposal           | Improper  | 46 | 10  | 2.35 (0.91–6.04) | 0.070 | 144 | 51  | 1.95 (1.12–3.38) | 0.010 | 190 | 61  | 2.19 (1.36–3.53) | < 0.001|
|                                | Proper    | 149| 13  | Ref           |        | 212| 29  | Ref           |        | 361| 42  | Ref           |        |
| Liquid waste disposal          | Improper  | 68 | 11  | 0.95 (0.30–3.05) | 0.940 | 120 | 40  | 1.13 (0.60–2.12) | 0.690 | 196| 51  | 1.06 (0.64–1.76) | 0.810|
|                                | Proper    | 127| 12  | Ref           |        | 228| 40  | Ref           |        | 355| 52  | Ref           |        |
| Livestock kept in house        | Yes       | 45 | 8   | 1.61 (0.52–4.96) | 0.400 | 71 | 15  | -              |        | 116| 23  | -              |        |
|                                | No        | 150| 15  | Ref           |        | 285| 65  | -              |        | 435| 80  | -              |        |
| Currently breastfeeding        | No        | 79 | 6   | 0.87 (0.16–4.70) | 0.870 | 132| 24  | 0.78 (0.43–1.42) | 0.420 | 211| 30  | 0.68 (0.41–1.14) | 0.14  |
|                                | Yes       | 116| 17  | Ref           |        | 224| 56  | Ref           |        | 340| 73  | Ref           |        |
| Home water treatment           | No        | 107| 18  | 2.77 (0.94–8.13) | 0.060 | 237| 66  | 2.33 (1.21–4.49) | 0.010 | 344| 84  | 2.53 (1.45–4.40) | 0.001|
|                                | Yes       | 88 | 5   | Ref           |        | 119| 14  | Ref           |        | 207| 19  | Ref           |        |
| Water drawing method           | Pouring   | 96 | 13  | -             |        | 163| 31  | Ref           | 0.540 | 259| 44  | -              |        |
|                                | Dipping   | 61 | 7   | -             |        | 189| 46  | 1.19 (0.67–2.10) | 0.750 | 250| 53  | -              |        |
|                                | Both      | 38 | 3   | -             |        | 4  | 3   | 4.29 (0.75–24.40) | 42  | 6  | Ref           |        |
| Hand washing material          | 1–2       | 89 | 16  | 3.02 (1.12–8.12) | 0.020 | 142| 52  | 2.57 (1.49–4.42) | 0.001 | 231| 68  | 2.54 (1.59–4.06) | < 0.001|
|                                | 3–5       | 106| 7   | Ref           |        | 214| 28  | Ref           |        | 320| 35  | Ref           |        |
| Feces seen in compound         | Yes       | 28 | 6   | 2.35 (0.75–7.33) | 0.140 | 133| 36  | 0.86 (0.48–1.56) | 0.630 | 161| 42  | 0.95 (0.56–1.60) | 0.086|
|                                | No        | 167| 17  | Ref           |        | 223| 44  | Ref           |        | 390| 61  | Ref           |        |
| CLTSH status of kebele         | Implemented|  |     | Ref           |        |     |       | Ref           |        |     |     |     |        |
|                                | Non-implemented|  |     | Ref           |        |     |       | Ref           |        |     |     |     |        |

Ref, reference category
CLTSH-implementing kebeles to be 10.6% (95% CI: 6.6–14.7) and among those that had not implemented CLTSH 18.3% (95% CI: 14.8–22.2).

The prevalence of acute diarrhea among CLTSH-implementing areas in Menz Gera Midir District similar to reports from Kenya (11.1%) [26] and rural Dangla District, Ethiopia (9.9%) [14]. However, this rate is lower than rates reported from rural Mali (22.0%) [27], Kersa District in Ethiopia (18.9%) [15], and Yaya Gulele District in Ethiopia (13.4%) [28]. The lower rate in our study might be due to effective monitoring, follow-up, and prohibition and declaration of open defecation-free kebeles after the CLTSH intervention.

In CLTSH-implementing kebeles, children whose households used only water for washing hands were 3.0 times more likely to develop acute diarrhea than children whose households used water and soap or other detergents for washing hands. This result is supported by other Ethiopian studies [21, 29]. Similarly, in this group the occurrence of acute diarrhea was higher among children whose mothers/caregivers did not wash their hands at critical times than among children whose mothers/caregivers washed their hands at critical times. This result agrees with studies in other Ethiopian communities [21, 30–34]. This pattern might be due to inadequate hand hygiene promotion in both CLTSH-implementing and non-implementing kebeles.

The prevalence of two-week acute diarrhea morbidity among children under five living in non-CLTSH-implementing kebeles in our study was 18.3% (95% CI: 14.8–22.2). This is lower than found in studies in Kenya (21.6%), Mali (24%), Yaya Gulele in Ethiopia (36.3%), and Kersa, Ethiopia (22.2%), areas that also lack implementation of CLTSH [15, 27, 28, 35]. These variations in prevalence might be due to differences in the performance and implementation of CLTSH packages across countries.

This study shows the prevalence of acute diarrhea in households in non-CLTSH-implementing kebeles to be significantly higher than in households in CLTSH-implementing kebeles. The higher rate might be due to effective implementation of the CLTSH strategy, a higher level of awareness about WASH and committed administrators in implementing kebeles, variations in coverage and utilization of the health extension package, and effective social mobilization programs in Gera Midir District.

Improperly disposed child feces are accessed by flies that then contaminate food and water by pathogenic organisms. In this study, unsafe child feces disposal was independently associated with diarrhea. Children whose households did not dispose of child feces safely in latrines were 2.0 times more likely to develop diarrhea than children whose parents properly disposed feces. In rural Bangladesh and Benishangul Gumuz Region in Ethiopia, unsafe disposal of children’s feces was significantly associated with the occurrence of diarrhea [28, 36, 37]. Reasons for these variations may be differences in educational level of the communities and inadequate follow-up and monitoring activities.

The finding that unimproved drinking water sources were significantly associated with acute diarrhea disease in non-CLTSH-implementing kebeles corroborates results of other studies [31, 32]. In this study, the occurrence of acute diarrhea was 2.81 times higher among households using water from unimproved sources compared to households using improved water sources. This might be due to the kebeles’ accessibility to water sources and unaffordability of installing improved drinking water supplies.

The overall prevalence of acute diarrhea in Menz Gera Midir District (pooled analysis) was 15.7 (95% CI: 13.1–18.7), which is much higher than reported by studies in slums of Addis Ababa (11.9%) [38] and in Dale District in southern Ethiopia (13.6%) [39]. However, the prevalence of under-five acute diarrhea in this study was lower than in cross-sectional studies in other parts of Ethiopia, including Arba Minch District (30.5%) [40], North Gondar Zone (22.1%) [41], Dejen District (23.8%) [42], and Hadaleala District (26.1%) [43]. But our results are similar with to other Ethiopian community-based cross-sectional studies in Bahr Dar City (14.5%) [30], Kamashi District (14.5%) [44], and Debre Berhan Town (16.4%) [45]. These differences might be due to variations in the age and sex distribution of samples, geographical location, and socioeconomic status of the population.

From the pooled analysis, use of unimproved drinking water sources was 2.5 times more likely to be associated with acute diarrhea than use of improved sources. This result agrees with some studies in Ethiopia [6, 29, 42]. The possible explanation for these finding might be lack of improved water source availability, poor performance of home-based water treatment, and low latrine coverage.

Children whose mothers or caregivers practiced unsafe child feces disposal were 2.0 times more vulnerable to acute diarrhea than children whose mothers or caregivers safely disposed of child feces in latrines. This result corroborates studies in Ethiopia and rural Bangladesh [34, 37, 42, 46]. This pattern may be due to pathogens in feces being disposed outside of latrines and children coming in contact with feces during playing. Similarly, the risk of diarrhea was 2.16 times greater in households that did not dispose of solid waste properly compared to households that did. This finding agrees with studies conducted in Dale District, southern Ethiopia [47]. This might be due to improper solid waste disposal, which exacerbates breeding of insect vectors of diarrheal pathogens.
The odds of developing acute diarrhea were 2.5 times higher among children whose mothers/caregivers did not wash their hands at critical times than among children whose mothers/caregivers practiced hand washing at critical times. This result agrees with studies in Arba Minch District [40], and Kamashi District in western Ethiopia [44] and might be due to the fact that human hands are primary vehicles for transmitting diarrheal infections. Children in households that did not treat their drinking water were 2.56 times more likely to develop acute diarrhea than children in households that used a water treatment method, a finding similar to those of other studies in Ethiopia [46, 48, 49].

Limitations of the study
The limitations of this study included the fact that it was not a randomized controlled trial, the unknown content and quality of CLTSH implementation, the self-reporting, not observing of many of the behavioral factors, the diarrhea being self-reported, that the study did not investigate the impact of seasonal variation on the occurrence of acute diarrhea, shortening the multiple comparisons with other studies and recall bias of the study participant.

Conclusion
Our findings show that the prevalence of acute diarrhea in CLTSH-implementing kebeles was lower than in non-CLTSH-implementing kebeles in Menz Gera Midir District. We also found that implementing the CLTSH program was a protective factor for acute diarrhea. In non-CLTSH-implementing kebeles, unimproved water sources, unsafe disposal of child feces outside of latrines, improper solid waste disposal, untreated drinking water, and failure to wash hands at critical times were important factors in the occurrence of diarrhea. These findings suggest that CLTSH implementation can have a positive impact on acute diarrhea prevention. Therefore, strengthening CLTSH programs and expanding them to other areas are highly recommended.

Abbreviations
AOR: Adjusted odds ratio; COR: Crude odds ratio; CLTSH: Community-Led Total Sanitation and Hygiene; WASH: Water, Sanitation, and Hygiene.

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s12887-022-03202-8.

Additional file 1.

Acknowledgements
We acknowledge Wollo University for providing the ethical clearance letter. We also acknowledge Health Bureau of North Shoa Zone and Menz Gera Midir District for their permission to conduct the study in Menz Gera Midir District. We thank Menz Gera Midir District Administration for cooperation and provision of valuable information. Data collectors, supervisors, and study participants are also highly acknowledged for their cooperation during data collection.

Authors’ contributions
GM, MA: contributed to the conception and design of the study; GM, MA: conducted the interviews; GM, MA: performed data management and analysis; MA, HK: wrote and edited the manuscript; GM, MA: Contributed equally to this study. All authors critically revised the draft manuscript and approved the final manuscript.

Funding
This study was funded by Amhara Regional Health Bureau, Ethiopia. The funders had no role in study design, data collection and analysis, decision to publish, interpretation of the data or in the preparation of the manuscript for publication.

Availability of data and materials
Data and all the materials will be available from the corresponding author upon request.

Declarations
Ethics approval and consent to participate
Ethical clearance was initially obtained from the Ethical Review Committee of the College of Medicine and Health Sciences, Wollo University. An official letter in support of the study was also obtained from Wollo University, which in turn helped us to obtain written permission from the Health Bureau of North Shoa Zone and each selected kebele in from the Menz Gera Midir District. Written informed consent was obtained from each mother/caregiver of the study participant children. Assent was also obtained from the mothers/caregivers on behalf of their participating children. The study participants were informed that they had the right to decline to participate and to withdraw from the study at any time for any reason. Study subjects found to have diarrhea were given oral rehydration salts (ORS) and referred to the nearest health center for further treatment if needed. Confidentiality and privacy of all participants was ensured. All study methods were performed in accordance with the ethical principles of the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
1 Menz Gera Midir District Health Office, Environmental Health and Hygiene Unit, North Shoa Zone, Amhara Region, Ethiopia. 2 Department of Epidemiology and Biostatistics, University of California, San Francisco, USA. 3 Department of Environmental Health, College of Medicine and Health Sciences, Wollo University, Dessie, Ethiopia.

Received: 20 April 2021 Accepted: 8 March 2022
Published online: 21 March 2022

References
1. WHO. The treatment of diarrhoea: A manual for physicians and other senior health workers. 4th revision. Geneva: World Health Organization; 2005.
2. WHO, UNICEF. Core questions on drinking water and sanitation for household surveys, JMP publication of the World Health Organizations and United Nations Children Fund. Geneva Switzerland: WHO; 2006.
3. UNICEF WHO. Diarrhoea: Why Children are still dying and what can be done. WHO and UNICEF. Geneva: World Health Organization; 2009.
4. Michael F, Salam M, Lindberg G, Khalif I, E S-L. Acute diarrhoea in adults and children. A global perspective. World Gastroenterology Organisation (WGO), and Global Guidelines and Cascades. 2013:47.
District, Sidama zone, Southern Ethiopia: A cross-sectional study. BMC Public Health. 2019;19:1235.

48. Beyene S, Meliku A. Prevalence of diarrhea and associated factors among under five years children in Harena Buluk Woreda Oromia Region, South East Ethiopia. J Public Heal Int. 2018;1(2):5

49. Tambe AB, Nzefa LD, Nicoline NA. Childhood diarrhea determinants in sub-Saharan Africa: A cross sectional study of Tiko-Cameroon. Challenges. 2015;6(2):229–43.

**Publisher’s Note**

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.