Determinants of Acute Diarrhea Among Children Under-Five in Northeast Ethiopia: Unmatched Case–Control Study

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Background: Diarrheal disease is the second leading causes of death among under-five children. Most of the death due to diarrhea is reporting in developing countries. To prevent this highly prevalent problem, identifying the contributing factors across different settings is necessary. Therefore, this study aimed to identify the determinants of acute diarrhea among under-five children in the Northeast part of Ethiopia.

Methods: An institution-based unmatched case–control study was conducted among 306 under-five children from March to April 2019. A systematic random sampling technique was employed to select study participants. Data were collected by face to face interviews using a pretested structured questionnaire. Data were entered using Epi-info 7 and analyzed with SPSS version 20.0. We applied logistic regression analysis. Those variables with p-value <0.05 were significant determinants of acute diarrhea.

Results: Improper child’s stool disposal [AOR=4.12; 95% CI (1.25,13.5)], absence of home-based water treatment [AOR=2.85; 95% CI (1.27,6.42)], did not wash hand at critical times [AOR=5.47; 95% CI (1.68,17.8)], did not practice exclusive breastfeeding [AOR=3.32; 95% CI (1.21,9.14)], unable to get counseling from health professionals [AOR= 3.23; 95%,CI (1.15,13.5)], provide left over food to the child [AOR=2.96; 95% CI (1.19,7.32)], and maternal diarrhea [AOR=6.06; 95% CI (2.42,15.22)] were determinants of acute diarrhea among under five children.

Conclusion: Most of the determinants of acute diarrhea could be preventable. Thus, collaborative intervention by emphasizing health education about the importance of personal and environmental hygiene, safe food handling, exclusive breastfeeding practice, and home-based water treatment are essential.

Keywords: acute, diarrhea, determinants, Ethiopia, children

Introduction

Globally, there were nearly 1.7 billion cases of childhood diarrheal disease by the end of the 2017 year that is the second leading cause of death among under five years of children.1 It contributes to one in eight deaths among children younger than 5 years.2 Similarly, approximately 525,000 children continue to die each year.1 Of these, 90% occur in Sub-Saharan Africa and South Asia.3

Likewise, acute diarrhea is one of the major contributors to the deaths of under-five-year-old children in Ethiopia. Based on the World Health Organization’s (WHO) estimate, diarrhea contributes to more than one in every ten (13%) child deaths in Ethiopia.4 According to the Ethiopian Demographic Health Survey...
(EDHS) 2016 report, 12% of under-5 children had a diarrheal episode within two weeks before the survey. In addition to the major cause of child mortality, diarrhea predisposes children to malnutrition and infections. The economic and educational consequences of diarrhea for children are clear with, for example, missed school days and workdays, affecting cognitive development and family resources that in turn influence health outcomes.

As an opportunity, diarrheal diseases are both preventable and treatable through simple and affordable interventions. Strengthening health systems to provide such interventions to all children will potentially save many young lives, which helps to fulfill the aim of Sustainable Development Goals (SDG). The SDG-3 aims to end preventable deaths of newborns and under-five children by 2030. Improvements in safe water and sanitation, improved nutrition, increased use of oral rehydration therapy (ORT), exclusive breastfeeding practice, optimum supplemental feeding, vaccination, and food safety awareness are the recommended approaches to reduce diarrheal disease. The Ethiopian government also have been implemented these various strategies to prevent and control diarrhea. Besides, after the introduction of the rotavirus vaccine, the burden of diarrheal diseases is decreasing. A single study in Ethiopia from 2011–2016 showed that the proportion of diarrhea hospitalizations due to rotavirus among children <5 years of age decreased by 17% from 24% in the pre-vaccine period and to 20% in post-vaccine introduction era. Similarly, a reduction of 18% in the proportion hospitalizations due to diarrhea due to rotavirus in children <12 months of age in the post (27%) vs pre-vaccine (33%) periods was observed.

Despite the implementation of recommendations, the burden of diarrheal diseases in developing countries are associated with different variables. Insufficient access to adequate hygiene, poor sanitation, unsafe drinking water, malnutrition, low maternal education, early weaning practice, and poor economic status were reported determinants acute diarrhea from the previous studies. To achieve the global and national aims of reducing childhood mortality, operational researches designed to identify the factors of diarrhea across the different geographical areas is required. This clue indicates there is a need to search further determinants of diarrhea to give input for healthcare policy and/or decision-makers. Therefore, this research identified the determinants of acute diarrhea among under-five children in the Northeast part of Ethiopia.

Methods
Study Period, Design, and Setting
A hospital-based unmatched Case-control study was employed from March 5 to April 20/2019 in Dessie referral hospital, Northeast Ethiopia. This study was conducted on mothers/caregivers with their children aged less than five years visiting the Dessie referral hospital.

Sample Size Determination and Sampling Technique
The sample size was determined by using a double population proportion formula, by considering the following assumptions: confidence level = 95%, power = 80%, control to case ratio = 3:1, the proportion of respondents who practiced home-based water treatment to be 60.1% and that did not practice home-based water treatment to be 79.05% from a study conducted in Pawi hospital Ethiopia. After assuming a non-response rate of 10%, the overall sample size was 306 (77 cases and 229 controls).

The cases were children with acute diarrhea in the pediatric outpatient department (POPD) coming for treatment during the study period. The controls were recruited from children without diarrhea coming to the same department during the same period for the treatment of other cases. The previous monthly flow of under-five children visiting Dessie referral hospital with acute diarrhea and without diarrhea was 260 and 986 respectively. Thus, Case=260/77=3.37 approximately 3 and K control=986/229=4.3 approximately 4. The controls and the cases were selected by using systematic random sampling with K=3 for cases and k=4 for controls.

Data Collection and Data Quality Control
Data was collected using a pretested structured questionnaires through face-to-face interview with mothers/caregivers in the POPD. The pre-test was conducted on 31 participants in Gondar comprehensive specialized hospital, Ethiopia. Based on the pretest, the questionnaire was assessed for clarity, understandability, flow, missed data, structure, and modified accordingly.

The first eligible case was selected for interview mother/caregiver at POPD after the child was diagnosed. But if the selected child referred to the inpatient ward, mothers/caregivers were interviewed in the inpatient ward, where their child received the appropriate drug and/or supportive therapy. The data collection tool was first
prepared in English and then translated to Amharic and back to English. The questionnaires have three parts including, socio-demographic characteristics of the child and parent, environmental sanitation factors, and behavioral and childcare practice. Weight scale and meter were used to measure the height and weight of the child. WHO Anthro software was used to calculate the height for age, weight for age, and weight for height. Two trained BSc nurses collected the data. Another one BSc nurse supervised the data collection process.

Statistical Analysis
The collected data was entered into Epi-info Version 7 and exported to SPSS version 20.0 for analysis. Chi-square assumptions were checked for all independent variables. Binary logistic regression analysis was run to check the presence or absence of association between the dependent variable with each independent variable. For model fitness, Hosmer-Lemeshow goodness of fit was tested. The multicollinearity of the independent variables was checked. Multivariable logistic regression analysis was done for variables with a p-value of less than 0.2 in the bivariate analysis. Adjusted odds ratio (AOR) with 95% confidence interval (CI) and p-value were used to identify significant associated factors of the outcome variable. Variables with a P-value of less than 0.05 were claimed as determinants of acute childhood diarrhea.

Operational Definitions
Acute Diarrhea: Having diarrhea for less than 14 days.
Diarrhea: Having three or more loose or watery stools in a 24-hours as entirely reported by the mother/caretaker of the child.
Improved water source: Protected spring and piped water.
Unimproved water source: Pond, river, unprotected dug well, an unprotected spring.
Hand-washing at critical times: Hand-washing after visiting the toilet, before preparing food, before eating food/feeding the child and after feeding children. In this study, it was categorized as “Yes”, which means when all practiced unless it was considered as “No”.

Vaccination Status
- Appropriate for age: Children received all basic vaccinations according to their age based on the Expanded Programme for Immunization (EPI) in Ethiopia.
- Inappropriate for age: Children did not receive all basic vaccinations according to their age based on the Expanded Programme for Immunization (EPI) in Ethiopia.

Ethical Consideration
Ethical clearance was obtained from the Ethical Review Committee of the School of Nursing on behalf of the Institutional Review Board (IRB) of the University of Gondar. Written permission was taken to Dessie referral hospital manager, Northeast Ethiopia. Then, the respective manager permitted the focal persons. All mothers and caregivers provided informed consent, and that this study was conducted in accordance with the Declaration of Helsinki.

The purpose and benefit of the study was explained for mothers and children. Name or identification numbers of study participants were not recorded. Any patient data was kept strictly confidential and used only for the study purpose.

Results
Sociodemographic Characteristics of Parents
A total of 306 participants (77 cases and 229 controls) were involved with the response rate of 100% for cases and controls. The mean age of mothers of cases and controls was 27.62 (standard deviation (SD) ± 5.12) with a range of 18–45 years and 28.99 (SD ± 5.1) with a range of 20–52 years, respectively. The majority (81.8%) of cases’ and (88.6%) controls’ mothers were married. Of the total cases, 35.1% of mothers had primary education and 59.7% were housewives. The largest proportion (41%) of mothers of controls were graduated from college or university (Table 1).

Sociodemographic Characteristics of the Child
The median age of children was 17 with a range (1 to 59) months. From the cases, more than half (54.5%) were males and 50.7% of controls were males (Table 2).

Environmental Characteristics
The majority (97.4%) of cases and controls were from a family with latrine. Of those latrines, 70.1% cases and 82.1% controls were owned privately. Eighteen (23.4%) of cases were not disposing of child stool in the latrine,
Table 1 Socio-Demographic Characteristics of the Parents of Under-Five Children in Northeast Ethiopia, 2019

| Characteristics       | Case (77) | Control (229) |
|-----------------------|-----------|---------------|
|                       | Frequency (%) | Frequency (%) |
| Maternal age          |           |               |
| 18–24                 | 20        | 26            | 38        | 16.6      |
| 25–34                 | 48        | 62.3          | 160       | 69.9      |
| ≥35                   | 9         | 11.7          | 31        | 13.5      |
| Marital status of a mother |           |               |
| Married               | 63        | 81.8          | 203       | 88.6      |
| Divorced              | 8         | 10.4          | 19        | 8.3       |
| Widowed               | 6         | 7.8           | 7         | 3.1       |
| Religion              |           |               |
| Muslim                | 38        | 49.4          | 112       | 48.9      |
| Orthodox              | 31        | 40.3          | 105       | 45.9      |
| Protestant            | 8         | 10.3          | 12        | 5.2       |
| Residence             |           |               |
| Urban                 | 51        | 66.2          | 183       | 79.9      |
| Rural                 | 26        | 33.8          | 46        | 20.1      |
| Family size           |           |               |
| ≤5                    | 65        | 84.4          | 194       | 84.7      |
| >5                    | 12        | 15.6          | 35        | 15.3      |
| Mother’s educational status |       |               |
| No formal education   | 27        | 35.1          | 63        | 27.5      |
| Primary               | 16        | 20.8          | 40        | 17.5      |
| Secondary             | 19        | 24.6          | 94        | 41        |
| University/college    |           |               |
| Mother’s occupation   |           |               |
| Housewife             | 46        | 59.7          | 109       | 47.6      |
| Governmental employee | 16        | 20.8          | 71        | 31        |
| Private gainful       | 15        | 19.5          | 49        | 21.4      |
| Father’s educational status |       |               |
| No formal education   | 12        | 15.6          | 20        | 8.7       |
| Primary               | 18        | 23.4          | 28        | 12.3      |
| Secondary             | 14        | 18.2          | 30        | 13.1      |
| College/University    | 33        | 42.8          | 151       | 65.9      |
| Father’s Occupation   |           |               |
| farmer                | 24        | 31.2          | 28        | 12.2      |
| Government employee   | 27        | 35.1          | 138       | 60.3      |
| Merchant              | 19        | 24.6          | 56        | 24.4      |
| Other*                | 7         | 9.1           | 7         | 3.1       |

(Continued)

Table 1 (Continued).

| Characteristics | Case (77) | Control (229) |
|-----------------|-----------|---------------|
|                 | Frequency (%) | Frequency (%) |
| Monthly income  |           |               |
| ≤1000           | 15        | 19.4          | 37        | 16.2      |
| 1000–5000       | 36        | 46.8          | 83        | 36.2      |
| >5000           | 26        | 33.8          | 109       | 47.6      |
| Family size     |           |               |
| ≤5              | 65        | 84.4          | 194       | 84.7      |
| >5              | 12        | 15.6          | 35        | 15.3      |

Note: Others*, Drivers and NGO workers.

whereas 94.8% controls disposed child stool in a latrine. Two hundred eighty-six participants used an improved source of water. About 82.5% of controls were treated drinking water at home, whereas 50.6% of cases did not use home-based water treatment (Table 3).

Childcare and Behavioral Characteristics
The majority (64.9%) of cases and 96.9% of controls were washed their hands at critical times. From controls, only 6.1% of mother’s caregivers had used only water to wash their hands, whereas 93.9% used both water and soap to wash their hands. Around three-fourth of the cases and 93% of controls had practiced exclusive breastfeeding. The majority (81.8%) of cases and 93% of controls were heard about diarrhea prevention and transmission. Thirty-four (44.2%) of cases and 7.4% of controls had a maternal history of diarrhea in the previous 2 weeks. Most of 88.3% of cases and 81.5% of controls were received appropriate immunization for their age (Table 4).

Determinants of Acute Diarrhea
After adjustment for the possible effects of confounding, in the multivariable analysis, seven factors remained significant determinants of acute diarrhea. These were improper child stool disposal, absence of home-based water treatment, did not wash hand at critical times, did not practice exclusive breastfeeding, did not get counseling from health professionals, feed the child with leftover food, and maternal history of diarrhea within the previous two weeks.

This study showed that children whose stool disposed of improperly were four times more likely to develop
acute diarrhea than children disposed of their stool in latrine [AOR=4.12; 95% CI (1.25,13.5)]. The odds of developing acute diarrhea were around three times higher among children whose families did not treat drinking water compared with children whose families treated water for drinking [AOR=2.85; 95% CI (1.27,6.42)]. This study revealed that children whose mothers/caregivers did not wash their hands at the critical time were nearly five times more likely to develop diarrhea than children who did handwashing at the critical time [AOR=5.47; 95% CI:1.68,17.8]. Children who did not exclusively breastfeed were three times more likely to experience acute diarrhea compared to those children who breastfeed exclusively [AOR= 3.32; 95% CI (1.206,9.14)]. Children whose mothers had not been counseled by health professionals were three times more likely to develop acute diarrhea compared to children whose mothers counseled by health professionals [AOR= 3.23; 95% CI (1.15,9.09)]. Children who consumed left-over food were nearly three times more likely to have acute diarrhea compared with children who did not consume left-over food [AOR=2.96; 95% CI (1.19,7.32)]. This study also revealed that children mother who had a history of diarrhea in the previous two weeks was six times more likely to develop diarrhea than without a history of maternal diarrhea in the previous 2 weeks [AOR= 6.06; 95% CI (2.42,15.22)] (Table 5).

**Discussion**

The result of this study revealed that preventable factors remained significant determinants of acute diarrhea. Children whose stool did not dispose of properly were more likely to develop acute diarrhea than children whose stool disposed of properly. This finding is supported by the study conducted in Benishangul Gumuz region Ethiopia, Pawi Hospital Ethiopia, west Gojjam Ethiopia, and India. An increase in the unsafe disposal of children’s stool in the community also increased the risk of diarrhea in children. Improper stool disposal could be including dump waste on the ground, in surface waters, in a landfill, or open field. These create an opportunity for diarrhea causative agents to finish their lifecycle and/or continue their chain of transmission after they are ingested by animals or humans. Therefore, the proper disposal of a child’s stool has a great contribution to the prevention of excreta-related disease.

Water can be contaminated by diarrheal causes of pathogens, harmful chemicals, industrial wastes and pesticides, and human and animal wastes. For this, globally, household water-treatment system, like boiling, household slow sand filter, domestic chlorination (Wuha agar, and aqua tabs), filter machine is recommended to be implemented. According to the current study, the odds of developing acute diarrhea was higher among children whose families did not treat drinking water as compared to their counterpart. This finding is consistent with a study conducted in Derashe district Ethiopia, Wolaita-Soddo Ethiopia, and Harar Ethiopia. The possible hypothesis might be water can be contaminated during transport, storage, or by the method to take water from storage containers. Subsequently, it creates a suitable environment for the multiplication of protozoan, bacterial, viral, fungal, and parasitic causes of water-borne diseases in non-treated water and they could cause diarrhea disease after they enter into a human body.

In this study, among the behavioral practices, children whose mothers/caregivers did not wash their hands at the critical time more likely to develop diarrhea than children whose mothers did hand-washing at critical times. This
Table 3 Environmental Characteristics Among Under-Five Children in Northeast Ethiopia, 2019

| Characteristics | Case (77) | Control (229) |
|-----------------|-----------|---------------|
|                 | Frequency (%) | Frequency (%) |
| Animal lives in the same house | 57 74 186 | 81.2 |
|                 | 20 26 43 | 18.8 |
| Availability of latrine | 2 2.6 6 | 2.6 |
|                 | 75 97.4 223 | 97.4 |
| Latrine ownership | 54 70.1 188 | 82.1 |
|                 | 21 27.3 35 | 15.3 |
| Open field (those who did not have latrine) | 2 2.6 6 | 2.6 |
| Child faces disposal | In latrine | 59 76.6 217 | 94.8 |
|                 | Not in latrine | 18 23.4 9 | 5.2 |
| Waste disposal | Pic | 20 26 68 | 29.7 |
|                 | Open field | 4 5.2 3 | 1.3 |
|                 | Burning | 16 20.8 36 | 15.7 |
|                 | Garbage can | 37 48 122 | 53.3 |
| Water source | Improved | 63 81.8 214 | 93.4 |
|                 | Not Improved | 14 18.2 15 | 6.6 |
| Distance to a drinking water source | ≤15 minutes | 63 81.8 195 | 85.2 |
|                 | >15 minutes | 14 18.2 34 | 14.8 |
| Home-based Water treatment | No | 39 50.6 40 | 17.5 |
|                 | Yes | 38 49.4 189 | 82.5 |
| Type of water Storage container | Pot | 9 11.7 16 | 7 |
|                 | Bucket | 17 22.1 81 | 35.4 |
|                 | Jerican | 46 59.7 126 | 55 |
|                 | Other ** | 5 6.5 6 | 2.6 |
| Duration of water without changing | ≤1 day | 25 32.5 79 | 34.5 |
|                 | >1 day | 52 67.5 150 | 65.5 |

(Continued)

Table 3 (Continued).

| Characteristics | Case (77) | Control (229) |
|-----------------|-----------|---------------|
|                 | Frequency (%) | Frequency (%) |
| Does the container have cover | 5 6.5 3 | 1.3 |
|                 | 72 93.5 226 | 98.7 |
| Method of drawing | Pouring | 44 57.1 131 | 57.2 |
|                 | Deepening | 33 42.9 98 | 42.8 |
| Presence of Handwashing facility near to a toilet | No | 30 39 43 | 18.8 |
|                 | Yes | 47 61 186 | 81.2 |
| Type of floor of house-made from | Cement | 49 63.6 171 | 74.7 |
|                 | Mud | 28 36.4 58 | 25.3 |
| Number of rooms | <3 | 26 33.8 56 | 24.5 |
|                 | ≥3 | 51 66.2 173 | 75.5 |
| Separate kitchen | No | 14 18.2 28 | 12.2 |
|                 | Yes | 63 81.8 201 | 87.8 |

Note: Other***, water tank.

finding is supported by a study conducted in Addis Ababa Ethiopia,26 west Gojjam Ethiopia,18 and Zambia.15 This can be justified by the fact that handwashing remains the most effective way of preventing germs and spread of diseases, like diarrhea and it can reduce diarrhea episodes by one third.27 Furthermore, hand washing after defecation, after handling of fecal materials, before preparing food and after feeding the child could reduce the occurrence of childhood diarrhea.

The result of this study also showed that children who did not exclusively breastfeed were more likely to experience acute diarrhea as compared to those children who breastfeed exclusively. This finding is consistent with a study conducted in Zambia15 and Uganda28 and Vietnam.29 This finding is explained by the fact that exclusively breastfeed for the first six months of life is a key to achieve optimal growth, development, health and it gives
Table 4 Child Care and Behavioral Characteristics Among Under-Five Children in Northeast Ethiopia, 2019

| Characteristics                                      | Case (77) | Control (229) |
|------------------------------------------------------|-----------|---------------|
|                                                      | Frequency (%) | Frequency (%) |
| Handwashing at a critical time                       |           |               |
| No                                                   | 27        | 7             | 3.1          |
| Yes                                                  | 50        | 222           | 96.9         |
| Method of Handwashing                                |           |               |
| Water only                                           | 15        | 14            | 6.1          |
| Water and substrate                                  | 50        | 215           | 93.9         |
| Exclusive breastfeeding                              |           |               |
| No                                                   | 18        | 16            | 7            |
| Yes                                                  | 58        | 213           | 93           |
| Initiation of complementary feeding                  |           |               |
| Before 6 month                                       | 19        | 21            | 9.4          |
| After 6 month                                        | 57        | 203           | 90.6         |
| Prepare the child food using a separate instrument   |           |               |
| No                                                   | 17        | 30            | 13.4         |
| Yes                                                  | 59        | 194           | 86.6         |
| Food cover after preparation                         |           |               |
| No                                                   | 3         | 5             | 2.3          |
| Yes                                                  | 73        | 219           | 97.7         |
| Food/fluid child mostly receiving                    |           |               |
| Cow milk                                             | 19        | 66            | 29.3         |
| Adult food                                           | 26        | 102           | 45.4         |
| Powder milk                                          | 16        | 22            | 9.8          |
| Gruel                                                | 13        | 29            | 12.7         |
| Other***                                              | 2         | 6             | 2.8          |
| Method of feeding                                    |           |               |
| Hand                                                 | 13        | 47            | 21           |
| Bottle                                               | 30        | 62            | 27.5         |
| Cup and spoon                                        | 20        | 62            | 27.5         |
| Child feed him/herself                               | 13        | 54            | 24           |
| Heard about diarrhea prevention and transmission     |           |               |
| No                                                   | 14        | 16            | 7            |
| Yes                                                  | 63        | 213           | 93           |

(Continued)

Table 4 (Continued).

| Characteristics                                      | Case (77) | Control (229) |
|------------------------------------------------------|-----------|---------------|
|                                                      | Frequency (%) | Frequency (%) |
| Source of information                                |           |               |
| Television                                           | 45        | 58.4          | 159          | 69.4 |
| Radio                                                | 55        | 71.4          | 158          | 69  |
| Magazine/newspaper                                   | 9         | 11.7          | 48           | 21  |
| Other***                                             | 4         | 5.2           | 9            | 3.9 |
| Counseling from health professionals                 |           |               |
| No                                                   | 21        | 27.3          | 18           | 7.9 |
| Yes                                                  | 56        | 72.7          | 211          | 92.1|
| Feed the child leftover food                         |           |               |
| No                                                   | 45        | 58.4          | 213          | 93  |
| Yes                                                  | 32        | 41.6          | 16           | 7   |
| Maternal history of diarrheal in the previous 2 wks.  |           |               |
| No                                                   | 43        | 55.8          | 212          | 92.6|
| Yes                                                  | 34        | 44.2          | 17           | 7.4 |
| Vaccination status                                   |           |               |
| Appropriate for age                                  | 68        | 88.3          | 213          | 93  |
| Inappropriate for age                                | 9         | 11.7          | 16           | 7   |
| Weight for height Z-score                            |           |               |
| Normal                                               | 60        | 77.9          | 198          | 86.5|
| Wasted                                               | 17        | 22.1          | 31           | 13.5|
| Height for age Z score                               |           |               |
| Normal                                               | 44        | 57.1          | 162          | 70.7|
| Stunted                                              | 33        | 42.9          | 67           | 29.3|
| Weight for age Z score                               |           |               |
| Normal                                               | 53        | 68.8          | 185          | 81.5|
| Underweight                                          | 24        | 31.2          | 42           | 18.5|

Notes: Other***, packed infant food; Other****, formal education and from other person.

extra protection against illness as a result.\textsuperscript{30,31} Besides, EBF could prevent diarrhoeal illness among infants on EBF practice because they are relatively safe from contaminated foods, liquids, and unsafe water drinking.

Children whose mothers did not get counseled by health professionals were likely to develop acute diarrhea as compared to those counterparts. This might be accounted for counseling given by health professionals
**Table 5** Bivariable and Multivariable Logistic Regression Analysis of Determinants of Acute Diarrhea Among Under-Five Children Northeast, 2019

| Variables                        | Case | Control | COR (95% CI) | AOR (95% CI) |
|----------------------------------|------|---------|--------------|--------------|
| Residence                        |      |         |              |              |
| Urban                            | 51   | 183     | 1.00         | 0.56(0.14,2.27) |
| Rural                            | 26   | 46      | 2.03 (1.14,3.59) | 1.92 (0.36,10.1) |
| Mothers educational status       |      |         |              |              |
| No formal education              | 15   | 32      | 2.32 (1.06,5.09) | 1.92 (0.36,10.1) |
| Primary                          | 27   | 63      | 2.12 (1.08,4.14) | 1.67 (0.49,5.67) |
| Secondary                        | 16   | 40      | 1.98 (0.92,4.24) | 1.5 (0.45,3) |
| Collage/university               | 19   | 94      | 1.00         |              |
| Father's educational status      |      |         |              |              |
| No formal education              | 12   | 20      | 2.74 (1.22,6.16) | 4.06 (0.57,7.53) |
| Primary                          | 18   | 28      | 2.94 (1.46,5.93) | 1.93 (0.37,9.96) |
| Secondary                        | 14   | 30      | 2.13 (1.02,4.47) | 3.2 (0.67,15.4) |
| Collage/University               | 33   | 151     | 1.00         |              |
| Father's occupation              |      |         |              |              |
| farmer                           | 24   | 28      | 1.00         | 1.00         |
| Government employee              | 27   | 138     | 0.23 (0.11,0.45) | 0.51 (0.19,1.32) |
| merchant                         | 19   | 56      | 0.39 (0.18,0.84) | 0.47 (0.16,1.37) |
| other*                           | 7    | 7       | 1.16 (0.35,3.8) | 3.6 (0.76,17.76) |
| Monthly income                   |      |         |              |              |
| ≤1000                            | 15   | 37      | 1.7 (0.81,3.55) | 0.24 (0.04,1.19) |
| 1000–5000                        | 36   | 83      | 1.82 (1.02,3.25) | 0.56 (0.18,1.72) |
| >5000                            | 26   | 109     | 1.00         |              |
| Child age                        |      |         |              |              |
| <6 month                         | 11   | 14      | 2.77 (1.06,7.21) | 4.93 (0.83,30.29) |
| 6–11 month                       | 22   | 57      | 0.41 (0.65,2.82) | 2.17 (0.66,7.1) |
| 12–23 month                      | 16   | 59      | 0.95 (0.44,2.07) | 1.09 (0.32,3.6) |
| 24–35 month                      | 11   | 39      | 0.99 (0.42,2.35) | 1.77 (0.46,6.69) |
| ≥36 month                        | 17   | 60      | 1.00         |              |
| Under-five children in the house |      |         |              |              |
| 1                               | 55   | 183     | 1.00         | 1.22 (0.44,3.41) |
| ≥2                              | 22   | 46      | 1.59 (0.88,2.87) |              |
| Animal lives in the same house   |      |         |              |              |
| No                               | 57   | 186     | 1.00         | 1.78 (0.54,5.82) |
| Yes                              | 20   | 43      | 1.52 (0.82,2.78) |              |
| Child faces disposal             |      |         |              |              |
| In latrine                       | 59   | 217     | 1.00         | 4.12 (1.25,13.5) |
| Not in latrine                   | 18   | 12      | 5.52 (2.52,12.1) |              |
| Latrine ownership                |      |         |              |              |
| Privately                        | 54   | 188     | 1.00         | 0.66 (0.20,2.17) |
| Shared                           | 21   | 35      | 2.08 (1.12,3.88) |              |
| Home-based Water treatment       |      |         |              |              |
| No                               | 39   | 40      | 4.849 (2.76,8.51) | 2.85 (1.27,6.42) |
| Yes                              | 38   | 189     | 1.00         |              |

(Continued)
Table 5 (Continued).

| Variables                                             | Case | Control | COR (95% CI)          | AOR (95% CI)         |
|-------------------------------------------------------|------|---------|-----------------------|----------------------|
| Cover of water container                              |      |         |                       |                      |
| No                                                    | 72   | 226     | 5.23 (1.22,22.4)      | 1.54 (0.08,26.82)    |
| Yes                                                   | 5    | 3       | 1.00                  |                      |
| Presence of Handwashing facility near to the toilet   |      |         |                       |                      |
| No                                                    | 47   | 186     | 2.76 (1.57,4.86)      | 1.53 (0.43,5.45)     |
| Yes                                                   | 30   | 43      | 1.00                  |                      |
| Number of rooms                                       |      |         |                       |                      |
| <3                                                    | 51   | 173     | 1.57 (0.89,2.75)      | 0.78 (0.23,2.65)     |
| ≥3                                                    | 26   | 56      | 1.00                  |                      |
| Separate kitchen                                      |      |         |                       |                      |
| No                                                    | 63   | 201     | 1.59 (0.79,3.22)      | 0.49 (0.11,2.27)     |
| Yes                                                   | 14   | 28      | 1.00                  |                      |
| Handwashing at a critical time                        |      |         |                       |                      |
| No                                                    | 50   | 222     | 3.715 (1.78,115)      | 5.47 (1.68,17.8)     |
| Yes                                                   | 27   | 7       | 1.00                  |                      |
| Method of Handwashing                                 |      |         |                       |                      |
| Water only                                            | 50   | 215     | 3.715 (1.78,115)      | 0.332 (0.06,1.66)    |
| Water and substrate                                   | 15   | 14      | 1.00                  |                      |
| Exclusive breastfeeding                               |      |         |                       |                      |
| No                                                    | 58   | 213     | 4.13 (1.98,8.60)      | 3.32 (1.21,9.14)     |
| Yes                                                   | 18   | 16      | 1.00                  |                      |
| Complementary feeding                                 |      |         |                       |                      |
| Before 6 month                                        | 57   | 203     | 3.22 (1.62,6.4)       | 0.35 (0.21,1.73)     |
| After 6 month                                         | 19   | 21      | 1.00                  |                      |
| Prepare the child food using a separate instrument    |      |         |                       |                      |
| No                                                    | 59   | 194     | 1.86 (0.96,3.6)       | 0.32 (0.08,1.22)     |
| Yes                                                   | 17   | 30      | 1.00                  |                      |
| Heard about diarrhea                                  |      |         |                       |                      |
| No                                                    | 63   | 213     | 2.95(1.37,6.39)       | 0.22 (0.03,1.31)     |
| Yes                                                   | 14   | 16      | 1.00                  |                      |
| Counseling from HP                                    |      |         |                       |                      |
| No                                                    | 56   | 211     | 4.39(2.19,8.8)        | 3.23(1.15,9.09)      |
| Yes                                                   | 21   | 18      | 1.00                  |                      |
| Feed the child leftover food                          |      |         |                       |                      |
| No                                                    | 32   | 16      | 9.46 (4.79,18.7)      | 2.96 (1.19,7.32)     |
| Yes                                                   | 45   | 213     | 1.00                  |                      |
| Maternal history of diarrheal in the previous 2 wks.   |      |         |                       |                      |
| No                                                    | 31   | 17      | 8.4(4.29,16.45)       | 6.06(2.42,15.2)      |
| Yes                                                   | 46   | 212     | 1.00                  |                      |
| Weight for height z-score                             |      |         |                       |                      |
| Normal                                                | 17   | 31      | 1.81 (0.93,3.49)      | 0.91 (0.25,3.3)      |
| Wasted                                                | 60   | 198     | 1.00                  |                      |

(Continued)
may improve mothers’ knowledge towards child health and could modify women’s beliefs about disease causation. Thus, it could influence both childcare practices and the use of modern healthcare services. Mothers are important promotor of counseling and practices within the home and the benefits of their knowledge extend to their children and others.

Children who consumed left-over food were at higher risk to develop acute diarrhea compared with children who did not consume left-over food. This finding is supported by a study conducted in Harar Ethiopia24 and Derashe district Ethiopia.23 Those studies showed that the occurrence of acute diarrhea was significantly associated with the consumption of leftover food. This might be due to improper food storage induces the growth of bacteria and leads the food to be easily contaminated32.

Children whose mothers had diarrhea in the past two weeks were more likely to develop acute diarrhea than those children whose mothers did not have a history of diarrhea within the previous two weeks. This finding is in agreement with a study conducted in Harar Ethiopia that showed that maternal history of diarrhea predicts the occurrence of diarrhea in children.24 This might be because mothers are the main childcare providers. As a result, maternal morbidity may compromise childcare.33 Besides, mothers usually participate in food preparation or cooking in the family, the poor hygienic practice of the mothers during illness may result in diarrhea in children.

**Limitation of the Study**
As to limitations, some behavioral practices, including handwashing practices were self-reported by the respondents. Self-reported data have been found to introduce bias to estimate behavioral practices.

**Conclusions**
In summary, the study revealed that improper child stool disposal, did not have home-based water treatment, mother did not wash hand at critical times, not exclusive breastfeeding, not getting counseling from health professionals, feed the child leftover food, and history of maternal diarrhea within the previous two weeks were determinants of acute diarrhea among under-five children. Thus, collaborative intervention by emphasizing health education about the importance of personal and environmental hygiene, safe food handling, exclusive breastfeeding practice, and home-based water treatment are essential.

**Abbreviations**
CI, confidence interval; CDDs, congenital diarrheal disorders; DD, diarrheal disease; EPI, Expanded Program of Immunization; EDHS, Ethiopian Demographic Health Survey; HEWs, health extension workers; IRB, Institution Review Board; OR, odds ratio; ORT, oral rehydration therapy; POPD, pediatric outpatient department; SPSS, Statistical Package of Social Science, SDGs, sustainable development goals; UNICEF, Unite Nation International Children’s Emergency Fund; WHO, World Health Organization.

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The authors declared that they have no competing interests in this work.
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