


# Prevalence of Open Defecation Practice and Associated Factors Among Households in Geshiyaro Project Implementation Sites in Ethiopia: A Cross-Sectional Study

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## ABSTRACT

**BACKGROUND:** Open defecation is a significant global challenge, impacting public health, environmental sanitation, and social well-being, especially in low- and middle-income countries like Ethiopia. It is the second-largest cause of disease burden worldwide by facilitating the spread of germs that cause diarrhea diseases. Studies examining open defecation practices are insufficient, especially in areas implementing Ethiopia's Geshiyaro project. Therefore, this study aimed to assess the status of open defecation practice and associated factors in the study area.

**METHOD:** A community-based cross-sectional study was conducted from June to July 2023. The total number of households included in this study was 7995. A structured questionnaire and observational checklist were used to collect data. Descriptive and multivariate logistic regression analyses were performed using STATA version 16.

**RESULTS:** The study found that 16.5% of households practiced open defecation. The following factors were significantly associated with the occurrence of open defecation: residence (AOR = 1.56, 95% CI: 1.26-1.92), education (AOR = 0.59, 95% CI: 0.49-0.72), age (AOR = 0.53, 95% CI: 0.41-0.69), knowledge on diarrhea prevention (AOR = 1.32, 95% CI: 1.17-1.50), marital status (AOR = 1.61, 95% CI: 1.32-1.97), and awareness creation about WASH services (AOR = 1.96, 95% CI: 1.71-2.25). On the other hand, no significant association was observed between the occurrence of open defecation and the household's income (AOR = 1.07, 95% CI: 0.93-1.23) or the head of household sex (AOR = 0.94, 95% CI: 0.78-1.12).

**CONCLUSION:** Open defecation remains a critical public health concern in Ethiopia's Geshiyaro project sites. Various factors influencing this practice have been identified. Targeted interventions are needed to enhance access to safe sanitation facilities and promote awareness of WASH services, aligning with SDG 3 target 3, and SDG 6 target 2.

**KEYWORDS:** Open defecation, sanitation, WASH, Geshiyaro, Ethiopia

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## Introduction

Open Defecation (OD) is a significant public health concern globally, in many low- and middle-income countries, with almost 892 million people worldwide still practicing it.<sup>1,2</sup> The problem is more pronounced in areas lacking access to sanitation services and infrastructure, which has caused communities to be disproportionately affected.<sup>3-6</sup> Granting communities access to safe and adequate sanitation facilities to fulfill their fundamental human rights, which include access to basic services and the right to live in a clean environment. Improved sanitation not only contributes to disease prevention but also

enhances human dignity and quality of life. Therefore, providing communities with basic sanitation services significantly imparts human dignity, improves individual and community health, and ultimately improves the quality of life.<sup>1</sup>

Numerous research conducted by academics from various countries, including Sub-Saharan Africa, Nigeria, Kenya, and India have demonstrated that open defecation poses a health risk to the public. For example, according to Belay et al, the combined prevalence of open defecation practices among households in Sub-Saharan Africa was 22.55%. The study revealed a significant disproportionate impact on the poorest



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households. Despite this, further subgroup analysis was not conducted to address the heterogeneity of the pooled estimate of open defecation.<sup>7</sup> Likewise, Abdullahi et al, reported that the majority of participants (77.8%) always practiced open defecation, 11.1% never did, and 11.1% frequently did. This presents a significant risk to the health and well-being of women and children.<sup>8</sup> In a similar vein, Okullo et al examined the bacteriological quality of drinking water sources in Isiolo County, Kenya, focusing on sanitation practices. Their study shown that inadequate sanitation, particularly open defecation, led to high levels of microbial pathogen contamination in water sources.<sup>9</sup> Open defecation persists even among latrine owners, indicating that only toilet construction may not eliminate the practice, as behavior is shaped by various structural and societal factors. Nonetheless, the study is subjected to limitations, including its limited geographic focus, potential societal desirability bias, and potential influence of the rainy season on the study outcomes.<sup>10</sup> In a South India study, 54.8% of participants continued to practice open defecation despite having household toilets, influenced by structural and societal factors. However, the study encountered limitations, including the inability to reach the required sample size of 560 participants due to factors like toilet unavailability and temporary migration. Moreover, over 45% of respondents were not from primary selection, potentially introducing social desirability bias. Additionally, the cross-sectional study design impedes clarity on the temporal relationship between factors and defecation practices.<sup>11</sup> We know that there are many studies on this topic; thus we have only provided an overview of a few studies.

Open defecation is more common in sub-Saharan African countries, including Ethiopia, and is regarded as an indicator of a low socioeconomic status.<sup>12</sup> In Ethiopia, open defecation remains a persistent and challenging issue that poses significant risks to public health and well-being, particularly in rural areas.<sup>13-15</sup> According to the Joint Monitoring Program (JMP) report, 17% of Ethiopian households still practice open defecation.<sup>12</sup> The statistics indicated that the availability of latrines alone could not prevent household members from practicing open defecation. Several factors categorized at the individual and community levels have influenced sanitation practices in Ethiopia. At the community level, factors such as residence area, the livelihood of the community, access to community health education, availability of sanitation facilities in public places (market, religious institutions, and schools), community perceptions of sanitation management, and inadequate emptying services are identified as determinants of open defecation. At the household level, inadequate or absent toilet facilities and water supply, lower educational attainment, marital status, media exposure, wealth status, and family size are considered coined as predictors of open defecation practices.<sup>13,16-19</sup>

Cognizant of the importance of Water, Hygiene, and Sanitation (WASH) services in reducing morbidity and mortality of children due to diarrheal and neglected tropical diseases, the Ethiopian government introduced a Community-Led

Total Sanitation and Hygiene (CLTSH) strategy in 2011 and continued to incorporate the model in recent national hygiene and environmental health strategy (2016-2020) and woredas transformation plan of the health sector.<sup>20,21</sup> CLTSH is primarily focused on the absolute reduction of open defecation by mobilizing grassroots communities to construct latrines at the household and community levels, while promoting the use of constructed latrines at all times.<sup>21</sup> Even though, the health sector and international development partners have invested resources to lift households residing at the lower level of the sanitation ladder to have access to basic sanitation services, and targeted grassroots to achieve CLTSH, the proportion of individuals practicing Open Defecation (OD), especially in rural communities is still staggering enough to propagate disease.<sup>22</sup>

Several learning opportunities have been created as part of the CLTSH approach to understand its effectiveness in Ethiopia.<sup>23</sup> Districts and Kebeles, which had declared an open defecation state, have been playing a pivotal role by creating scenarios for learning and expansion of best practices to the rest of the country. As a country that is geographically, culturally, and socioeconomically diverse, having model sites representing the cultural, geographical, and socioeconomic diversity of Ethiopia is important for a comprehensive understanding of the barriers and facilitators of open defecation in Ethiopia. In light of this, the Geshiyaro project is an important endeavor designed to alleviate the staggering prevalence of open defecation practices in addition to the eradication of schistosome and soil-transmitted helminths in the Wolayita zone in Ethiopia. The project has 3 pillars that are stipulated to provide effective eradication of schistosome and soil-transmitted helminths as well as end open defecation through the provision of Water, Sanitation, and Hygiene (WASH) services, Behavior Change Communication (BCC), and high-coverage Community-wide Mass drug administration (MDA) are the main components of this strategy.<sup>24</sup>

Nevertheless, the project failed to fully address socio-demographic disparities in its activities. The current study designed to bridge this gap in efforts to eradicate open defecation. Thus, this cross-sectional study aimed to investigate more about specific project implementation sites in Ethiopia to explore the prevalence of open defecation and associated factors among households, which provides valuable insight into the local context and informs targeted interventions to address the problem. Findings will inform Ethiopians' Community-Led Total Sanitation Hygiene (CLTSH) program, contributing to national goals and aligning with SDG 3 target 3, and SDG 6 target 2. Additionally, outcomes will offer practical insight for public health interventions, aiding in reducing open defecation and improving health outcomes in similar settings.

## Materials and Methods

### *Study site*

The study was conducted in Geshiyaro project implementation sites (Wolayita and adjacent woredas to Wolayita zone).

Wolayita zone, in South Ethiopia Region (SER), is located 330 km away from Ethiopia's capital, Addis Ababa. Its administrative units are organized into kebeles (lowest administration units), and woredas (districts).<sup>25</sup> Twelve districts from the Wolayita zone were surveyed; of them, about half are supported by the Children's Investment Fund Foundation (CIFF), while the remaining woredas are managed under the routine One-WASH program. The other adjacent woredas to the Wolayita zone (Wondo, Wondo Genet, and Hawela Tula Sub city) are managed under the One-WASH program. The study site included 321 Enumeration Areas (EAs) in Geshiyaro project implementation sites, with a focus on selected EAs from the study site. The majority of households participating in the Geshiyaro project implementation sites are rural, with many headed by farmers whose income relies on agriculture, resulting in low income levels.

### Study design

A cross-sectional study was conducted at the Geshiyaro project implementation sites in Ethiopia in 2023. The study involved household-level interviews and the use of an observational checklist designed to understand households' access to water, sanitation, and hygiene services, open defecation practice, and exposure to health information and education level during the past 12 months, among others.

### Households selection criteria

All households ranked from the  $K^{\text{th}}$  interval within the selected Enumeration Areas (EAs) of the Kebele were the inclusion criteria.

### Respondent selection criteria

The inclusion criteria for respondents in the household were individuals aged 18 and above, who were selected randomly. However, the exclusion criteria were individuals with mental disorders (mental illness), and respondents residing in the households for less than 6 months.

### Operational definition

Open Defecation (OD) is the disposal of human feces with solid waste in open areas, such as fields, forests, beaches, shrubs, open bodies of water, or other open spaces.<sup>26</sup>

Enumeration Areas (EAs) are defined geographic areas used to speed up collecting data in surveys and censuses. As they are smaller units within larger regions, they make population surveys more effective by covering certain households or population sizes and making data collection and analysis easier.

Woreda is an administrative division in Ethiopia that oversees local government and service provision; comparable to a district or county.

Kebele is the smallest woreda administrative unit, similar to a village or neighborhood, which promotes community development and grassroots governance.

### Household sample size estimation

The sample size for this study was calculated using a single population proportion formula that included a 10% non-response rate, 95% confidence interval (CI), 25.4% proportion ( $p$ ), and 1% marginal error ( $e$ ). The coverage of improved latrine facilities was estimated to be 25.36% based on previous studies.<sup>27</sup> The following sampling formula was used to compute the estimated sample size of the study area:

$$n = \frac{(Z^2 * P(1 - P))}{e^2}$$

$$n = \frac{(4 * 0.254(1 - 0.254))}{(0.01)^2}$$

$n = 7279$

Therefore, the estimated total sample size for this study was 8025 after considering a 10% non-response rate.

### Data collection

Enumerators with environmental health and health-related backgrounds were involved in data collection. The enumerators were given 5 days of training. The training was designed to acquaint them with ethical research conduct, rapport building while engaging with community and household respondents, interviewing techniques, theoretical and practical aspects of WASH services, observational modules to understand the availability of latrines and their components, and the identification of open defecation practice at the household level. A standardized questionnaire was used to collect data by Open Data Kit (ODK) tool. Data collection took place between June and July 2023.

### Data quality control

The data quality was evaluated through statistical and visual methods. Visual inspection was employed to identify data entry and compilation errors, while the goodness-of-fit test assessed the statistical appropriateness of the model. Furthermore, the utilization of standardized questionnaires, along with trained supervisor and data collectors, supported the validity of the data.

### Logistic regression analysis

The study data was analyzed using a logistic model to ascertain the factors influencing open defecation practices. This predictive model is suitable for categorical dependent variables and considers predictors that can be continuous or dichotomous.

Binary outcomes were coded as 0 (failure) or 1 (success). Variables with  $P$ -value exceeding .2 in bivariate analysis were not included in the multivariate analysis.

Generally, binary logistic regression is typically employed when the dependent variable is dichotomous (eg, presence or absence, success or failure).<sup>28</sup> Hence, the logistic regression model is utilized to explore how predictors impact the likelihood of open defecation practice. The dependent variable is defined as follows:

Let  $\pi$  denote the proportion of success (open defecation practice):  $P(Y_{ij} = 1) = \pi_{ij}$ ,  $P(Y_{ij} = 0) = 1 - \pi_{ij}$ , and  $Y_i \sim \text{Bernoulli } \pi_i$

Then, the logistic regression function is given as

$$\pi_i = \frac{e^{\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik}}}{1 + e^{\beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik}}} = \frac{e^{X_i \beta}}{1 + e^{X_i \beta}}$$

Where:  $\pi_i^{(i=1,2,\dots,n)}$  is the probability of  $i$ th households practiced open defecation and given the vector of predictors ( $x_i$ ).

Logistic regression offers advantage due to its fewer assumptions compared to other analyses. It is well-suited for dichotomous outcome variables without influential outliers and with an adequate sample size.<sup>29,30</sup> Moreover, consideration such as multicollinearity, as outlined in Hosmer et al,<sup>28</sup> were taken into account for practical application. Additional studies corroborate this model assumption, as their findings revealed no indication of poor fit or misspecification.<sup>31</sup> Thus, this analysis was conducted to verify that hypothesized conditions were true.

Similarly, the study employed the odds ratio to predict the likelihood of open defecation practice for a specific category of the predictor variable compared to the reference category. The odds ratio (OR) represents the ratio of the odds for  $x = 1$  to the odds for  $x = 0$  and is calculating using the equation.<sup>32</sup>

$$\log\left(\frac{\pi_i}{1 - \pi_i}\right) = a + b_1 x_{i1} + b_2 x_{i2} + \dots + b_p x_{pi}$$

Where  $\frac{\pi_i}{(1 - \pi_i)}$  is the odds that the response variable takes the value of 1.

The model's overall goodness of fit was evaluated as the last step in the evaluation process. Finally, Pearson goodness-of-fit tests were used to check model adequacy.<sup>33</sup> The models employed to analyze open defecation practice were determined to be appropriate for the data, and their validity was confirmed and validated by the authors.

### Data analysis

The prevalence of open defecation practice was determined using descriptive statistics. After accounting for possible confounders, multivariate logistic regression ( $P$ -value, adjusted odds ratio (AOR)) analysis was used to determine the factors associated with open defecation. Statistical significance was defined as a  $P$ -value  $\leq 0.05$ , in the multivariate logistic regression analysis. STATA Version 16 was used for data analysis.

Four assumptions of the logistic regression analysis were tested: no highly significant outliers, no multicollinearity, independent observations, and an appropriate sample size.<sup>28-30</sup> Model adequacy was assessed and verified using the Pearson goodness-of-fit test.<sup>33</sup>

### Ethical considerations

The Ethiopian Public Health Institute's Scientific and Ethical Review Board granted ethical approval for this study (reference number: EPHI-IRB-321-2020). After asking each study participant for their informed consent, we subsequently obtained consent in written. The privacy and confidentiality of the study participants were protected at every stage of the investigation.

## Results and Discussion

### Socio-demographic characteristics of respondents

A total of 7995 households from the Geshiyaro project implementation sites were included in this study. The study found that 16.5% of households practiced open defecation. This study finding was not consistent with another study conducted in Tamil Nadu (India) which revealed that 64% practiced open defecation.<sup>34</sup> Table 1 provides information on open defecation based on the sociodemographic characteristics of the households. The results showed that 18.3% and 9.8% of rural and urban households practiced open defecation, respectively. Open Defecation (OD) practices were 19.7% in female-headed households and 16% in male-headed households. It was also found that 15.7% of household heads with an annual income of  $\geq 20000$  Ethiopian birr and 20.7% of those heads with less income practiced open defecation. Similarly, the median OD prevalence was 18.2 and 14.8% in households with fewer than 6 members and greater than or equal to 6, respectively. The OD practices of household heads with a level of education in secondary school and above were 9.8%, whereas those with no education and primary levels were 18.7% and 21.9%, respectively. In a different study, according to Busienei et al,<sup>35</sup> the quantitative results revealed that latrine adoption and open defecation practice are influenced by cultural factors (frequency of 44%) and high levels of poverty (frequency of 27%).

The percentage of open defecation (OD) practices among household heads of different age groups is presented in Table 1. The practice was 22.9% for 18 to 28 years old, 17.3% for 29 to 39 years old, 16.4% for 40 to 50 years old, 15.9% for 51 to 61 years old, 16.8% for 62 to 72 years old, and 13.7% for 73 years old and more. This finding was in line with a cross-sectional study carried out in Ethiopia that found household age has an impact on the likelihood of open defecation.<sup>16</sup> In this investigation, Open Defecation (OD) practices among married, single, and not in a union, as well as the occupational status of the household head, were also discovered.

Furthermore, the prevalence of open defecation at the woreda level was investigated. The percentage of Wolayita



**Table 1.** Sociodemographic characteristics of respondents (n=7995).

CHARACTERISTICS	TOTAL NUMBER OF HOUSEHOLDS	OPEN DEFECATION	
	FREQUENCY	YES	NO
<b>Residence</b>			
Rural	6673	18.3	81.7
Urban	1322	9.8	90.2
<b>Sex of household head</b>			
Male-headed	6058	16.0	84.0
Female-headed	1937	19.7	80.3
<b>Annual income</b>			
<20000 (median)	1883	20.7	79.3
≥20000 (median)	6112	15.7	84.3
<b>Family size</b>			
<6 (median)	4863	18.2	81.8
≥6 (median)	3132	14.8	85.2
<b>Household head education</b>			
No education	5392	18.7	81.3
Primary	703	21.9	78.1
Secondary and above	1900	9.8	90.2
<b>Occupation</b>			
Farmer	6355	18.8	81.2
Merchant	509	8.8	91.2
Government worker	529	5.5	94.5
Unemployed	602	13.0	87.0
<b>Age of household head</b>			
18-28	449	22.9	77.1
29-39	2092	17.3	82.7
40-50	3545	16.4	83.6
51-61	1104	15.9	84.1
62-72	536	16.8	83.2
>73	269	13.7	86.3
<b>Marital status</b>			
Married	6732	15.5	84.5
Single	1263	24.1	75.9

woredas that practiced open defecation was 15.4%. This study finding was not consistent with the current (2020) report of the World Bank and WHO/UNICEF Joint Monitoring Program (JMP) which revealed that 17% of Ethiopians practiced open

defecation.<sup>12</sup> This reduction could be attributed to the effective implementation of the Geshiyaro WASH project. However, 30.1% of the households in Abela Abaya Woreda in the Wolayita zone used open defecation practice. Also, households

**Table 2.** Prevalence of open defecation practice at woredas level, 2023 (n=7995).

HOUSEHOLD OPEN DEFECATION PRACTICE				
WOREDAS CLASSIFICATION		NUMBER OF HOUSEHOLDS	YES (%)	NO (%)
Wolayita woredas	Boloso Sore	600	17.8	82.2
	Boloso Bombe	575	15.0	85.0
	Damot Sore	544	12.3	87.7
	Damot Gale	575	20.9	79.1
	Damot Pulasa	546	19.8	80.2
	Duguna Fango	547	19.2	80.8
	Abela Abaya	495	30.1	69.9
	Damot Weyde	550	5.5	94.5
	Humbo	525	13.5	86.5
	Kindo Didaye	549	8.9	91.1
	Ofa	521	11.1	88.9
Sodo Zuria	547	11.3	88.7	
Total Wolayita woredas		6574	15.4	84.6
Adjacent woredas to Wolayita zone	Hawela Tula sub-city	525	11.1	88.9
	Wondo Genet	475	29.5	70.5
	Wondo	421	24.9	75.1
Total adjacent woredas (Wondo, Wondo Genet, Hawela Tula sub-city)		1421	21.3	78.7
Total (Wolayita and adjacent woredas)		7995	16.5	83.5

in Wondo Genet (29.5%), and Wondo (24.9%) had open defecation practice. Therefore, urgent action is required to prevent sanitation-related health problems. Similarly, Damot Gale (20.9%), Damot Pulasa (19.8%), and Duguna Fango (19.2%) households used open defecation practice. Additionally, 21.3% of households in adjacent woredas in the Wolayita zone (Wondo, Wondo Genet, and Hawela Tula Sub-city) used open defecation practice. These results also need priority action to prevent sanitation-related health issues (Table 2).

#### *Household's open defecation practice and exposure to health information*

Open defecation was practiced by 16.9% of the households overall. This finding is much lower than the finding of the 2019 mini Ethiopian Demographic and Health Survey for the Afar Region, where 70% of households had open defecation practice.<sup>36</sup> On the other hand, the current finding is higher compared to a study in Bishoftu town of Ethiopia in 2023 where only 4.2% of households had open defecation practice.<sup>37</sup> This could be due to differences in urbanization and poor attitudes toward the impact of open defecation practice. Despite Ethiopia having made significant progress in reducing open defecation<sup>38</sup> practice from 79% in 1990 to 17% in 2017,<sup>12</sup> still open defecation practice is a major public health issue. In

addition, 16.5% of households lacked sanitation facilities. A significant number (13%) of households used shared sanitation facilities, and the majority of households (68.8%) used unimproved sanitation facilities. This could cause major health risks and exacerbate the transmission of communicable diseases. Similarly, 61.1% and 76.9% of household heads did not participate in awareness creation sessions about WASH services and did not obtain WASH products, respectively (Table 3).

#### *Factors associated with open defecation practice*

In the binary logistic regression analysis, 10 independent variables, including residence type, sex, education status, occupation, age, marital status, family size, annual income, knowledge about diarrhea prevention, and health information about WASH were significantly associated ( $P < 0.05$ ) with the utilization of open defecation practice. However, in the multivariable logistic regression model, the sex of participants and household income had no significant association with the utilization of open defecation practice. In this investigation, the occurrence of open defecation practice was 1.56 times higher among rural households than urban households (AOR=1.56, 95% CI: 1.26-1.92). Since, as Table 1 shows, the majority of household heads lived in rural areas and had a high rate of open defecation practice. This could be due to having good knowledge about the health

**Table 3.** Households' open defecation practice and exposure to health information (n=7995).

STUDY VARIABLES	CATEGORY	FREQUENCY	PERCENTAGE
Open defecation	Yes	1350	16.9
	No	6645	83.1
Latrine availability	Yes	6680	83.6
	No	1315	16.5
Latrine sharing	Unshared	5644	70.6
	Shared	1036	13.0
	No toilet	1315	16.4
Latrine type	Improved	1183	14.8
	Unimproved	5497	68.8
	OD	1315	16.4
Household head attended awareness creation sessions about WASH practices in the past 12 months	Yes	3109	38.9
	No	4886	61.1
The household head obtained WASH products and services in the past 12 months	Yes	1844	23.1
	No	6151	76.9

risks of open defecation among urban residents, as they expected to have access to different health-related information through different Media. This is supported by a recent study conducted among households where utilization of open defecation practice was 95% less likely among urban than rural households.<sup>39</sup> Additionally, a previous study found that a variety of factors contribute to the increased prevalence of open defecation (OD) in rural areas compared to urban ones. These variables include household size,<sup>40</sup> occupation,<sup>40</sup> residence,<sup>41,42</sup> region,<sup>41</sup> and level of education.<sup>40,43</sup>

On the other hand, households having heads with secondary and above education were 59% less likely to utilize open defecation practice (AOR=0.59, 95% CI: 0.49-0.72) than household heads with no education. This indicated that educated household heads had a higher sense of responsibility and concern about their health and families than illiterate heads. This finding is consistent with a cross-sectional study done in Ethiopia, and Kenya, and a mixed-method approach studied in Ghana.<sup>16,40,44</sup> The occurrence of open defecation practice was nearly two times higher among farmer respondents (AOR=2.12, 95% CI: 1.40-3.20) compared to government workers. This could stem from their familiarity with the health risk associated with open defecation and their relatively lower concern regarding it. This finding is consistent with a study in Ghana, which found that women with formal education had a decreased likelihood of practicing open defecation compared to those without formal education (AOR=0.69, 95% CI: 0.56-0.85).<sup>31</sup> In this study, the majority of household heads were farmers residing in rural areas, as indicated in Table 1, and they exhibited a high prevalence of open defecation practices. This observation aligns with research conducted in Haiti, which similarly noted higher rates of open defecation among farmers and their households.<sup>45</sup>

A disparity in knowledge regarding open defecation practices may exist between households led by government employees and farmers. Farmers, often lacking access to higher education that meets government job standards, may encounter challenges in accessing information relevant to their profession. As the age of household heads increased to 29 to 39, 40 to 50, 51 to 61, 62 to 72,  $\geq 73$ , the odds of open defecation practice decreased by 35% (AOR=0.65, 95% CI: 0.50-0.85), 47% (AOR=0.53, 95% CI: 0.41-0.69), 57% (AOR=0.43, 95% CI: 0.32-0.57), 58% (AOR=0.42, 95% CI: 0.30-0.59), and 68% (AOR=0.32, 95% CI: 0.21-0.49), respectively. This result was consistent with a cross-sectional study conducted in Ethiopia which indicated that the likelihood of OD usage was reduced by 21% (AOR=0.79; 95% with CI: 0.68-0.93) and 31% (AOR=0.69; 95% with CI: 0.59-0.82), respectively as the age of the household head grew to 41 to 59 and  $\geq 60$ .<sup>16</sup>

The odds of having open defecation practice were 1.61 times higher among single respondents (AOR=1.61, 95% CI: 1.32-1.97) as compared to married participants. This result is in line with a cross-sectional study of secondary data that was conducted in Ethiopia and found that open defecation was more common in unmarried respondents than in married households.<sup>16</sup> As well as, the outcome aligns with a study conducted in Haiti, which revealed that households with divorced or widowed individuals had higher odds of practicing open defecation compared to households in union.<sup>46</sup> But, this needs further research to identify the main cause. The number of households having 6 and above family size were 84% less likely to practice open defecation (AOR=0.84, 95% CI: 0.74-0.96) as compared to those who have less than 6. This could be due to the difference in having access to a toilet, although it needs further research (Table 4).

**Table 4.** Multivariate analysis (n=7995).

DESCRIPTION	TOTAL NUMBER OF HHS	OPEN DEFECACTION		P-VALUE	AOR [95% CI]	SIG.
		YES	NO			
<b>Residence</b>						
Urban	1322	9.8	90.2		Reference	
Rural	6673	18.3	81.7	0.00	1.56 [1.26, 1.92]	***
<b>Sex of household head</b>						
Male-headed	6058	16.0	84.0		Reference	
Female-headed	1937	19.7	80.3	0.47	0.94 [0.78, 1.12]	
<b>HH head education</b>						
No education	5392	18.7	81.3		Reference	
Primary	703	21.9	78.1	0.03	1.25 [1.02, 1.53]	**
Secondary and above	1900	9.8	90.2	0.00	0.59 [0.49, 0.72]	***
<b>Occupation</b>						
Government worker	529	5.5	94.5		Reference	
Farmer	6355	18.9	81.2	0.00	2.12 [1.40, 3.20]	***
Merchant	509	8.8	91.2	0.94	1.02 [0.62, 1.68]	
Unemployed	602	13.0	87.0	0.08	1.52 [0.96, 2.41]	*
<b>Age of household head</b>						
18-28	449	22.9	77.1		Reference	
29-39	2092	17.3	82.7	0.00	0.65 [0.50, 0.85]	***
40-50	3545	16.4	83.6	0.00	0.53 [0.41, 0.69]	***
51-61	1104	15.9	84.1	0.00	0.43 [0.32, 0.57]	***
62-72	536	16.8	83.2	0.00	0.42 [0.30, 0.59]	***
≥73	269	13.8	86.3	0.00	0.32 [0.21, 0.49]	***
<b>Marital status</b>						
Married	6732	15.5	84.5		Reference	
Singles	1263	24.1	75.9	0.00	1.61 [1.32, 1.97]	***
<b>Family size</b>						
<6 (median)	4863	18.2	81.8		Reference	
≥6 (median)	3132	14.8	85.2	0.01	0.84 [0.74, 0.96]	***
<b>Household income</b>						
<20000 (median)	1883	20.7	79.3		Reference	
≥20000 (median)	6112	15.7	84.3	0.32	1.07 [0.93, 1.23]	
<b>Diarrhea prevention knowledge</b>						
Yes	4235	13.5	86.5		Reference	
No	3760	20.7	79.3	0.00	1.32 [1.17, 1.50]	***
<b>Household head attended awareness creation sessions about WASH practices in the past 12 mo</b>						
Yes	3109	11.0	89.0		Reference	
No	4886	20.6	79.4	0.00	1.96 [1.71, 2.25]	***

\*\*\* $P < 0.01$ . \*\* $P < 0.05$ . \* $P < 0.1$



Furthermore, the existence of open defecation practice was 1.32 times higher among households who did not know diarrhea prevention methods (AOR=1.32, 95% CI: 1.17-1.50) than those who did. This shows that a lack of knowledge encourages households to use open defecation practice. This result was similar to that of a cross-sectional study conducted in Ethiopia, where households with open defecation practice were 5.17 times more likely to have diarrheal disease.<sup>47</sup> In addition, the odds of having open defecation practice were 1.96 times higher among households who had no access to awareness creation sessions about WASH services (AOR=1.96, 95% CI: 1.71-2.25) than households with access. This revealed that obtaining information about WASH services has an impact on the reduction of open defecation practice (Table 4).

This study is not without limitations. The household income levels in this study were divided into two categories, which could explain the lack of a significant association between open defecation occurrence and household income. Typically, the Ethiopian Demographic Health Survey (EDHS) classifies wealth quantiles into 5 categories. Increasing the wealth categories might increase the significance association, as demonstrated in some previous studies.<sup>48</sup> Additionally, the study's inclusion criteria did not account for households led by individuals under the age of 18, often referred to as minor adults. This oversight may result in overlooking valuable insights, particularly regarding sanitation practices among children and adolescents, as the study only interviewed households with respondents aged 18 and above. Moreover, the study emphasis on particular implementation sites of the Geshiyaro project in Ethiopia could restrict the applicability of the results to different settings within or outside the country. However, while the primary aim is to address national context, we anticipated international relevance, as the finding contributes to Sustainable development Goals and informs broader public health initiatives.

In future research, it is essential to include households led by individuals under the age of 18, commonly known as minor adults, as well as children and adolescents. Their perspective is crucial for collecting valuable insights into WASH services, open defecation, and sanitation practices. Also, future studies could explore nationwide assessments of open defecation practices. Moreover, the authors of the study suggest that understanding socio-demographic factors and implementing evidence-based interventions, such as Community-Led Total Sanitation (CLTS) and hygiene promotion programs (such as awareness campaigns need to make use of mass media), can lead to meaningful changes in sanitation practices.

## Conclusion

The prevalence of open defecation practice is high in the study area, posing a complex issue with significant public health and societal implications. Many factors that influence open defecation practices have been identified. Addressing this issue

requires targeted interventions focused on enhancing access to safe sanitation facilities and promoting behavioral change communication (example use of mass media). Additionally, thoughtful consideration of socio-demographic factors is crucial when designing and implementing projects aimed at reducing open defecation. Furthermore, the results of this study will support the achievement of Sustainable Development Goals (SDG) Targets 3.3 and 6.2, which address communicable diseases, as well as access to adequate and equitable sanitation and hygiene for everyone, and end open defecation.

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## Author Contributions

ZAA managed the project, planned the research, interpreted the data, and wrote the manuscript. EAA carried out statistical analysis and data quality control. AWK and AMG conceptualized the document, wrote a review, and edited it. All authors have made critical revisions, reviewed, and approved the final manuscript.

## Patient and Public Involvement

The plans for the design, conduct, reporting, and distribution of this research did not involve patients or people in general.

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## REFERENCES

1. Saleem M, Burdett T, Heaslip V. Health and social impacts of open defecation on women: a systematic review. *BMC Public Health*. 2019;19:158-212.
2. UNICEF. Drinking water, sanitation and hygiene in schools: global baseline report 2018. 2018.
3. Adesogan S. Assessment of sustainable development goals 6.1 and 6.2 in rural small communities of Ondo State, Nigeria. *J Glob Ecol Environ*. 2018;8:104-111.
4. Spears D, Ghosh A, Cumming O. Open defecation and childhood stunting in India: an ecological analysis of new data from 112 districts. *PLoS One*. 2013;8:e73784.
5. Brown J, Cairncross S, Ensink JH. Water, sanitation, hygiene and enteric infections in children. *Arch Dis Child*. 2013;98:629-634.
6. Schmidlin T, Hürlimann E, Silué KD, et al. Effects of hygiene and defecation behavior on helminths and intestinal protozoa infections in Taabo, Côte d'Ivoire. *PLoS One*. 2013;8:e65722.
7. Belay DG, Asratie MH, Aragaw FM, et al. Open defecation practice and its determinants among households in sub-Saharan Africa: pooled prevalence and multilevel analysis of 33 sub-Saharan Africa countries demographic and health survey. *Trop Med Health*. 2022;50:28.
8. Abdullahi MA, Sarkingobir Y, Yabo AG. Open defecation practices in rural areas threat public health: an assessment of selected area in Sokoto, Nigeria. *J Int Environ Appl Sci*. 2023;18:40-47.
9. Okullo JO, Moturi WN, Ogendi GM. Open defecation and its effects on the bacteriological quality of drinking water sources in Isiolo County, Kenya. *Environ Health Insights*. 2017;11:1-8.
10. Punia A, Rani B, Yadav A, Jha S, Singh S. Prevalence of open defecation among households with toilets and associated factors in rural areas of district Sonapat in Haryana. *Environ Dis*. 2020;5:87-92.
11. Yogananth N, Bhatnagar T. Prevalence of open defecation among households with toilets and associated factors in rural south India: an analytical cross-sectional study. *Trans R Soc Trop Med Hyg*. 2018;112:349-360.

12. WHO and UNICEF. Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs. 2021.
13. Temesgen A, Molla Adane M, Birara A, Shibabaw T. Having a latrine facility is not a guarantee for eliminating open defecation owing to socio-demographic and environmental factors: the case of Machakel district in Ethiopia. *PLoS One*. 2021;16:e0257813.
14. Gedefaw M, Amsalu Y, Tarekegn M, Awoke W. Opportunities, and challenges of latrine utilization among rural communities of Awabel District, Northwest Ethiopia, 2014. *Open J Epidemiol*. 2015;05:98–106.
15. Adank M, Butterworth J, Godfrey S, Abera M. Looking beyond headline indicators: water and sanitation services in small towns in Ethiopia. *J Water Sanit Hyg Dev*. 2018;6:435–446.
16. Belay DG, Chilot D, Asratie MH. Spatiotemporal distribution and determinants of open defecation among households in Ethiopia: a mixed effect and spatial analysis. *PLoS One*. 2022;17:e0268342.
17. Adugna D. Challenges of sanitation in developing counties - evidenced from a study of fourteen towns, Ethiopia. *Heliyon*. 2023;9:e12932.
18. Tesfaye A, Abel FD, Zemichael G. Latrine utilization and associated factors among kebeles declared open defecation free in Wondo Genet district, South Ethiopia, 2015. *ISABB J Health Environ Sci*. 2018;5:43–51.
19. Gebremariam B, Hagos G, Abay M. Assessment of community led total sanitation and hygiene approach on improvement of latrine utilization in Laelay Maichew District, North Ethiopia. A comparative cross-sectional study. *PLoS One*. 2018;13:e0203458.
20. FMOH, Federal Democratic Republic of Ethiopia, Ministry of Health. *National Hygiene and Environmental Health Strategy (2016–2020)*. FMOH; 2016.
21. Kamal KAR, Chambers R. *Handbook on Community-Led Total Sanitation*. Plan International; 2008.
22. Terry C. *Promoting Sustainable and Equitable WASH in Ethiopia*. The world Bank; 2023.
23. FMOH. *Community-Led Total Sanitation and Hygiene (CLTSH) Facilitators Training Guide*. FMOH; 2011.
24. Phillips AE, Ower AK, Mekete K, et al. Baseline soil-transmitted helminth and schistosome infection in the geshiyaro project, Ethiopia: a unique transmission interruption project using biometric fingerprinting for longitudinal individual analysis. *PLoS Negl Trop Dis*. 2023;17:e0011589.
25. Alemayehu B, Kelbore AG, Alemayehu M, et al. Knowledge, attitude, and practice of the rural community about cutaneous leishmaniasis in Wolaita zone, southern Ethiopia. *PLoS One*. 2023;18:e0283582.
26. JMP. *Core Questions on Water, Sanitation and Hygiene for Household Surveys: 2018 Update*. United Nations Children's Fund (UNICEF) and World Health Organization; 2018.
27. Andualem Z, Dagne H, Azene ZN, et al. Households access to improved drinking water sources and toilet facilities in Ethiopia: a multilevel analysis based on 2016 Ethiopian demographic and health survey. *BMJ Open*. 2021;11:e042071.
28. Hosmer DW Jr, Lemeshow S, Sturdivant RX. *Applied Logistic Regression*. Vol. 398. John Wiley & Sons; 2013.
29. Nick TG, Campbell KM. Logistic regression. In: Ambrosius WT, ed. *Topics in Biostatistics*. Humana Press; 2007:273–301.
30. Stoltzfus JC. Logistic regression: a brief primer. *Acad Emerg Med*. 2011;18:1099–1104.
31. Appiah-Effah E, Boakye K, Salihu T, et al. Determinants of open defecation among rural women in Ghana: analysis of demographic and health surveys. *Environ Health Insights*. 2024;18:1–12.
32. Wang D, Bakhai A. *Clinical Trials: A Practical Guide to Design, Analysis, and Reporting*. Remedica; 2006.
33. Pearson K. X. On the criterion that a given system of deviations from the probable in the case of a correlated system of variables is such that it can be reasonably supposed to have arisen from random sampling. *Lond Edinb Dubl Philos Mag J Sci*. 1900;50:157–175.
34. Roselin M, Newtonraj A, Girija G, Manikandan M, Vincent A. Open defecation practice in twenty remote villages located in South India: a population-based cross-sectional study. *J Datta Meghe Inst Med Sci Univ*. 2022;17:620–623.
35. Busieni PJ, Ogendi GM, Mokuia MA. Open defecation practices in Lodwar, Kenya: a mixed-methods research. *Environ Health Insights*. 2019;13:1178–630219828370.
36. EPHI and ICF. *Ethiopia Mini Demographic and Health Survey 2019: Final Report*. EPHI and ICF; 2021.
37. Girmay AM, Mengesha SD, Dinssa DA, et al. Access to water, sanitation and hygiene (WASH) services and drinking water contamination risk levels in households of Bishoftu Town, Ethiopia: a cross-sectional study. *Heal Sci Rep*. 2023;6:e1662.
38. Abebe TA, Tucho GT. Open defecation-free slippage and its associated factors in Ethiopia: a systematic review. *Syst Rev*. 2020;9:252–315.
39. Girmay AM, Alemu ZA, Mengesha SD, et al. Effect of demographic disparities on the use of the JMP ladders for water, sanitation, and hygiene services in Bishoftu Town, Ethiopia. *Discov Water*. 2022;2:8.
40. Osumanu IK, Kosoe EA, Ategeeng F. Determinants of open defecation in the Wa municipality of Ghana: empirical findings highlighting sociocultural and economic dynamics among households. *J Environ Public Health*. 2019;2019;18:1–10.
41. WHO. Progress on drinking water, sanitation and hygiene: 2017 update and SDG baselines. 2017.
42. Bhatt N, Budhathoki SS, Lucero-Prisno DEI, et al. What motivates open defecation? A qualitative study from a rural setting in Nepal. *PLoS One*. 2019;14:e0219246.
43. Leshargie CT, Alebel A, Negesse A, et al. Household latrine utilization and its association with educational status of household heads in Ethiopia: a systematic review and meta-analysis. *BMC Public Health*. 2018;18:901–912.
44. Mumbi TL, Cholo W. An assessment of open defecation among residents of Thika East Sub-County, Kiambu County, Kenya. *Int J Med Res*. 2017;2:09–20.
45. Paul B. Socio-economic factors associated with open defecation among agricultural households: a cross-sectional study in Haiti. *Am J Public Health*. 2023;1:e000082.
46. Paul B, Jean Simon D, Kiragu A, Génés W, Emmanuel E. Socio-economic and demographic factors influencing open defecation in Haiti: a cross-sectional study. *BMC Public Health*. 2022;22:2156.
47. Girmay AM, Weldetinsae A, Mengesha SD, et al. Associations of WHO/UNICEF Joint Monitoring Program (JMP) water, sanitation and hygiene (WASH) service ladder service levels and sociodemographic factors with diarrhoeal disease among children under 5 years in Bishoftu town, Ethiopia: a cross-sectional study. *BMJ Open*. 2023;13:e071296.
48. Alemu ZA, Adugna EA, Likasa BW, et al. Trends and impacts of demographic disparity on JMP ladders for drinking water and sanitation services: further analysis of the Ethiopian demographic and health surveys. *Discov Water*. 2023;3:4.