The impact of Ethiopian community-based health extension program on diarrheal diseases among under-five children and factors associated with diarrheal diseases in the rural community of Kalu district, Northeast Ethiopia: a cross-sectional study

Ahmed Tadesse, Fasil Walelign Fentaye, Asnakew Molla Mekonen* and Toyeb Yasine

Abstract

Background: The health extension program is a community-based health care delivery program with eighteen defined packages. The main aim of the health extension program is to help to reduce child mortality. So, the aim of this study is to assess the impact of a health extension program on diarrheal disease under-five children in the rural community of Kalu district, Northeast Ethiopia, 2021.

Methods: A community-based cross-sectional study design was conducted from March to April/2021. A Multi-stage sampling technique was used to get a total sample size of 556 (182 model households and 374 non-model households) with a response rate of 92.22%. Binary logistic regression analysis was done, and P-value < 0.05 was considered statistically significant. Propensity score matching analysis was used to determine the contribution of health extension program “model households” on diarrhea diseases among under-five children. The average treatment effect on the treated was calculated to compare the means of outcomes across model and non-model households.

Results: Health extension program (HEP) model household contributed a 17.7% (t = -5.02) decrease in children's diarrheal diseases among under-five children compared with HEP non-model households. Mothers from non-model households were 2.19 times more likely to develop under-five children diarrheal diseases AOR (Adjusted Odds Ratio): 2.19, 95% CI: 1.34–3.57 than mothers from model households. Households who got no frequent home visits were 3.28 times more likely to develop under-five diarrheal diseases AOR (Adjusted Odds Ratio): 3.28, 95% CI: 1.40–7.68.

Conclusion: When the health extension program is implemented fully (model household), the prevalence of under-five diarrheal disease in the rural community could decrease. The need to develop supportive strategies for the sustainability of model households and encouraging households to be model households is very important.

Keywords: Health extension program, Impact, Diarrheal disease, Rural community, Kalu district, Ethiopia

Background

The Alma-Ata Declaration of 1978 recognized primary health care (PHC) as the most approach to the attainment of the objective of “Health for All”. The PHC
approaches the most health issues in the community through the arrangement of basic health services. The execution of the PHC approach depends on healthcare workers including health extension workers (HEW) [1, 2]. Endeavors by the government to grow the PHC framework and stress preventive, promotional, and basic curative health services brought in encouraging changes in health coverage and utilization [3–5].

The health extension program is a community-based health care delivery program with eighteen defined packages [6]. The program was officially rolled out by the Ethiopian Federal Ministry of Health in 2003 and became implemented after the graduation of 7,136 health extension workers-trained to work mainly in disease prevention and health promotion in rural villages [7]. The program has four health subprograms; disease prevention, family Health; environmental hygiene and sanitation; and health education. The health extension program helps to reduce child mortality and maternal mortality and mortality and food and water hygiene, health housing management, solid and liquid waste management, personal hygiene, child health and immunization are the packages that influence under-five diarrheal diseases (see S1.table) [8, 9].

Diarrheal infection is transmitted through contaminated food or drinking water or from person-person as a result of poor hygiene. Globally, 9% of under-five deaths are due to diarrhea and the burden of diarrhea disease remains high [10]. Some ways to reduce the risk of diarrhea are safe drinking water, the use of improved sanitation and hand washing with soap [11].

About 7.2 million children died under the age of 5 years globally and of them 1.3 million children died due to preventable diarrhea and was the second leading cause in 2012 [9]. The majority of these deaths occur in India, Nigeria, Afghanistan, Pakistan, and Ethiopia [12]. Studies have suggested that diarrhea was even more likely in children with HIV, and the leading cause of death among HIV-infected infants. Persistent diarrhea adds to mortality by causing malnutrition and wasting that weaken the children's immunity [10, 13].

Even if improvement were made in reducing childhood mortality from 88 under-five deaths per 1,000 live births in 2011 [14] to 67 under-five deaths per 1,000 live births in 2016 in Ethiopia, children in the country still suffer from diarrhea [15]. In Ethiopia, about 90% of diarrhea disease occurs due to poor sanitation, lack of access to clean water supply, and inadequate personal hygiene which can be easily improved by health promotion and education [16]. Health promotion and education is an important aspect of primary health care [17].

The studies done in different areas of the globe showed that risk factors related to childhood diarrhea diseases were the child's sex, child's age, husband's education level, mother's work status, mother's marital status, breastfeeding status, and socio-economic status of the household [18–23]. But a study in Iran showed that the sex of a child is not associated with under-five diarrheal diseases [24]. Additional studies conducted in three South Asian countries, and Bolivia showed that a higher level of formal educational status of the caregiver or mother was protective against childhood diarrhea disease [21, 23, 25, 26]. Other studies were done in Latin American countries, India, Indonesia, Iran, and Tanzania, and they showed that the age of the mother or caregiver, the age of children, and the age of children had a significant effect on childhood diarrheal disease [19–22, 24, 26]. Studies conducted in Ethiopia and West African countries showed that the low level of husband education, private workers of mothers’ and farmer fathers’ occupation, large family size, older children having more risk for diarrheal disease [18, 27–32].

Studies done in Bangladesh and Ethiopia revealed that hand washing at recommended times, food preparation, hand washing, and family fetch water storage containers affected under-five children's diarrheal diseases [27, 33, 34]. But other studies showed that there was no significant association between hand washing with or without soap before feeding a child or after cleaning a child's anus who has defecated and washing at a critical time with child diarrhea [33, 35, 36]. Also, another study in Ethiopia revealed that children whose mother didn't practice hand washing at a critical time and families did not treat drinking water had more likely to conduce childhood diarrhea [11, 18, 35]. Different studies done in Africa revealed that the child toilet, the child's water storage container, water sources, the type of toilet, and lack of latrine ownership had a significant contribution to childhood diarrhea [31, 32, 37, 38]. Studies were done on different community health programs in Nepal (training and engaging community health volunteers) [39], Kenya (community unit performance), South Africa (community health worker home visits), Southern Asian countries (community health workers), Ethiopia (health extension program), revealed diarrheal diseases less likely occurred [11, 40–43].

The national scale-up of integrated community case management (ICCM) in 2010–2012 provided a needed boost to the HEP by introducing a package of high-quality basic curative interventions meeting the demand of the communities. According to the national ICCM guidelines, a health extension worker (HEW) assesses and classifies newborn infections and treats them. If a severe infection is diagnosed, refer after the first pre-referral management [44]. Oral rehydration salt (ORS) and zinc supplements as management of under-five diarrheal diseases recommended by the united nation international
children’s fund (UNICEF) and the world health organization (WHO) since 2004 [45]. The health extension program enabled Ethiopia to achieve significant improvements in maternal and child health, communicable diseases, hygiene and sanitation, knowledge, and health care seeking [7].

The HEP is one means of implementing the sustainable development goal (SDG) by bringing main maternal, neonatal, and child health interventions to the community [46]. A model household is a household graduated by the health extension program after fulfilling health extension packages, but a non-model household is a household not graduated. Although HEP was implemented in 2005, the impact of HEP on child diarrhea was not investigated in this study area as far as my knowledge is concerned. So, the investigator wants to fill these gaps. The objective of this study is to assess the impact of HEP on diarrheal disease among under-five children and to identify factors associated with diarrheal disease in the rural community of Kalu district, Northeast Ethiopia.

Methods
A community-based cross-sectional study was carried out from March 20 to April 20/2021. The study was conducted in Kalu district, Amhara regional state, Northeast Ethiopia. The 2021 district population projection was 238,162 of which 51% were males. Additionally, the total numbers of households in the district are 55,323. In the Kalu district, there are nine health centers, 33 health posts and 73 health extension workers. About 70% of households are models and the rest are non-model households. The district has 35 rural kebeles. Kebele is the smallest administrative unit in Ethiopia which comprises 5000 people.

The study population for model households and non-model households was all households with under-five children from randomly selected kebeles in the rural community of Kalu district, Northeast Ethiopia during the data collection period. Households who had permanent residence in the area for at least 12 months and households classified as model households by data collectors by the standard checklist on the data collection period were included in the study. For non-model households’ families who had permanent residence in the area for at least 12 months and did not fulfill or resist implementing the health extension program packages were included. But households with critically ill household mothers or caregivers during the study period were excluded from the study.

The required sample size was calculated by using Epi-Info version 7.2 through assumption of 95% confidence level, 5% margin of error (d), 80% power, 1:2 ratio for model to non-model household, AOR (Adjusted Odds Ratio) = 2.25 and the percentage of outcome unexposed to pit or flush toilet (p = 57.2) from a previous study [11], design effect two and 10% non-response rate which yielded 603 participants (201 model household and 401 non-model households).

A multi-stage sampling procedure was employed to select study participants. First seven Kebeles from the thirty-five Kebeles were selected randomly using a lottery method and households who had under five children were identified in each kebele [47]. The kebeles were Adame (1818 households), Beke (1588 households), Qedida (870 households), Agamsa (1465 households), Jejeba (860 households), Mekanity (2394 households), and Ardibo (1656 households). Then proportionally the study participants allocated for each kebele. By using 1:2 ratio (model to non-model household) the allocated proportions in each kebele divided. Data found from each kebele (family folder) was used to identify model and non-model households. Then by using a sampling frame from the family folder, a simple random sampling method was used to select model and non-model household.

Data was collected from model and non-model households using an interviewer administered structured questionnaire. The questionnaire was adapted from other different studies [11, 28–30, 48, 49]. The questionnaire was prepared primarily in English, then it was translated to the local language Amharic and back-translated to English by language experts. Data collection tools mainly measure: socio-demographic characteristics, environmental-related factors, behavioral-related factors, HEP related factors, and clinical-related factors of the child.

Operational definitions
The dependent variable was the existence of under-five children with diarrheal disease, and the treatment variable is health extension program. The independent variables were: socio demographic characteristics (residence, wealth index, parental education, maternal occupation, maternal age, child age, house hold size, number of children < 5 year), environmental characteristics (distance to water source, availability of latrine, availability of hand washing facility, daily per capita water consumption, refuse disposal), behavioral factors (method of water storage, hand washing practice, feeding practice, duration of breast-feeding, breast feeding status, time of introducing supplementary feeding, home based water treatment), and health extension program related factors (model household, home to home visit, health post visit). Diarrheal disease is usually loose and watery stools, and at least three times in a 24-h period and the mother or care giver says diarrhea in the last two weeks before data collection. The model household is a household graduated from the health extension program after
fulfilling health extension packages and those who have a graduation certificate and continuity of package use or greater than or equal to eighty-five point from hundred by standard checklist assessment. But a non-model household is a household which had less than eighty-five points from hundred by standard checklist of model household measurement during data collection time. The cutoff point 85 is used as standard in the Amhara regional health bureau (see S2 table) [8]. Hand washing at critical time is if a mother/caregiver practiced all hand washings before food preparation, before child feeding, after child cleaning and after latrine visiting was considered “all practiced” unless considered as “partially practiced”. Proper refuse disposal is a way of waste disposal which includes burning, buried in a pit or store in a container, compost, and disposed in a designed site, whereas disposing in an open field was considered improper refuse disposal.

Data quality control
The training was given for data collectors and supervisors for two days on information about the research objective, eligible study participants, data collection tools and procedures, and interview methods. Additionally, day-to-day supervision during the whole period of data collection was provided by the principal investigator. The data collection instruments were pre-tested on 50 households in Kutaber district, Northeast Ethiopia two weeks before the actual data collection period and revised accordingly.

The filled questionnaire was checked for completeness and accuracy by both data collectors and supervisors before they returned from the field. Typographic errors were manually edited, but incomplete questionnaires were considered non-response rates. Every questionnaire was checked by the principal investigator every day after data collection before data entry.

Data analysis procedures and management
Data were entered to Epi-data version 3.1 and exported to Statistical Package for Social Science (SPSS) version 26 for cleaning, coding and analysis. Data consistency and missing values were checked before analysis. Descriptive statistics were computed for the prevalence of the disease of the child, number of people in the house, water container, and time to fetch water, main water sources, and hand washing practice at the critical time, birth order of the child, number of people in the house, water container, and time to fetch water, main water sources, and age of the child were the variables used to construct it.

In general, a program (in this case HEP) evaluation using a propensity score matching requires a series of steps. First, fitted probit model using pre-intervention/pre-exposure covariates to estimate the propensity that a household is included in the treatment (T=1) or not (T=0). Second, and upon estimating the propensity scores, a relevant matching estimator is called for to match the treatment observations with comparable observations using the propensity scores (in this research using Kernel matching). An important precursor to ensure the quality of matches is to impose what is known as ‘the common support condition’ in which 0<P(T=1/Z)<1 is satisfied [51].

Results
Socioeconomic and demographic related characteristics
A total of 603 (201 models and 402 non-models) households that had at least one under-five child was planned to participate in the study. Out of these 556 (182 models and 374 non-models) were participated
in the study, which makes a response rate of 92.2%. The mean age of the respondents (mother or caregiver) was 32.14 ± 6.23 years of age. Out of the participants, 536 (96.4%) were married, 182 (32.7%) were illiterate, 519 (93.3%) were farmers, 554 (99.9%) were Muslims and 181 (32.6%) were illiterate fathers. The mean family size of the households was 5.36 ± 1.9 (Table 1).

Table 1 Socio-economic and demographic characteristics of households in Kalu district rural community, Northeast Ethiopia, 2021\(^n=556\)

| Variable                        | Frequency | Percent |
|---------------------------------|-----------|---------|
| Age of mother or care giver     |           |         |
| 24 and below                    | 42        | 7.60    |
| 25-35 years                     | 328       | 59.00   |
| Above 35 years                  | 186       | 33.30   |
| Marital status of respondent    |           |         |
| Single                          | 6         | 1.10    |
| Marriage                        | 536       | 96.40   |
| Widowed                         | 7         | 1.30    |
| Divorced                        | 7         | 1.30    |
| Educational status of the mother|           |         |
| Illiterate                      | 182       | 32.70   |
| Read and write                  | 46        | 8.30    |
| 1–6 grade                       | 175       | 31.80   |
| 7–8 grade                       | 77        | 13.80   |
| 9–12 grade                      | 67        | 12.10   |
| Diploma and above               | 9         | 1.60    |
| Parent’s religion               |           |         |
| Muslim                          | 554       | 99.60   |
| Orthodox                        | 2         | 0.40    |
| Educational status of the father|           |         |
| Illiterate                      | 181       | 32.60   |
| Read and write                  | 60        | 10.80   |
| 1–6 grade                       | 138       | 24.80   |
| 7–8 grade                       | 86        | 15.50   |
| 9–12 grade                      | 79        | 4.20    |
| Diploma and above               | 12        | 2.20    |
| Occupation of mother            |           |         |
| Farmer                          | 519       | 93.30   |
| Other                           | 37        | 6.70    |
| Family size of the household    |           |         |
| 5 or less                       | 300       | 54.00   |
| 6 and above                     | 256       | 46.00   |
| Wealth index                    |           |         |
| Poor                            | 295       | 53.10   |
| Medium                          | 92        | 16.50   |
| Rich                            | 169       | 30.40   |
| Relationship with the child     |           |         |
| Mother                          | 541       | 97.30   |
| Care giver                      | 15        | 2.70    |

The health extension program status of the households’ characteristics
A total of 554 (99.6) heard about HEP of which 364 (65.5%) were heard information from health extension workers. Among them, 374 (63.7%) of the household were non-model, and 300 (54%) did not accurately mention the health extension packages. A total of 542 study participants (97.5%) had home visits by HEWs, and 283 (50.9%) had frequent visits (at least one visit every 4 weeks). A total of 556 (100%) of the participants visit the health post-visit (Table 2).

Environmental characteristics of the participants
A total of 510 (97.1%) and 155 (30.39%) of the households had a latrine and hand washing facility respectively. The majority of the latrine facilities of the households were private, 502 (98.43%) but 33 (6.47%) were not improved. Out of the total households, 244 (43.88%) households take 15–30 min to fetch water. Only 281 (50.5%) of the households do not treat their drinking water at home (Table 3).

Table 2 HEP related characteristics of the households in Kalu district rural community, Northeast Ethiopia, 2021\(^n=556\)

| Variable                        | Frequency | Percent |
|---------------------------------|-----------|---------|
| Heard about HEP                 |           |         |
| Yes                             | 554       | 99.60   |
| No                              | 2         | 0.40    |
| Sources of information (554)     |           |         |
| HAD                             | 99        | 17.80   |
| WDA                             | 88        | 15.80   |
| HEW                             | 364       | 65.50   |
| Mass media                      | 3         | 0.50    |
| HEP status of the household     |           |         |
| Model household                 | 182       | 32.70   |
| Non model household             | 374       | 67.30   |
| Number of HEP packages          |           |         |
| Accurately mentioned            | 300       | 53.96   |
| Not accurately mentioned        | 240       | 43.16   |
| I don’t know                    | 16        | 2.88    |
| Home to home visit by health extension worker | 556 | 100.00 |
| Yes                             | 529       | 95.14   |
| No                              | 27        | 4.86    |
| Frequency of home visit         |           |         |
| No visit                        | 27        | 4.90    |
| Less frequent visit             | 246       | 44.20   |
| Frequent visit                  | 283       | 50.90   |
| Health post visit by the community |         |         |
| Yes                             | 556       | 100.00  |
| No                              | 0         | 0.00    |

**HAD** Health Development Army, **HEW** Health Extension Worker, **WDA** Women Development Army
A total of 65.6% of households perform improper disposal methods. Besides, 28.04% of the households properly utilized the latrine, 69.96% of the households properly practiced children's stool disposal, and 37.77% of respondents practiced hand washing at critical times. Soap utilization for hand washing was practiced at 52.16% of respondents (Table 4).

### Table 3: Environmental characteristics of the households in Kalu district rural community, Northeast Ethiopia 2021 (n = 556)

| Variable                                      | Frequency | Percent |
|-----------------------------------------------|-----------|---------|
| Latrine availability                          |           |         |
| Yes                                           | 510       | 91.73   |
| No                                            | 46        | 8.27    |
| Ownership of latrine                          |           |         |
| Private                                       | 502       | 98.43   |
| Common                                        | 8         | 1.57    |
| Types of latrines                             |           |         |
| Improved                                      | 477       | 93.53   |
| Not improved                                  | 33        | 6.47    |
| Latrine location from water sources           |           |         |
| Uphill                                        | 163       | 31.96   |
| Same level                                    | 169       | 33.14   |
| Downward                                      | 178       | 34.90   |
| Hand washing facility near to latrine         |           |         |
| Yes                                           | 155       | 30.39   |
| No                                            | 355       | 69.60   |
| Time to fetch water (minutes)                 |           |         |
| Less than 15                                  | 182       | 32.70   |
| 15–30                                         | 244       | 43.90   |
| More than 30                                  | 130       | 23.40   |
| Water container                               |           |         |
| Cover                                         | 555       | 99.80   |
| No cover                                      | 1         | 0.20    |
| Water consumption (L/p/d)                     |           |         |
| ≤ 7                                           | 164       | 29.50   |
| > 7                                           | 392       | 70.50   |
| Water treatment at home                       |           |         |
| Yes                                           | 275       | 49.50   |
| No                                            | 281       | 50.50   |

### Table 4: Behavioral characteristics of households in Kalu district rural community, Northeast Ethiopia, 2021 (n = 556)

| Variable                                      | Frequency | Percent |
|-----------------------------------------------|-----------|---------|
| Refuse disposal method                        |           |         |
| Proper                                        | 191       | 34.40   |
| Improper                                      | 365       | 65.60   |
| Proper latrine utilization                    |           |         |
| Proper                                        | 143       | 28.04   |
| Improper                                      | 367       | 71.96   |
| Children stool disposal methods               |           |         |
| Proper                                        | 389       | 69.96   |
| Improper                                      | 167       | 30.04   |
| Hand washing at critical time                 |           |         |
| All practiced                                 | 210       | 37.77   |
| Partial practiced                             | 346       | 47.84   |
| Soap utilization for hand washing            |           |         |
| Yes                                           | 290       | 52.16   |
| No                                            | 266       | 47.84   |

from model houses and 32.89% were from non-model households.

### Factors associated with under-five child diarrheal diseases
HEP status of the household, frequency of home visits by HEW, and hand washing at the critical time were

### Table 5: Demographic and health characteristics of the index child in Kalu district rural community, Northeast Ethiopia, 2021 (n = 556)

| Variable                                      | Frequency | Percent |
|-----------------------------------------------|-----------|---------|
| Age                                           |           |         |
| < 6 months                                    | 87        | 15.60   |
| 6–12 month                                    | 125       | 22.50   |
| 12–24 month                                   | 163       | 29.30   |
| > 24                                          | 181       | 32.60   |
| Sex                                           |           |         |
| Male                                          | 297       | 50.40   |
| Female                                        | 259       | 46.60   |
| Birth order                                   |           |         |
| 1                                             | 118       | 21.20   |
| 2–3                                           | 220       | 39.60   |
| 4–5                                           | 186       | 33.50   |
| > 6                                           | 32        | 5.80    |
| Rota vaccination of the child                  |           |         |
| Yes                                           | 548       | 98.60   |
| No                                            | 8         | 1.40    |
| Occurrence of diarrhea in last 2 weeks         |           |         |
| Yes                                           | 149       | 26.80   |
| No                                            | 407       | 73.20   |
statistically associated with under-five children diarrheal disease. The likelihood of developing under-five child diarrheal disease from HEP non-model households was 2.19 times AOR (Adjusted Odds Ratio): 2.19, 95%CI: 1.34–3.57 more likely as compared to HEP model households. Among the study participants, households who did not get frequent home visits were 3.28 times AOR (Adjusted Odds Ratio): 3.28,95%CI: 1.40–7.68 to develop under-five child diarrheal diseases as compared to households who had gotten frequent home visits (at least one visit within a month by a health extension worker). Children whose mothers did partial hand washing at the critical times were 2.85 times AOR (Adjusted Odds Ratio): 2.85, 95% CI: 1.78–4.56 more likely to develop under-five diarrheal diseases than children whose mothers practiced hand washing at critical times (Table 6).

Impact health extension program on under-five diarrheal diseases

The study showed that the average treatment effect on treated model households (ATT) was found to be -0.177 points ($t = -5.02$) 95% CI: -0.25 -0.11) for under five-year child diarrheal diseases. This indicated that HEP contributed 17.7% decrease in diarrheal diseases under five children diarrheal diseases compared with non-HEP implementing households (Table 7).

The common support region for model and non-model households (Fig. 1). Propensity score distribution in the model and non-model households before and after matching (Fig. 2).

Discussion

The aim of this study was to assess the impact of a health extension program on diarrheal diseases among under-five children and to identify factors associated with under-five children diarrheal diseases in the rural community of Kalu district. Health extension program status, mothers or caregivers practice hand washing at a critical time and the frequency of home visits by health extension workers was statically associated with under-five children diarrheal diseases.

The prevalence of diarrheal disease among under-five children in this study was 26.8% (95% CI: 23.2–30.6). This finding is consistent with other studies done in different parts of Ethiopia which were, 27.2% Northern Ethiopia [52], 23.5% Southern Ethiopia [53], across regions of Ethiopia [16], 22.1% Western Ethiopia [28], and 23.1% Northeast Ethiopia [54] and 26.1% Cameroon [53]. But the finding is higher with studies reported in different areas, 12% the national report [15], 14.7% Eastern Ethiopia [49], 13.6% South Ethiopia [55], 16.4% Debre Berhan city, and 13% Nigeria [29, 56]. The difference might be due to the difference in the socio-demographic characteristics, seasonal variation, sanitation, and basic environmental infrastructures of study households. Because the study on other areas showed that the highest average incidence rate

Table 6 Factors associated with under five children diarrheal disease in Kalu district rural community, Northeast Ethiopia, 2021 ($n = 556$)

| Variable                              | Diarrheal disease | AOR (95% CI) |
|---------------------------------------|-------------------|--------------|
|                                      | Yes | No |                |
| **Age of mother or care giver**       |     |    |                |
| 24 and below years                    | 17  | 25 | 1              |
| 25 - 35 year                          | 83  | 245| 0.62(0.34–1.14) |
| Above 35 years                        | 49  | 137| 0.74 (0.32–1.74) |
| **Wealth index**                      |     |    |                |
| Poor                                  | 86  | 209| 1              |
| Medium                                | 19  | 73 | 0.62(0.30–1.35) |
| Rich                                  | 44  | 125| 0.86(0.54–1.40) |
| **HEP status of the household**       |     |    |                |
| Model household                       | 26  | 156| 1              |
| Non model household                   | 123 | 251| **2.17(1.33–3.55)** |
| **Frequency of home visit**           |     |    |                |
| Frequent visit                        | 69  | 214| 1              |
| Less frequent                         | 66  | 180| 1.04(0.69–1.56) |
| No visit                              | 14  | 13 | 3.24 (1.37–7.58)* |
| **Hand washing at critical time**     |     |    |                |
| All practiced                         | 29  | 181| 1              |
| Partial practiced                     | 120 | 226| **2.92(1.82–4.66)** |
| **Time to fetch water**               |     |    |                |
| Less than 15 min                      | 42  | 143| 1              |
| 15 to 30 min                          | 75  | 166| 1.4 (0.86–2.33) |
| More than 30 min                      | 32  | 98 | 1.1(0.61–1.99)  |
| **Child age in month**                |     |    |                |
| Up to six months                      | 20  | 67 | 1              |
| From six to 12 month                  | 26  | 99 | 0.96 (0.46–1.99) |
| From 12 to 24 month                   | 44  | 119| 1.20 (0.6–2.53) |
| Above 24 months                       | 59  | 122| 1.56 (0.80–3.03) |
| **Birth order of child**              |     |    |                |
| 1                                     | 39  | 79 | 1              |
| 2–3                                   | 56  | 164| 0.73 (0.44–1.23) |
| 4–5                                   | 47  | 139| 0.6 (0.35–1.02) |
| 6 and above                           | 7   | 25 | 0.48(0.2–1.27)  |
| **Occupation of mother**              |     |    |                |
| Farmer                                | 142 | 377| 1              |
| Other                                 | 7   | 30 | 0.6(0.24–1.06)  |
| **Sex of child**                      |     |    |                |
| Male                                  | 71  | 226| 1              |
| Female                                | 78  | 181| 1.42 (0.96–2.11) |
| **Number of people in the house**     |     |    |                |
| ≤ 5                                   | 81  | 188| 1              |
| > 5                                   | 68  | 68 | 1.69 (0.89–3.34) |

AOR Adjusted Odds Ratio, CI Confidence Interval,*P-value < 0.05 **P-value < 0.0001
was observed during the pre-rainy season (March to May) [57], and implemented community-led total sanitation and hygiene was a tool to reduce child diarrheal prevalence.

Being non-model households for the health extension program was more likely to develop under-five diarrheal diseases as compared to model households for the health extension program. This is consistent with a study done on the South Ethiopia rural community [11]. This is obvious the implementation of eighteen health extension packages have a positive effect on diarrheal diseases. Especially, food and water hygiene, solid and liquid waste management, personal hygiene, and immunization have a direct influence on diarrheal diseases.

The study also revealed that mothers who had not practiced hand washing at a critical time were more likely to develop diarrhea when compared to children whose mothers practiced hand washing at a critical time. This was consistent with the study finding where mothers or caregivers who lack hand washing practice and hand washing with water only contributed to under-five diarrheal disease [58]. Another study in eastern and northern Ethiopia showed that hand washing with soap complemented with hand hygiene promotion significantly decreased diarrheal episodes [59, 60]. This might be due to hand washing decreases the contamination of foods with microorganisms and which in turn prevent the occurrence of diarrhea and other hygiene related diseases.

Besides, households that did not have home visits by health extension workers (HEW) were more likely to develop under-five diarrheal diseases than those that had a frequent home visit by health extension workers. It is supported by studies in south Asia [43], South Africa [42], and other studies elsewhere [61–63]. This may be the health extension worker (community-based health workers) promoting personal and environmental hygiene during home visits and the best opportunity for behavioral change for the whole family and caregivers for their children. Thus, change in behavior affects the occurrence of diarrheal diseases in rural communities [64]. Another study done in Ethiopia showed that health extension workers’ home visits improved the utilization of health services [65]. Particularly, increasing vaccine coverage, especially the Rota vaccine which decreased diarrheal diseases [66].

The study revealed that the health extension program had an interesting impact on under-five children’s diarrheal diseases reduction. The propensity score matching

| Dependent variable          | Model households | Non-model households | ATT   | SE   | t     | 95% CI       |
|-----------------------------|------------------|----------------------|-------|------|-------|-------------|
| Under five diarrheal diseases | 182              | 362                  | -0.177| 0.04 | -5.02 | -0.25 -0.11 |

Number of observations = 544

**ATT** Average Treatment effect on Treated, CI Confidence Interval, HEP Health Extension Program, SE Standard Error

![The common support region for model and non-model households](image)

**Fig. 1** The common support region for model and non-model households
analysis showed that being a model household decreased diarrheal diseases under-five children diarrheal disease by 17.7%. This is evidenced by government reports and different scientific researches [55, 61]. This may due to the implementation of eighteen health extension program packages such as hand washing facility near the latrine, latrine construction, and use, which may improve the personal hygiene of the mother or caregiver. Besides, mothers or caregivers in HEP model households participate in women development army conferences and health development army conferences, which is a tool to convince the mother for health extension packages.

There were certain limitations to the research. First, this study used a cross-sectional study design to assess the impact of HEP model households on diarrheal diseases among under-five children, so causal relationships between factors and under-five diarrheal diseases could not be determined, even though propensity score analysis could provide an option. Additionally, to determine the impact of HEP (model households), the propensity score may not be as successful as randomized controlled trials. Because there was no baseline data on under-five diarrheal diseases before the HEP was implemented, we were unable to determine the HEP’s actual contribution to under-five diarrheal diseases from the baseline, and propensity score ignores the effects of unobserved characteristics that may have an impact on the study’s results. As a result, the outcomes of this study should be viewed in light of these factors.

Conclusions
This study showed that the prevalence of the diarrheal disease among under-five children was high. Besides, it revealed that implementing a health extension program
(being a model household) has a significant reduction of diarrheal disease among under-five children. Hand washing practice at a critical time, model household status, and frequency of home visits were significantly associated with under-five diarrheal diseases. Therefore, the health extension program is important to reach the United Nations (UN) target, by 2030, to end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births. Kalu District health office should scale up the number of model households from non-model households in order to reduce under-five diarrheal diseases. The health extension workers should frequently visit the households and educate the hand washing practice.

Declarations

Ethics approval and consent to participate
The ethical clearance letter was obtained from the ethical review Board (ERB) from Wolol University College of Medicine and Health Sciences. The permission letter was obtained from Kalu district health office. Written informed consent was obtained from all the literate participants and also from the legal guardians of the illiterate participants. The participants’ right to refuse or withdraw from participating in the interview was fully maintained, and the information provided by each participant was kept strictly confidential. The study was conducted in accordance with the Declaration of Helsinki, 2008.

Consent for publication
Not applicable.

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

Received: 4 July 2021   Accepted: 31 January 2022
Published online: 09 February 2022

Acknowledgements
We deeply express our gratitude to the Kalu district health office, the study participants, data collectors, and other individuals or organizations that have participated in the study directly or indirectly in the study.

Authors’ contributions
AT designed the study, performed analysis, and interpretation of data, and drafted the paper, and prepared the manuscript. FW assisted in the design and approved the article with revisions. AM assisted in the design, approved the article with revisions, participated in data analysis, and revised subsequent write-up of the paper. TY revised the subsequent write-up of the paper. All authors reviewed the manuscript. All authors have read and approved the manuscript.

Authors’ information
Not applicable.

Funding
Not applicable.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the first author on reasonable request.

Abbreviations
ATT: Average Treatment effect on the Treated; EDHS: Ethiopian Demographic health survey; HEP: Health Extension Program; HEW: Health Extension Worker; HIV/AIDS: Human Immune Virus/Acquired immune Deficiency Syndrome; HSDP: Health Sector Development Program; ICCM: Integrated Community Case Management; MDG: Millennium Development Goal; NGO: Non-Governmental Organization; ORS: Oral Rehydration Salt; PHC: Primary Health Care; UNICEF: United Nation International Children’s Emergency Fund; WHO: World Health Organization; SDG: Sustainable Development Goal; HDA: Health Development Army; WDA: Women Development Army.

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s12913-022-07565-7.

Additional file 1: Table S1. The Ethiopian health extension program packages.
Additional file 2: Table S2. Model and non-model household assessment checklist.

References
1. Kizaw V. Reflecting back on Alma Ata Declaration: Primary Health Care Implementation Models, Impacts, Challenges and Lessons Learned in Ethiopia. 1978.
2. WHO. Primary Health Care Programme in the WHO African Region from Alma-Ata to Ouagadougou and beyond. In: World Health Organ Reg Off Africa. 2018.
3. Abdullah A, Dhingra S. Strengthening Primary Health-Care Services to Help Prevent and Control Long-Term (Chronic) Non-Communicable Diseases in Low- and Middle-Income Countries. 2020.
4. World Health O, United Nations Children’s F. A vision for primary health care in the 21st century: towards universal health coverage and the Sustainable Development Goals. Geneva: World Health Organization; 2018 2018. Contract No.: WHO/HF5/SDS/2018.15.
5. Dynes M, Buffington ST, Carpenter M, Handley A, Kelley M, Tadesse L, et al. Strengthening maternal and newborn health in rural Ethiopia: Early results from frontline health worker community maternal and newborn health training. Midwifery. 2013;29(3):251–9. https://doi.org/10.1016/j.midw.2012.01.006.
6. Extension H, Hew W. 2011 On Family Folder and HMIS Procedures Facilitators’ Guide. 2011.
7. Assefa Y, Gelaw YA, Hill PS, Taye BW, Van Damme W. Community health extension program of Ethiopia, 2003–2018: Successes and challenges toward universal coverage for primary healthcare services. Global Health. 2019;15(1):1–11.
8. Wang H, Tesfaye R, Ramana GNV, Chekagn CT. Ethiopia Health Extension Program. 2016. p. 1–121 (https://openknowledge.worldbank.org/bitstream/handle/10986/24119/9781464808159.pdf?sequence=2).
9. Ministry of Finance and Economic Development Federal Democratic Republic of Ethiopia, UN. Assessing progress towards the millennium development goals: Ethiopia MDGs report, 2012.
10. Carvajal-Vélez L, Amouzou A, Perin J, Maiga A, Tarekegn H, Akinyemi A, et al. Diarrhea management in children under five in sub-Saharan Africa: Does the source of care matter? A Countdown analysis BMC Public Health. 2016;16(1):1–14. https://doi.org/10.1186/s12889-016-3475-1.
11. Gebru T, Taha M, Kassahun W. Risk factors of diarrhoeal disease in under-five children along health extension model and non-model families in Sene district rural community, Southwest Ethiopia: Comparative cross-sectional study. BMC Public Health. 2014;14(1):1–6.
12. WHO. WHO recommendations on the management of diarrhoea and pneumonia in infants and children Integrated Management of Childhood Illness (IMCI). WHO Libr Cat Data. 2017;3(2008):281–398.
13. Ayuk TB, Carine NE, Ashu NJ, Christine NA, Josette EV, Roger BM, et al. Prevalence of diarrhoea and associated risk factors among children under-five years of age in Efoulan health district- Cameroon, sub-Saharan Africa. MOJ Public Heal. 2018;7(6):259–64.
14. Central Statistical Agency Addis Ababa El. Demographic health survey Ethiopia. 2011.
15. Central Statistical Agency Addis Ababa El. Demographic health survey Ethiopia. 2016.
16. Alebel A, Tesema C, Temesgen B, Gebrie A, Petrucca P, Kibret GD. Prevalence of and determinants of diarrhea among under-five children in Ethiopia: A systematic review and meta-analysis. PLoS ONE. 2018;13(6):e019784.
17. What are the 8 components of primary health care? [Internet]. [cited 2020 Dec 31]. Available from: https://askingt.net/what-are-the-8-components-of-primary-health-care
18. Takele K, Zewoit T, Ndanguza D. Risk factors of morbidity among children aged under five in Ethiopia. 2019. p. 1–9.
19. Genser B, Strina A, Teles CA, Prado MS, Mauricio L, Genser B, et al. Risk Factors for Childhood Diarrhea Incidence Dynamic Analysis of a Longitudinal Study Design and Population. Epidemiology. 2015;17(6):658–67.
20. Arif A, Naheed R. Socio-economic determinants of diarrhoea morbidity in Pakistan. Acad Res Int. 2012;2(1):490–518 (http://www.savap.org.pk/journ als/ArInt/Vol2012/2-1-50.pdf)
21. Lakshminarayanan S, Jayalakshmy R. Diarrheal diseases among children in India: Current scenario and future perspectives. J Nat Sci Biol Med. 2015;6(1):24-8.
22. Edwin P, Azage M. Geographical Variations and Factors Associated with Childhood Diarrhea in Tanzania: A National Population Based Survey. Afr J Health Sci. 2015-16. Ethiopia: J Health Sci. 2019;39(4):513-24.
23. George CM, Perin J, Neiswender de Calani KJ, Norman WR, Perry H, Davis TP Jr. et al. Risk Factors for Diarrhea in Children under Five Years of Age Residing in Peri-urban Communities in Cochabamba Bolivia. 2014;9(6):1190-96.
24. Kokali A-A, Nabavi M, Schrubi M-R. EPIDEMIOLOGY OF ACUTE DIARRHEAL DISEASES AMONG CHILDREN UNDER 5 YEARS OF AGE IN TEHRAN, IRAN. Iranian J Clin Infectious Diseases. 2008;3:193-8.
25. Hasan M, Richardson A. How sustainable household environment and knowledge of healthy practices relate to childhood morbidity in South Asia: analysis of survey data from Bangladesh, Nepal and Pakistan. 2017. p. 1–10.
26. Komang N, Santika A, Efedri E, Rachmawati PO, Mishbahatul E, Kusnantoro K, et al. Children and Youth Services Review Determinants of diarrhea among children under two years old in Indonesia. Child Youth Serv Rev. 2020;110:104838. https://doi.org/10.1016/j.childyouth.2020.104838.
27. Mamo A, Hailu A. Assessment of Prevalence and Related Factors of Diarrheal Diseases among Under-Five-Year’s Children in Debrehireh Referral Hospital, Debrehireh Town, North Shoa Zone, Amhara Region. Ethiopia Qual Prim Care. 2014;2014:01(01):1–14.
28. Mihrete TS, Alemie GA, Tefera AS. Determinants of childhood diarrhea among under-five children in Benshangul Gumuz Regional State, North West Ethiopia. 2014.
29. Shine S, Muhumud S, Adaneew S, Demelash A, Abane M. Prevalence and associated factors of diarrhea among under-five children in Debre Berhan town, Ethiopia 2018: a cross sectional study. 2020. p. 1–6.
30. Gedamu G, Kurnie A, Hafu D. Magnitude and associated factors of diarrhoea among under five children in Farta weeda, North West Ethiopia. Qual Prim Care. 2017;25(4):199-207.
31. Tambe AB, Nzelfa LD, Nicoline NA. Childhood Diarrhea Determinants in Sub-Saharan Africa: A Cross Sectional Study of Tiko-Cameroon. 2015. p. 229–43.
32. Hussein H. Prevalence of diarrhea and associated risk factors in children under five years of age in Northern Nigeria: a secondary data analysis of Nigeria demographic and health survey 2013. Unpublished Degree Project, Uppsala University. 2017.
33. Saha CK, editor Dynamics of Risk Determinants Regarding Diarrhea Affected Slum Children in Urban Dhaka: A Dysfunctional Health Care System. 2012.
34. Billah SM, Raihana S, Ali NR, Iqbal A, Rahman MM, Khan ANS, et al. Bangladesh: a success case in combating childhood diarrhea. J Glob Health. 2019;9(2):020803.
35. Luby SP, Halder AK, Huda T, Unicomb L, Johnston RB. The Effect of Hand washing at Recommended Times with Water Alone and With Soap on Child Diarrhea in Rural Bangladesh: An Observational Study. PLOS Medicine. 2011;8(6):e1000552.
36. Befekadu A, Yitayal M. Knowledge and practice of health extension workers on drug provision for childhood illness in west Gojam, Amhara, Northwest Ethiopia. 2020. p. 1–10.
37. Bado AR, Susumam AS, Nebie EI. Trends and risk factors for childhood diarrhea in sub-Saharan countries (1990-2013): assessing the neighborhood inequalities. Glob Health Action. 2016;9:30166.
38. Godana W, Mengiste B. Environmental factors associated with acute diarrhea among children under five years of age in derashe district, Southern Ethiopia. 2013;3(13):119–24.
39. Ghimire M, Pradhan YV, Maskey MK. Community-based interventions for diarrhoeal diseases and acute respiratory infections in Nepal. Bull World Health Organ. 2010;88(3):216–21.
40. Kawakatsu Y, Tanaka J, Ogawa K, Ongendo K, Honda S. Community unit performance : factors associated with childhood diarrhea and appropriate treatment in Nyanza Province, Kenya. 2017. p. 1–14.
41. Gogia S, Singh H. Home visits by community health workers to prevent neonatal deaths in developing countries : a systematic review, 2010. p. 658–66.
42. Marsh DR, Hazel E, Nelfdt R. Integrated Community Case Management (ICCM) at Scale in Ethiopia: Evidence and Experience. Ethiopian Medical Journal. 2014; 52.
43. UNICEF WHO 2004 WHO/UNICEF joint statement clinical management of acute diarrhea. WHO Library. https://www.unicef.org/publications/files/ENA_Acute_Diarrhoea_reprint.pdf
44. The Federal Democratic Republic of Ethiopia Ministry of Health. Health Sector Transformation Plan 2015 (2016). Available from: https://www.globa lhandwashingfacility.org/sites/gf new/files/Ethiopia-health-system-trans formation-plan.pdf. Accessed 4 Mar 2021.
45. Kali District Health office. Report: Unpublished, 2021.
46. Mengistie B, Berhane Y, Worku A. Prevalence of diarrhea and associated risk factors among children under-five years of age in Eastern Ethiopia: A cross-sectional study. Open J Prev Med. 2012;2(6):572.e15-572.e17.
47. Wakigari R, Regassa W, Lemma S. Assessment of Diarrhoeal Disease Prevalence and Associated Risk Factors in Children of 6–59 Months Old at Adama District Rural. 2015.
48. Kelly P. Diarrhoeal disease. Clin Med J R Coll Physicians London. 2011;11(5):488–91 (https://www.who.int/news-room/fact-sheets/detail/ diarrhoeal-diseasedetailed 2021 Feb 18).
49. Heckman JJ, Ichimura H, Todd PE. Matching As An Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme. Rev Econ Stud. 1997;64(4):605–54.
50. Melese B, Paulos W, Astawesegn FH, Gelgelu TB. Prevalence of diarrheal disease among under-five children in Jamma district, South Wello zone, Northeast Ethiopia. 2019. p. 1–10.
51. Stansert Katzen L, Tomlinson M, Christodoulou J, Laurentini C, Le Roux I, Baker V, et al. Home visits by community health workers to prevent neonatal deaths in developing countries : a systematic review, 2010. p. 658–66.
52. Befekadu A, Yitayal M. Knowledge and practice of health extension workers on drug provision for childhood illness in west Gojam, Amhara, Northwest Ethiopia. 2020. p. 1–10.
53. Bado AR, Susumam AS, Nebie EI. Trends and risk factors for childhood diarrhea in sub-Saharan countries (1990-2013): assessing the neighborhood inequalities. Glob Health Action. 2016;9:30166.
54. Godana W, Mengiste B. Environmental factors associated with acute diarrhea among children under five years of age in derashe district, Southern Ethiopia. 2013;3(13):119–24.
55. Ghimire M, Pradhan YV, Maskey MK. Community-based interventions for diarrhoeal diseases and acute respiratory infections in Nepal. Bull World Health Organ. 2010;88(3):216–21.
56. National Population Commission (NPC) [Nigeria], ICF. Nigeria Demographic Health Survey 2018. DHS Program ICF Rockville, Maryland, USA [Internet]. 2019.748. Available from: https://dhsprogram.com/publicatio ns/publication-FR359-dhs-final-reports.cfm
57. Azage M, Kumie A, Worku A, C. Bagtzoglou A, Anagnostou E. Effect of climatic variability on childhood diarrhoea and its high risk periods in northwestern parts of Ethiopia. PLOS ONE. 2017;12(10):e0186933.
58. Merrie YA, Tegegne MM, Munaw MB, Alemu HW. Prevalence of diarrhea and associated factors among under-five children in Bahir Dar city, Northwest Ethiopia, 2016: a cross-sectional study. Clin Optom. 2019;11:135–43.

59. Dagre H, Bogale L, Borcha M, Tesfaye A, Dagnew B. Hand washing practice at critical times and its associated factors among mothers of under five children in Debark town, northwest Ethiopia, 2018. Ital J Pediatr. 2019;45(1):120.

60. Health P. Determinants of Acute Diarrhea Among Children Under-Five in Northeast Ethiopia: Unmatched Case – Control Study. 2020.

61. Moore TG, Mcdonald M, Sanjeevan S, Price A. Sustained home visiting for vulnerable families and children: A literature review of effective processes and strategies. 2012(January):166. Available from: https://www.rch.org.au/uploadedFiles/Main/Content/ccch/resources_and_publications/Home_visiting_lit_review_RAH_processes_final.pdf

62. Foundation P. Early Care and Education and Home Visiting A Key Topic Resource List. 2014.

63. Supplee L. 5 Things to Know About Early Childhood Home Visiting [Internet]. October 25, 2016. [cited 2021 Jun 7]. Available from: https://www.childtrends.org/publications/5-things-to-know-about-early-childhood-home-visiting

64. Negesse Y, Taddese AA, Negesse A, Ayele TA. Trends and determinants of diarrhea among under-five children in Ethiopia: cross-sectional study: multivariate decomposition and multilevel analysis based on Bayesian approach evidenced by EDHS 2000–2016 data. BMC Public Health. 2021;21(1):1–16.

65. Tafesse N, Gesessew A, Kidane E. Urban health extension program model housing and household visits improved the utilization of health Services in Urban Ethiopia: A community-based cross-sectional study. BMC Health Serv Res. 2019;19(1):1–11.

66. Troeger C, Khalil IA, Rao PC, Cao S, Blacker BF, Ahmed T, et al. Rotavirus Vaccination and the Global Burden of Rotavirus Diarrhea among Children Younger Than 5 Years. JAMA Pediatr. 2018;172(10):958–65.

**Publisher's Note**

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