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Determinants of Diarrheal Morbidity among Under-Five Children in Negelle-Arsi District, Oromia Regional State, Ethiopia

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Abstract

Background

Integrated water, sanitation, and hygiene (WASH) interventions are essential for improving public health and reducing the burden of preventable diseases in rural communities. To address these challenges, governments and development partners work together to expand access to safe water, improved sanitation facilities, and appropriate hygiene practices. This study examines the factors associated with diarrhea morbidity among children under five years of age, while also assessing water supply and accessibility, sanitation conditions, and hygiene practices in rural communities.

Methods

The cross-sectional data were collected in May 2025 from six kebele administrations (KAs), consisting of three intervention areas and three non-intervention areas, using a structured household questionnaire. A total of 396 households with under five children participated in the study, with an equal split between the intervention and control groups. Descriptive analysis was applied to compare differences between the groups in water access and supply, as well as sanitation and hygiene conditions. In addition, logistic regression analysis was conducted to identify the determinants of diarrhea morbidity among children under five years of age.

Results

The findings show clear improvements among intervention households compared with controls. Average household water consumption was higher in the intervention group (20.60 liters per person per day) than in the control group (10.08 liters), and the time required to fetch water was substantially lower (13.85 minutes vs. 55.84 minutes). All intervention households used protected water sources compared with 76.8% of controls, while reliable water access was reported by 90.4% and 60.6%, respectively. Sanitation conditions were also better among intervention households, with higher latrine access (95.0% vs. 78.3%), greater open defecation-free status (76.8% vs. 48.0%), and improved availability of handwashing facilities with soap and water (81.8% vs. 32.8%). Handwashing knowledge and practices were consistently higher in the intervention group, including knowledge of critical times (77.3% vs. 45.0%) and improved hygiene behaviors across all key practices. Consequently, under-five diarrhea prevalence was much lower in intervention households (2.5%) compared with controls (34.9%). The logistic regression analysis further showed that participation in the WASH intervention was strongly associated with reduced childhood diarrhea (AOR = 0.053), while caregiver diarrhea (AOR = 3,589.75), lack of latrine access (AOR = 0.043), improper latrine use (AOR = 6.386), longer distance to roads (AOR = 1.0165), and lower wealth status were all important predictors of increased diarrhea risk.

Conclusion

Overall, the study highlights that integrated WASH interventions, combined with efforts to improve household hygiene behaviors, sanitation utilization, infrastructure access, and socioeconomic conditions, can play a critical role in reducing the burden of childhood diarrhea and improving child health outcomes in rural communities.

Keywords: Water, Sanitation and Hygiene, Children Diarrhea, Ethiopia

Background

Development and public health-driven Water, Sanitation, and Hygiene (WASH) are fundamental areas of focus for improving public health and ensuring access to clean water, proper sanitation, and hygiene in communities.

Global theories consistently show that inadequate WASH (water, sanitation, and hygiene) increases morbidity, mainly through diarrheal diseases, parasitic infections, and other hygiene-related illnesses. Environmental health and disease ecology models highlight how contaminated environments, pathogens, and human exposure interact to cause disease [1]. Globally, evidence confirms that improved WASH reduces disease burden, especially in low- and middle-income countries [2].

Safe drinking water is defined as water from an improved water source, which includes household connections, public standpipes, boreholes, protected dug wells, protected springs and rainwater collections. Similarly, access to safe drinking water is defined as the availability of at least 20 liters per person per day from an improved source within 1 kilometer of the user's dwelling [3]. Sanitation is defined as access to and use of facilities and services for the safe disposal of human excreta. Hygiene is the conditions and practices that help maintain health and prevent the spread of disease including handwashing, food hygiene, and menstrual hygiene management [1].

Morbidity is the state of being diseased or unhealthy within a population, encompassing the incidence, prevalence, and severity of illnesses or health conditions [4]. Diarrhea morbidity refers to the occurrence or prevalence of diarrheal within a population, indicating the burden of illness caused by frequent loose or watery stools, often resulting from infections transmitted through contaminated water, poor sanitation, or inadequate hygiene practices.

Diarrheal disease is a leading cause of child mortality and morbidity worldwide and is mostly caused by contaminated food and water sources. Diarrhea resulting from infection is prevalent in developing countries. In low-income countries, children under 3 years old typically experience three episodes of diarrhea each year. Each episode deprives the child of the nutrition needed for growth. Consequently, diarrhea is a significant cause of malnutrition, and malnourished children are more susceptible to illness from diarrhea [5]. Worldwide, unsafe water, inadequate sanitation, or insufficient hygiene leads to 80% of diarrhoea cases [6].

The burden of diarrheal disease has fallen dramatically over the past 20 years from 2.6 million in 2000 to 1.5 million in 2019. Among children under five, diarrhea deaths dropped from 1.1 million in 2000 to 381 000 in 2019. However, diarrhea deaths remain especially high in low- and lower-middle-income countries [7].

Sub-Saharan Africa remains the region with the largest disease burden from inadequate WASH: 53% of all WASH-attributable deaths and 60% of all WASH-attributable DALYs occur in this region, and nearly one fifth of all deaths of children under 5 years could be prevented with adequate WASH [1].

Diarrheal disease is a leading cause of child mortality and morbidity in the world and mostly results from contaminated food and water sources. Worldwide, 780 million individuals lack access to improved drinking water and 2.5 billion lack improved sanitation. Diarrhea due to infection is widespread throughout developing countries [8]. A recent systematic review and meta-analysis found that the pooled prevalence of diarrhea among under-five children in Ethiopia was 19.6% during the two weeks preceding surveys conducted between 2015 and 2024 [9].

Studies consistently show that improved water, sanitation, and hygiene (WASH) services reduce childhood diarrhea. WASH interventions in Bangladesh significantly lowered diarrhea prevalence among children under five, particularly when households practiced proper handwashing, used clean latrines, and safely disposed of child feces [10,11]. Similarly, inadequate access to safe water and sanitation, especially in conflict-affected areas such as Tigray, was linked to higher rates of childhood diarrhea [12].

Maternal education and hygiene practices strongly influence childhood diarrhea. Children's mothers with limited education are more likely to experience diarrhea because educated mothers tend to have better hygiene knowledge and child-care practices [13,14]. Poor maternal handwashing, maternal illness, inadequate child feeding practices, and having multiple young children in the household have also been associated with increased diarrhea risk [15-17].

Household economic status and access to services are important determinants of childhood diarrhea. Children from poorer households are more vulnerable due to limited access to clean water, sanitation facilities, hygiene supplies, and healthcare services [18,19]. Likewise, households located far from roads, markets, and health facilities often face greater challenges in accessing essential services, increasing the risk of diarrheal diseases among children [20,21].

Poor sanitation and hygiene practices remain major contributors to childhood diarrhea. Lack of handwashing facilities, improper waste disposal, unsafe water sources, poor latrine use, and inadequate handwashing at critical times have been consistently linked to higher diarrhea prevalence among children under five [22,23]. Studies also show that improving hygiene knowledge, sanitation facilities, and handwashing practices can significantly reduce childhood diarrhea [24,25].

Methods

Design and Setting of the Study

A cross-sectional study was carried out in Negelle-Arsi District of the Oromia Regional State, Ethiopia, to assess the influencing factors of under-five year child diarrhea. Descriptive statistical methods were used to compare and explore the relationships among variables between households that received the intervention and those that did not. Subsequently, the study employed a multivariate logistic regression model to examine the influencing factors of covariates on the dependent variable of under-five year children diarrhea.

To address the poor WASH conditions in the project area, Habitat for Humanity Ethiopia, with financial support from Korea International Cooperation Agency, implemented an integrated WASH project between 2019 and 2022. The project combined Water, Sanitation, and Hygiene (WASH) interventions with the Community-Led Total Sanitation and Hygiene (CLTSH) approach to improve health outcomes and promote sustainable behavior change within the community. Improving access to safe drinking water, adequate sanitation facilities, and proper hygiene practices plays a critical role in enhancing child health and well-being by reducing the transmission of infectious diseases and supporting better nutritional outcomes [26].

Data Sources and Types

The study collected quantitative primary data from rural households in both intervention and non-intervention Kebele Administrations (KAs) using a structured household survey conducted over a one-week period in May 2025. Prior to the actual survey, the questionnaire was pilot tested to assess its clarity, relevance, and reliability. Experienced data collectors were recruited and provided with thorough training on the survey instrument, interview techniques, and data collection procedures to ensure the quality and consistency of the data collected.

Sampling Design and Techniques

The study used a probability-based random sampling method to ensure that all eligible households had an equal chance of being selected. Overall, a two-stage random sampling approach was applied to systematically identify and select the households that participated in the study.

During the first stage, three Kebele Administrations (KAs) were randomly selected from the intervention areas and three from the non-intervention areas, resulting in a total of six KAs. Using the lottery method, Kersa Elala, Gorbi Derera, and Danshe were selected from the intervention group, while Hada Bila, Hada Bosso, and Chri Lalu were selected from the non-intervention group.

In the second stage, households were chosen through systematic random sampling. After randomly selecting the first household, the remaining households were identified at regular sampling intervals (n) until the required sample size was reached. The final number of households selected from each KA was allocated proportionally according to the population size of each kebele, ensuring adequate representation across all study areas.

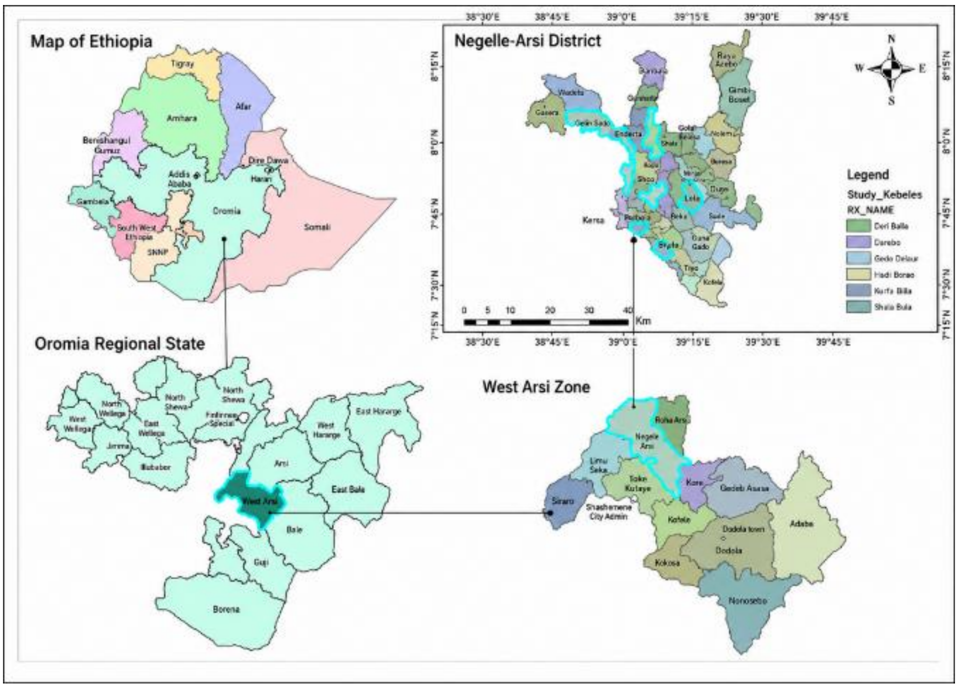

Figure 1: Map of The Study Area

Sample Size Determination

The study included households that participated in the WASH intervention, along with comparable non-beneficiary households from control kebeles. The sample size was calculated using the Yemane formula to obtain a representative sample of the population without conducting a full census [41]. The formula used is presented below:

$$n = \frac{N}{1 + N\,(e^2)}$$

In the formula, n represents the required sample size, N is the total population, and e refers to the margin of error or level of precision. Based on this equation, the sample size was calculated from the six selected kebele administrations, three intervention and three non-intervention, using the defined sampling frame. The total population (N) was 44,156, with a precision level (e) of 5%. Accordingly, a total of 396 households were selected, comprising 198 households in the intervention group and 198 in the control group

$$Sample\ size = \frac{44{,}156}{1+44{,}156\,(0.05^2)} = 396 \text{ households}$$

The calculated sample size was distributed across the kebele administrations based on probability proportional to their respective population sizes, as shown in Table 1 below.

	Sampled KAs	Population		Sample Size	
		Treated	*Control*	*Treated*	*Control*
Treated KAs	Kersa Elala	6,736		60	
	Gorbi Derara	8,409		71	
	Danshe	7,861		67	
Control KAs	Shala Bila		6,661		62
	Hada Bosso		5,922		56
	Chri Lalu		8,567		80
	Sub-Total	*23,006*	*21,150*	*198*	*198*
	Grand Total	*44,156*		*396*	

Table 1: Study Sample Size and Sample Frame

Definitions and Measurement Of Study Variables

Dependent Variable

Under-Five Year Child Diarrhea Morbidity

The incidence of children diarrhea in households is represented by a dichotomous value based on the occurrence of diarrhea. Households whose children experienced diarrhea in the two weeks prior to the survey are assigned a value of 1, while those without diarrhea are assigned a value of 0.

Independent Variables

Drawing on previous studies, the analysis included several covariates associated with under-five diarrheal morbidity, covering WASH program participation as well as socioeconomic, maternal, demographic, institutional, and household-level factors. Accordingly, the logistic regression model incorporated variables such as WASH program participation, recent diarrheal illness among mothers/caregivers (within the last two weeks), access to and use of latrines, knowledge of critical handwashing practices, proximity to all-weather roads, and the household asset index.

Participation in a Program

Household participation in the program was defined as a binary variable based on whether or not a household had access to the WASH intervention. Households with full access to the intervention were coded as 1 (participants), while those without access were coded as 0 (non-participants).

Asset Index

Measuring household socio-economic position by an asset index is considered one of the alternatives to income and consumption expenditure. This study collected data on asset ownership in a rural setting, including durable assets (mobile phones and radios), housing characteristics (iron sheet roof), land and livestock ownership (land, cattle, and equine animals), and basic services (electricity supply – hydropower and/or solar). These lists of assets were reduced to a single asset score using principal component analysis. The cumulative factor scores of the first, second, and third components (57 percent) were used as weights for each asset to create an asset index for each household. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was performed to validate the result, which was 0.5742, indicating that the use of PCA is acceptable when KMO is greater than 0.5. According to literature, the average mean values of components 1, 2, and 3 indices were stratified into wealth quintiles in which a higher household asset index score indicates a higher relative economic status in the sample.

Data Analysis
The data was collected from respondents using the Kobo Toolbox platform. After collection, the dataset was cleaned and organized in Stata 17 by running variable-by-variable tabulations to detect and correct missing data, inconsistencies, outliers, and entry errors. Descriptive statistics were then used to summarize the socio-demographic, socio-economic, and maternal characteristics of both the intervention and control groups. The study also assessed participants' access to water, sanitation, and hygiene services.

The study employed a multivariate logistic regression model to examine the influencing factors of covariates on the dependent variable of under-five child diarrhea. Logistic regression is a powerful statistical method widely used in health research to model and predict the probability of binary and categorical outcomes [27]. It is a statistical method widely used in health research to model the relationship between one or more independent variables and a binary or categorical dependent variable [28]. In line with this, the study specifically used binary logistic regression model which is extensively applied in public health research. This model is specified as follows: -

$$Logit(P) = \log\left(\frac{P}{1-P}\right) = \beta0 + \beta1X1 + \beta2X2 + \cdots + \beta iXi$$

Where: P stands for the probability of getting childhood diarrhea, which is the dependent variable 1 for children with diarrhea incidence and 0 for otherwise; $\left(\frac{P}{1-P}\right)$ stands for the odds of the outcome, $\log\left(\frac{P}{1-P}\right)$ represents the log-odds or logit; βi stands for coefficients estimated from data and Xi represents independent variables.

Logistic Regression Model Test
Prior to estimation, key model assumptions were checked. Linearity in the logit was tested using the Box–Tidwell approach, and no evidence of non-linearity was found for continuous predictors such as distance to all-weather roads, indicating an appropriate linear relationship in the logit. Multicollinearity was also assessed using the Variance Inflation Factor (VIF), and all variables showed low values (mean VIF = 1.53), confirming that multicollinearity was not a concern. The model demonstrated excellent predictive performance, with an Area Under the ROC Curve (AUC) of 0.987 (95% CI: 0.978–0.997), indicating outstanding ability to distinguish between children with and without diarrhea. Overall model fit was strong, supported by a significant likelihood ratio test (LR $\chi^2(13) = 274.91$, $p < 0.001$), a pseudo-R^2 of 0.7848, and a high classification accuracy based on 396 observations, confirming the model's robustness and reliability.

Quality Assurance
All data collectors held bachelor's degrees and had prior experience in similar field data collection work. The questionnaire was pre-tested with 20 respondents to ensure clarity, completeness, and reliability, and the results confirmed its appropriateness for the study. Data quality was further strengthened through the Kobo Toolbox platform, which provided built-in validation and monitoring features. GPS coordinates were captured for each household, and photographs of housing conditions, latrines, or handwashing facilities were taken with consent where applicable. In addition, data were submitted daily through the online system and routinely reviewed, with particular attention to geographic coordinates, to verify respondent locations and ensure overall data accuracy.

Ethical Considerations
The study was carried out in accordance with the ethical principles outlined in the 1964 Helsinki Declaration and its 2024 revision, along with other relevant ethical guidelines [29]. Before data collection began, official approval was secured by the local government through written authorization. Data collectors ensured confidentiality throughout the data collection process, and although respondents were identifiable for study purposes, their information was handled anonymously to protect their privacy. Ethical standards were strictly followed, including obtaining informed consent, safeguarding confidentiality, minimizing potential harm, avoiding conflicts of interest, and respecting local cultural beliefs and practices. The study also adhered to applicable local laws and administrative requirements.

Results
Household Characteristics of Respondents
The study involved 396 households drawn from six Kebele administrations. Of these, 9% (34 households) were headed by females, while the vast majority, 91% (362 households), were male headed. Female-headed households were relatively more prevalent in the control group (25 households) compared to the intervention group (9 households).

The results in Table 2 show clear differences between the treated and control groups across several household characteristics. The mean age of household heads is almost identical between groups, with 39.17 years in the treated group and 38.60 years in the control group, showing no statistically significant difference ($t = 0.8513$, $p > 0.05$). However, household family size is significantly smaller among treated households, with a mean of 5.69 compared to 6.47 in the control group, and the difference is statistically significant ($t = 3.989$, $p < 0.001$).

In terms of sex of household head, male-headed households dominate both groups, 95.5% (189) in the treated group and 87.4% (173) in the control group, while female-headed households account for 4.5% (9) and 16.6% (25), respectively. This difference is statistically significant ($\chi^2 = 8.236$, $p = 0.004$).

Educational attainment of household heads also varies significantly ($\chi^2 = 27.778$, $p < 0.001$). In the treated group, 7.5% (15) cannot read and write, compared to 25.3% (50) in the control group. Conversely, higher levels of education are more common among treated households, including secondary education (25.3%, 50 vs. 15.7%, 31) and tertiary education (1.0%, 2 vs. 1.5%, 3), indicating relatively better educational status in the intervention group.

Regarding the relationship of the respondent to the child, most were mothers in both groups, 98.5% (195) in the treated group and 86.4% (171) in the control group, while caregivers accounted for 1.5% (3) and 13.6% (27), respectively. This difference is statistically significant ($\chi^2 = 20.774$, $p < 0.001$).

Marital status of mothers/caregivers shows that nearly all were married: 99.5% (197) in the treated group and 96.0% (190) in the control group, with a small proportion being single (0.5%, 1 vs. 4.0%, 8). The difference is statistically significant ($\chi^2 = 5.571$, $p = 0.018$). For caregiver education level, the distribution shows slight variation across groups ($\chi^2 = 8.2365$, $p = 0.083$). In the treated group, 18.7% (37) were not literate compared to 27.3% (54) in the control group, while 15.7% (31) and 8.6% (17) reached secondary education, respectively, indicating a somewhat better educational profile in the intervention group.

Finally, recent diarrhea among mothers/caregivers was significantly higher in the control group. Overall, 22.7% (90) reported diarrhea in the past two weeks, compared to 8.1% (16) in the treated group and 37.4% (74) in the control group, highlighting a significant difference between the two populations ($\chi^2 = 48.371$, $p < 0.001$).

Variables	**Sample HHs**	**Treated**	**Control**	**Difference in**	**t-value**
	Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	
Household head age	38.89 (6.61)	39.17 (6.20)	38.60 (6.99)	0.56 (-0.79)	0.8513
Household family size	6.08 (2.00)	5.69 (2.03)	6.47 (1.90)	0.78 (-0.78)	3.989***
Characteristics		**Sample HHs**	**Treated**	**Control**	**x^2-Value (p-value)**
		N (396) (Percent)	**N(198) (Percent)**	**N (198) (Percent)**	
Household head sex	Male	362 (91.4) 34 (8.6)	189 (95.5) 9 (4.5)	173 (87.4) 25 (16.6)	8.236 (0.004)**
Household head education level	Not Read Write Read & Write Primary Secondary Tertiary	65 (16.4) 118 (29.8) 127 (32) 81 (20.5) 5 (1.3)	15 (7.5) 59 (29.8) 72 (36.4) 50 (25.3) 2 (1.0)	50 (25.3) 59 (29.8) 55 (27.8) 31 (15.7) 3 (1.5)	27.778 (0.00)***
Maternal relation of child with household women	Mother Caregiver	366 (92.4) 30 (7.6)	195 (98.5) 3 (1.5)	171 (86.4) 27 (13.6)	20.774 (0.000)***
Household mother marital status	Single married	9 (2.3) 387 (97.7)	1 (0.5) 197 (99.5)	8 (4.0) 190 (96.0)	5.571 (0.018)**
Household mother/ caregiver education level	Not Read Write Read & Write Primary Secondary Tertiary	91 (23.0) 121 (30.6) 129 (32.6) 48 (12.2) 7 (1.8)	37 (18.7) 58 (29.3) 69 (36.9) 31 (15.7) 3 (1.5)	54 (27.3) 63 (31.8) 60 (30.3) 17 (8.6) 4 (2.0)	8.2365 (0.083)*
Mother/caregiver experience diarrhea in the last two weeks.	Yes No	90 (22.7) 306 (77.3)	16 (8.1) 182 (91.9)	74 (37.4) 124 (62.6)	48.371 (0.000)***
Source: Survey Data, 2025 Note: *, ** and *** represent significant at the level of 10%, 5% and 1%, respectively.					

Table 2: Background Characteristics of Households and Under-Five Year Children (n=396)

Variables	Sample HHs	Treated	Control	Difference in	t-value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Water consumption in liter per person per day	15.34 (7.65)	20.60 (6.09)	10.08 (4.63)	10.51 (1.46)	18.80***
Time taken to fetch H2O in minute	34.85 (38.73)	13.85 (10.33)	55.84 (44.88)	-41.99 (-34.55)	12.83***
Water storage in house in days	1.97 (1.01)	1.73 (0.66)	2.22 (1.22)	-0.49 (-0.56)	-4.94***
Characteristics		**Sample HHs**	**Treated**	**Control**	**x^2-Value (p-value)**
		N (396) (Percent)	**N(198) (Percent)**	**N (198) (Percent)**	
Water source for the last one year	Protected Unprotected	350 (88.4) 46 (11.6)	198 (100) 0 (0)	152 (76.8) 46 (23.2)	52.045 (0.000)***
Water source reliability in terms of availability	Yes No	299 (75.5) 97 (24.5)	179 (90.4) 19 (9.6)	120 (60.6) 78 (39.4)	47.529 (0.000)***
Source: Survey Data, 2025 Note: *, ** and *** represent significant at the level of 10%, 5% and 1%, respectively.					

Table 3: Water Access and Supply Variables (n=396)

Household Water Supply and Access

The findings in Table 3 above highlight important differences between the treated and control groups in water access, usage, and related conditions. On average, household water consumption was significantly higher in the treated group at 20.60 liters per person per day compared to 10.08 liters in the control group, with an overall mean of 15.34. The difference between groups is statistically significant (mean difference = 10.51, t = 18.80, $p < 0.001$), indicating substantially better water access among treated households.

Similarly, the time required to fetch water was much shorter for treated households, averaging 13.85 minutes compared to 55.84 minutes for the control group. The overall mean time was 34.85 minutes, and the difference is highly significant (mean difference = -41.99, t = 12.83, $p < 0.001$), showing a major reduction in water collection burden among intervention beneficiaries.

Household water storage duration also differed significantly between groups. Treated households stored water for an average of 1.73 days, while control households stored it for 2.22 days, with an overall mean of 1.97 days. The difference is statistically significant (mean difference = -0.49, t = -4.94, $p < 0.001$), suggesting more frequent water turnover in the treated group.

Regarding water sources, all treated households (100%, 198) relied on protected water sources, compared to 76.8% (152) in the control group, while 23.2% (46) of control households depended on unprotected sources. This difference is statistically significant ($\chi^2 = 52.045$, $p < 0.001$), indicating better water safety among intervention households which is due to the project intervention.

Finally, water source reliability also differed significantly between groups ($\chi^2 = 47.529$, $p < 0.001$). In the treated group, 90.4% (179) reported reliable water availability compared to 60.6% (120) in the control group, while 9.6% (19) and 39.4% (78), respectively, reported unreliable access. Overall, these results demonstrate substantially improved water access, quality, and reliability among households benefiting from the intervention.

Sanitation and Hygiene Situation of Households

The findings in Table 4 present key differences between the treated and control groups in sanitation, hygiene, and child health outcomes. Regarding latrine access, a high proportion of households overall reported having access to a latrine, 86.6% (343), while 13.4% (53) had no access. However, access was significantly higher in the treated group at 95.0% (188) compared to 78.3% (155) in the control group. The difference is statistically significant ($\chi^2 = 23.722$, $p < 0.001$), indicating better sanitation infrastructure among intervention households.

Open defecation-free (ODF) status also shows clear variation between groups. Overall, 62.4% (247) of households were ODF, while 37.4% (149) were not. In the treated group, 76.8% (152) were ODF compared to only 48.0% (95) in the control group, and the difference is statistically significant ($\chi^2 = 34.959$, $p = 0.001$).

Access to water and handwashing facilities at the toilet was reported by 55.4% (190) of households overall. This was much higher in the treated group at 68.6% (129) compared to 39.4% (61) in the control group, with a significant difference ($\chi^2 = 29.441$, $p < 0.001$). Similarly, availability of a handwashing facility with water and soap at home was significantly better among treated households. Overall, 57.3% (227) had such facilities, with 81.8% (162) in the treated group compared to 32.8% (65) in the control group ($\chi^2 = 97.124$, $p < 0.001$).

Household practice of proper latrine use also differed notably between groups. Overall, 73.2% (290) reported proper use, including 89.4% (177) of treated households compared to 57.1% (113) in the control group, and the difference is statistically significant ($\chi^2 = 52.766$, $p < 0.001$).

Finally, under-five diarrhea morbidity in the last two weeks was substantially lower in the treated group. Overall prevalence was 18.7% (74), with only 2.5% (5) in the treated group compared to 34.9% (69) in the control group. This difference is highly significant ($\chi^2 = 68.072$, $p < 0.001$), suggesting a strong protective effect associated with the WASH intervention.

Characteristics		**Sample HHs**	**Treated**	**Control**	**x²-Value (p-value)**
		N (396) (Percent)	**N (198) (Percent)**	**N (198) (Percent)**	
Sanitation Situation					
Latrine accessibility	Yes No	343 (86.6) 53 (13.4)	188 (95.0) 10 (5.0)	155 (78.3) 43 (21.7)	23.722 (0.000)***
Open defecation free household	Yes No	247 (62.4) 149 (37.4)	152 (76.8) 46 (23.2)	95 (48.0) 103 (52.0)	34.959 (0.001)***
Water & handwashing facility at the toilet	Yes No	190 (55.4) 153 (44.6)	129 (68.6) 59 (31.4)	61 (39.4) 94 (60.7)	29.441 (0.000)***
Hygiene Situation					
Hand washing facility with water and soap at home	Yes No	227 (57.3) 169 (42.7)	162 (81.8) 36 (18.2)	65 (32.8) 133 (67.2)	97.124 (0.000)***
Households use latrine properly all time	Use properly Not use properly	290 (73.2) 106 (26.8)	177 (89.4) 21 (10.6)	113 (57.1) 85 (42.9)	52.766 (0.000)***
Under five-children diarrhea morbidity in the last two weeks	Yes No	74 (18.7) 322 (81.3)	5 (2.5) 193 (97.5)	69 (34.9) 129 (65.1)	68.072 (0.000)***
Source: Survey Data, 2025 Note: *, ** and *** represent significant at the level of 10%, 5% and 1%, respectively.					

Table 4: Sanitation and Hygiene Situation of households (n=396)

Handwashing Knowledge and Practice

Table 5 below presents the handwashing knowledge and practices of respondents across the total sample and by study group (treated and control households), showing clear differences between the two groups. Overall, about 61.1% of households knew the five critical times for handwashing, while 38.9% did not. This knowledge was considerably higher among the treated group (77.3%) compared to the control group (45.0%), and the difference between the groups was statistically significant ($\chi^2 = 43.523$, $p < 0.001$).

In terms of actual practice, the findings show consistently better hand hygiene behaviors among treated households across all indicators.

Most respondents reported washing hands before and after eating food (87.9% overall), with near-universal practice among treated households (98.0%) compared to 77.8% in the control group ($\chi^2 = 37.993$, $p < 0.001$). A similar pattern is observed for washing hands after cleaning the house, where 85.1% of all respondents reported doing so, but the rate was significantly higher among treated households (96.0%) than controls (74.2%) ($\chi^2 = 36.826$, $p < 0.001$).

Handwashing after using the toilet showed one of the strongest contrasts: overall practice was 82.3%, but it was almost universal in the treated group (99.0%) compared to only 65.7% in the control group, with a highly significant difference ($\chi^2 = 75.590$, $p < 0.001$).

Similarly, washing hands during food preparation was reported by 87.6% of respondents overall, again higher among treated households (97.0%) than controls (78.3%) ($\chi^2 = 31.884$, $p < 0.001$). Finally, handwashing after cleaning a child's bottom was practiced by 85.9% of respondents, with a marked difference between treated (98.5%) and control groups (72.2%) ($\chi^2 = 51.996$, $p < 0.001$).

Overall, the findings indicate that households exposed to the intervention consistently demonstrate higher knowledge and significantly better handwashing practices across all critical hygiene moments compared to the control group.

Characteristics		Sample HHs	Treated	Control	x^2-Value (p-value)
		N (396) (Percent)	N (198) (Percent)	N (198) (Percent)	
Knowledge of the five handwashing critical times	Yes No	242 (61.1) 154 (38.9)	153 (77.3) 45 (22.7)	89 (45.0) 109 (55.0)	43.523 (0.000)***
Practice of handwashing at five critical times					
Always making hand wash before and after eating food	Yes No	348 (87.9) 48 (12.1)	194 (98.0) 4 (2.0)	154 (77.8) 44 (22.2)	37.9931 (0.000)***
Always wash hands after cleaning houses	Yes No	337 (85.1) 59 (14.9)	190 (96.0) 8 (4.0)	147 (74.2) 51 (26.8)	36.826 (0.000)***
Wash hands after using toilet or after defecation	Yes No	326 (82.3) 70 (17.7)	196 (99.0) 2 (1.0)	139 (65.7) 68 (34.4)	75.590 (0.000)***
Apply hands wash before during and after preparing food	Yes No	347 (87.6) 49 (12.4)	192 (97.0) 6 (3.0)	155 (78.3) 43 (21.8)	31.884 (0.000)***
Wash hands after child bottom cleaning	Yes No	340 (85.9) 56 (14.1)	195 (98.5) 3 (1.5)	145 (72.2) 53 (26.8)	51.996 (0.000)***
Source: Survey Data, 2025 Note: *, ** and *** represent significant at the level of 10%, 5% and 1%, respectively.					

Table 5: Handwashing Knowledge and Practice of Respondents

Households Access to Road and Nearest Market Place

Table 6 presents respondents' access to key infrastructure, focusing on travel time to the nearest all-weather road and nearby market/shops. The average distance to an all-weather road is about 19.48 minutes for the full sample. Treated households report a slightly lower average (18.62 minutes) compared to control households (20.34 minutes), resulting in a small mean difference of -1.72 minutes. However, this difference is not statistically significant (t = 1.005), suggesting that both groups have broadly similar access to roads.

In contrast, a clearer and statistically significant difference is observed in access to markets. On average, households travel about 34.31 minutes to reach the nearest shop or market. Treated households report substantially better access, with an average travel time of 26.56 minutes, compared to 42.06 minutes among control households. The resulting difference of -15.5 minutes is statistically significant (t = 5.575, $p < 0.001$).

In summary, while access to all-weather roads is fairly comparable between the two groups, treated households enjoy noticeably closer access to markets and shops. This suggests better market connectivity for the treated group, which could have implications for household economic opportunities and service utilization.

Variables	Sample HHs	Treated	Control	Difference in	t-value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Distance to all-weather road in minutes	19.48 (17.04)	18.62 (20.60)	20.34 (12.51)	- 1.72 (8.09)	1.005
Distance to the nearest shop market in minutes	34.31(28.71)	26.56 (28.71)	42.06 (26.60)	-15.5 (2.11)	5.575***
Source: : Survey Data, 2025 Note: *, ** and *** represent significant at the level of 10%, 5% and 1%, respectively.					

Table 6: Respondents Access to Road and Market

Respondents Asset-Index

The study gathered information on household asset ownership in a rural context, covering a range of indicators. These included durable goods such as mobile phones and radios, housing features like iron-sheet roofing, productive assets such as land and livestock (including cattle and equine animals), and access to basic services, particularly electricity from sources like hydropower and solar energy.

Table 7 presents the distribution of households across wealth quintiles based on the PCA-derived wealth index, comparing treated and control groups. The differences between the two groups are statistically significant ($\chi^2 = 32.985$, $p < 0.001$), indicating unequal wealth distribution.

Overall, the treated group is relatively better off economically. A larger proportion of treated households fall within the upper wealth categories, with 21.7% in the richest group and 23.7% in the richer group. Additionally, 27.8% are in the middle category, while smaller shares are found in the poorer (15.7%) and poorest (11.1%) groups. In contrast, the control group is more concentrated in the lower wealth quintiles. About one-third of control households (32.8%) fall into the poorest category, and another 22.2% are in the poorer category. Fewer households are found in the middle (20.2%), richer (12.6%), and richest (12.1%) groups. Overall, the results suggest that treated households are comparatively wealthier than control households, while the control group has a higher concentration of economically disadvantaged households. This indicates a clear baseline socio-economic imbalance between the two groups.

Characteristics		**Sample HHs**	**Treated**	**Control**	**x^2-Value (p-value)**
		N (396) (Percent)	**N (198) (Percent)**	**N (198) (Percent)**	
Wealth status (wealth index based on PCA)	Richest	67 (16.9)	43 (21.7)	24 (12.1)	32.985 (0.000)***
	Richer	72 (18.2)	47 (23.7)	25 (12.6)	
	Middle	95 (24.0)	55 (27.8)	40 (20.2)	
	Poorer	75 (18.9)	31 (15.7)	44 (22.2)	
	Poorest	87 (22.0)	22 (11.1)	65 (32.8)	
Source: : Survey Data, 2025 Note: *, ** and *** represent significant at the level of 10%, 5% and 1%, respectively.					

Table 7: Household Asset Ownership

Determining Factors for Diarrhea Morbidity Among Under-Five Children

Table 8 presents the multivariable logistic regression results identifying determinants of childhood diarrhea among under-five children in Negelle-Arsi District. The model shows several significant predictors related to WASH participation, household conditions, caregiver health, and socio-economic status.

Participation in the WASH intervention is strongly associated with reduced odds of childhood diarrhea. Children from households that participated in the intervention were significantly less likely to experience diarrhea compared to those who did not participate (AOR = 0.053, 95% CI: 0.009–0.300, $p < 0.001$), indicating a strong protective effect.

Caregiver health status also shows a very strong association. Children whose mothers or caregivers reported experiencing diarrhea in the last two weeks had dramatically higher odds of diarrhea (AOR = 3,589.75, 95% CI: 260.88–49,394.49, $p < 0.001$), suggesting strong clustering of infection within households.

Sanitation conditions were also important predictors. Households with access to a latrine had significantly lower odds of childhood diarrhea compared to those without latrines (AOR = 0.043, 95% CI: 0.043–0.402, $p = 0.006$). However, proper utilization of latrines was also critical; respondents who did not consistently use latrines properly had higher odds of diarrhea compared to those who used them properly (AOR = 6.386, 95% CI: 1.032–35.512, $p = 0.046$).

Knowledge of critical handwashing times showed a protective trend, although it was only marginally significant. Caregivers with good knowledge were less likely to report childhood diarrhea compared to those with poor knowledge (AOR = 0.204, 95% CI: 0.034–1.216, $p = 0.081$).

Longer walking time to the nearest all-weather road was associated with slightly increased odds of childhood diarrhea (AOR = 1.0165, 95% CI: 1.003–1.030, $p = 0.014$), suggesting that remoteness may contribute to poorer health outcomes.

Socio-economic status further influenced diarrhea risk. Compared to the poorest households, children in richer households had substantially lower odds of diarrhea, although the relationship varied across categories. Overall, wealth status showed a significant association with childhood diarrhea ($p < 0.05$), indicating that economic conditions remain an important underlying determinant.

In summary, the findings highlight that participation in WASH interventions, improved sanitation access and use, caregiver health, and socio-economic conditions all play key roles in influencing childhood diarrhea. The results strongly support the importance of integrated WASH and household-level improvements in reducing diarrheal disease among under-five children.

Variables	**AOR**	**95% CI**	**P-value**
Participation in WASH Intervention			
Participated	1		
Not Participated	**0.053**	**0.0094, 0.3000**	**0.001*** **
Mother/Caregiver Experienced Diarrhea in the Last Two Weeks			
Yes	1		
No	**3,589.75**	**260.88, 49,394.49**	**0.000*** **
Latrine Utilization			
Use properly all-time	1		
Not Use properly all-time	**6.3860**	**1.0321, 35.5119**	**0.046** **

Knowledge of Critical Handwashing Good Poor	 1 **0.2044**	 **0.0343, 1.2159**	 **0.081***
Distance to All Weather Road in Walking Minutes (log)	1.0165	1.0033, 1.0298	0.014***
Asset-Index Poorest Poor Medium Rich Richest	 1 **8.6774** 5.5759 0.2139 2.9570	 **1.1278, 66.7647** 0.5893, 52.7521 0.0211, 2.1687 0.4257, 20.5388	 **0.038**** 0.134 0.192 0.273
Constant	**0.0073**	**0.0006, 0.0824**	**0.000*****
Number of observations = **396**			
LR $chi^2(10)$ = **274.91**			
Prob > chi^2 = **0.0000**			
Pseudo R^2 = **0.7848**			
Log likelihood = **-37.68747**			
Source: : Survey Data, 2025 Note: *, ** and *** represent significant at the level of 10%, 5% and 1%, respectively.			

Table 8: Determinants of Childhood Diarrhea among Under-five Children in Negelle-Arsi District, Oromia Regional State, 2025

Discussion

This cross-sectional study was carried out in Negelle-Arsi District, Oromia Regional State, Ethiopia, to evaluate water supply and accessibility, sanitation and hygiene conditions, and the determining factors of under-five year child diarrhea morbidity that participated in the WASH intervention and those that did not. The intervention was implemented between 2018 and 2022 with the objective of improving WASH services and reducing the burden of waterborne diseases, particularly diarrhea disease.

Diarrheal diseases are still one of the major causes of morbidity in children under five in sub-Saharan Africa. It is among the top ten causes of death in Ethiopia in 2021, following lower respiratory infections and preterm birth complications, respectively. It is the cause of 33.67 deaths per 100 thousand population in total aged years. Access to at least a basic water supply service and improved sanitation contributes to human health and socio-economic development of a country [30].

The descriptive analysis findings revealed substantial differences in water access and supply between the two groups. Households participating in the intervention consumed an average of 20.60 liters of water per person per day, compared with 10.08 liters among non-participants. The average time spent collecting water was 13.85 minutes for intervention households and 55.84 minutes for control households. All intervention households relied on protected water sources, whereas nearly one-quarter of control households used unprotected sources. Reliable water availability was reported by 90.4% of intervention households compared with 60.6% of control households, indicating better access to safe and dependable water supplies among beneficiaries of the intervention.

The intervention group also demonstrated better sanitation and hygiene conditions. Latrine access was reported by 95.0% of intervention households compared with 78.3% of control households, while 76.8% of intervention households were open defecation free compared with 48.0% of control households. Access to handwashing facilities with water and soap at home was available in 81.8% of intervention households, compared with 32.8% of control households. Knowledge of the five critical handwashing times was reported by 77.3% of intervention households and 45.0% of control households, and handwashing practices at key moments were consistently higher among intervention households. These improvements were reflected in child health outcomes, with under-five diarrhea reported in only 2.5% of intervention households compared with 34.9% of control households. In addition, intervention households had better access to markets, requiring an average travel time of 26.56 minutes compared with 42.06 minutes among control households.

The logistic regression analysis demonstrated that participation in WASH intervention was strongly associated with a reduced risk of childhood diarrhea. Children from households participating in the intervention had approximately 95% lower odds of experiencing diarrhea compared to those from non-participating households. This finding aligns with previous studies and suggests that improvements in water supply, sanitation facilities, hygiene promotion, and community-led total sanitation activities contributed to reducing diarrheal morbidity among under-five children [5,31,32].

Maternal or caregiver diarrhea was also found to be a significant predictor of childhood diarrhea, with children in affected households facing substantially higher odds of illness. Similar findings have been reported by, highlighting the role of intra-household disease transmission and shared environmental exposures [23,33].

Access to and proper utilization of latrines were significant protective factors. Households with latrine access had 96% lower odds of childhood diarrhea, while improper latrine use increased the likelihood of diarrhea by more than six times. These findings are consistent with studies conducted by, emphasizing the importance of both availability and correct use of sanitation facilities [23,24,34-36].

Knowledge of critical handwashing practices was also associated with lower diarrheal risk. Households with good handwashing knowledge had significantly reduced odds of childhood diarrhea, supporting evidence from that hygiene awareness plays a crucial role in disease prevention [17,23,24,36,37].

The study further revealed that greater distance from all-weather roads increased the likelihood of childhood diarrhea. Households located farther from accessible roads were more vulnerable, likely due to reduced access to healthcare services, safe water, and health information. This finding is consistent with [38].

Finally, household wealth status influenced diarrheal outcomes, with children from poor households experiencing significantly higher odds of diarrhea compared to wealthier households. This finding concurs with, indicating that socioeconomic disparities continue to affect access to sanitation, hygiene resources, and healthcare services [37,39].

Conclusions

This study demonstrated that the WASH intervention substantially improved household water access, sanitation, and hygiene conditions in Negelle-Arsi District, which was associated with a marked reduction in diarrhea among under-five children. Households that participated in the intervention had better access to safe and reliable water sources, improved sanitation facilities, greater adoption of handwashing practices, and significantly lower prevalence of childhood diarrhea compared to non-participating households. The findings further revealed that participation in the WASH intervention, access to and proper use of latrines, good handwashing knowledge, and improved caregiver health were important protective factors against childhood diarrhea. Conversely, maternal or caregiver diarrhea, poor sanitation practices, greater distance from all-weather roads, and low household wealth increased the likelihood of diarrheal illness among children.

Overall, the study highlights that integrated WASH interventions, combined with efforts to improve household hygiene behaviors, sanitation utilization, infrastructure access, and socioeconomic conditions, can play a critical role in reducing the burden of childhood diarrhea and improving child health outcomes in rural communities.

Abbreviations

- CLTSH: Community-led total sanitation and hygiene
- KAs: Kebele Administrations
- PCA: Principal Component Analysis
- UNICEF: United Nation International Children's Emergency Fund
- WASH: Water, Sanitation and Hygiene
- WHO: World Health Organization

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Availability of Data and Materials

Declarations

Consent for Publication

Competing Interests

The author declares that he has no competing interests.

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