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Households access to improved drinking water sources and toilet facilities in Ethiopia: a multilevel analysis based on 2016 Ethiopian Demographic and Health Survey

Zewudu Andualem [ORCID] ,[1] Henok Dagne,[1] Zelalem Nigussie Azene,[2] Asefa Adimasu Taddese [ORCID] ,[3] Baye Dagnew [ORCID] ,[4] Roman Fisseha,[5] Atalay Goshu Muluneh,[3] Yigizie Yeshaw [ORCID] [4]

For numbered affiliations see end of article.

Correspondence to
Mr Zewudu Andualem;
Zewuduandualem12@gmail.com

ABSTRACT

Objective This study aimed to assess households access to improved drinking water sources and sanitation facilities and their associated factors in Ethiopia.

Design Cross-sectional study.

Setting Ethiopia.

Participants Household heads.

Primary outcomes Access to improved drinking water sources and toilet facilities.

Methods We conducted an in-depth secondary data analysis of 2016 Ethiopian Demographic and Health Survey. Data from a total of 16 650 households and 645 clusters were included in the analysis. The households were selected using a stratified two-stage cluster sampling technique. Multilevel binary logistic regression analyses were performed to identify factors associated with access to an improved drinking water source and toilet facilities. Adjusted OR with a 95% CI was reported with p value <0.05 was used to declare a significant association between the covariates and the outcome variables.

Results The proportions of households' access to improved sources of drinking water and toilet facilities were 69.94% (95% CI: 69.23% to 70.63%) and 25.36% (95% CI: 24.69% to 26.03%), respectively. Households headed by women and households with a better wealth index were positively associated with access to improved drinking water sources. Whereas rural households, ≥30 min round trip to obtain drinking water and region were factors negatively associated with households access to improved drinking water sources. A higher probability of having access to improved toilet facilities: households with heads who had attained higher education, households having better access to improved sources of drinking water and households with better wealth index. While the following households were less likely to have access to improved toilet facilities: households with heads were widowed, households with four to six members, rural households and region.

Conclusion The study found that the proportions of households' access to improved drinking water sources and toilet facilities in Ethiopia were relatively low, which

Strengths and limitations of this study

► The use of nationally representative data that can enhance the generalisability of the findings is one of the strengths of this study.
► This study used data from a cross-sectional survey; as a result, the results from analysing the data cannot establish causal relationships.
► Moreover, important variables such as culture, traditions and social norms were not available in Ethiopian Demographic and Health Survey data which could influence the use of toilet facility type.

demands the need to tailor strategies to increase the coverage of access to improved drinking water sources and toilet facilities.

INTRODUCTION

Access to safe water and basic sanitation is one of the fundamental human rights, and an essential step towards improving living standards to maintain and improve health, human growth and development.[1–3] It is one of the critical sustainable development challenges. Sustainable Development Goal 6 aims to ensure the availability and sustainable management of water and sanitation for all by 2030.[4]

Unimproved sources of drinking water and sanitation facilities are responsible for increased risks of various infectious diseases such as; cholera, typhoid, schistosomiasis, infections of the respiratory systems, skin and eye.[1 5 6] The currently available evidences also indicate that to prevent the novel coronavirus

disease outbreak, the provision of safe water, sanitation and hygienic conditions is crucial.[7]

Globally, 2 billion people lack basic sanitation services and 785 million people have no access to clean water.[8] More than 1.9 million deaths and 123 million disability-adjusted life-years (DALYs) could have been prevented by the provision of adequate access to water, hygiene and sanitation (WASH) worldwide. The WASH-attributable disease burden accounts for 4.6% of global DALYs and 3.3% of global mortality.[9] About 13% of under-five mortality was accounted by WASH-attributable disease.[10] In Ethiopia, 60%–80% of communicable diseases are attributed to limited access to safe water, inadequate sanitation and hygiene services.[11]

Regarding factors associated with improved drinking water sources and toilet facilities: Sex of household heads, region, residence, family size and time to get to drinking water source, age of household head, educational level and marital status of the household heads were predictors linked to access to improved drinking water sources and toilet facilities reported by previous studies.[2 12–16]

In sub-Saharan Africa, particularly in Ethiopia, access to improved sources of drinking water and toilet facilities is still lacking and people are practicing open defecation.[17 18] There is no study in Ethiopia using nationally representative data (2016 Ethiopian Demographic and Health Survey (EDHS) data), which accounts for the hierarchical nature of the data. However, national studies conducted in sub-Saharan African countries in 2014 indicated the spatial variation in the coverage of households' use of improved drinking water supply and sanitation.[19] Therefore, the current study aimed to assess access to improved drinking water sources and toilet facilities and their associated factors in Ethiopia using EDHS 2016 data.

METHODS
Patient and public involvement
This study was based on a publicly available data set (EDHS 2016). Thus, there were no patients or members of the public involved.

Study design and area
The 2016 main EDHS was a cross-sectional survey conducted from 18 January 2016 to 27 June 2016 in Ethiopia by the Ethiopian Central Statistical Agency. For our case, we used an in-depth secondary data analysis of the survey. It was the fourth survey conducted in each of the 11 regions of Ethiopia (9 regional states and 2 administrative cities). Administratively, each region in Ethiopia is divided into Zones, each Zone, in turn, is divided into Woredas, and each Woreda into Kebeles (the lowest administrative units in the country).[20]

Data sources
Data were obtained from EDHS 2016 after being registered as an authorised user. The survey collects data on key indicators of health and health-related events including access to improved drinking water sources and toilet facilities. A total of 16 650 households from 645 enumeration areas (EAs) were included in the survey.[20]

Sample size and sampling procedure
A two-stage stratified cluster sampling technique was employed to select study participants. Sampling frame of the 2007 population and housing censuses in which EAs were the sampling units for the first stage and households for the second stage was used. A total of 18 008 households were selected for the sample, of which 17 067 were occupied. Of the occupied households, 16 650 were successfully interviewed, yielding a response rate of 98%.[20] The current study included individual-level data for 16 650 household heads as well as community characteristics of 645 clusters.

Variables of the study
Outcome variables
Access to improved drinking water sources and improved toilet facilities.

Explanatory variables
The explanatory variables for this study were classified as individual-level and community-level factors for both outcome variables. The individual-level factors for the outcome variables were; sex, age, educational level and marital status of the household head. Whereas, the community-level factors for the first outcome variable (access to improved drinking water sources) were; household wealth index, time to get to drinking water sources, family size, place of residence and region. While, for the second outcome variable (access to improved toilet facilities) the community-level factors were; household wealth index, household size, sources of drinking water, place of residence and region. The variables were selected based on the literature review for factors affecting access to improved drinking water sources and improved toilet facilities. The basis of the classification of explanatory variables into the individual-level, household-level and community-level variables were based on previous studies[2 21 22] and our professional judgements.

Operational definitions
Improved sources of drinking water:
A household is said to have access to an improved drinking water source if it has water piped into its dwelling, water piped to a yard/plot, a public tap/standpipe, a tube well/borehole, a protected dug well, a protected spring, rainwater, bottled water or sachet water.[23]

Improved types of toilet facilities:
A household is said to have access to improved toilet facilities if it has unshared flush/pour flush to piped sewer systems, septic tanks or pit latrines, ventilated improved pit latrines, composting toilets or pit latrines with slabs.[23]

Data processing and analysis

Statistical analysis was performed using Stata V.16 software. The weighted frequencies and the percentages (based on the population size of each region) were computed. The detailed weighting procedure is described elsewhere.[20]

Multilevel binary logistic regression model was used to assess the impact of individual-level and community-level factors on households' access to improved sources of drinking water and improved toilet facilities. The model, which is most appropriate to consider the cluster random effect in a multivariate setting and the reason to apply multilevel modelling was the nature of the data collected which have a hierarchical or clustered structure. The first level represents the individual and household and the second level factor is the clusters. Four models were tested in each of the cases (access to improved sources of drinking water and toilet facilities). Model 0 (the null model) was fitted without explanatory variables to test random variability in the intercept and to estimate the intraclass correlation coefficient (ICC). Model I was used to investigate the impact of individual-level factors on the likelihood of having access to improved sources of drinking water and toilet facilities. Model II was used to assess the impact of community-level factors on the likelihood of having access to improved sources of drinking water and toilet facilities. Model III was employed to assess the impact of individual-level and community-level factors altogether on access to improved sources of drinking water and toilet facilities.

The random effects (variation of effects) were measured by ICC, percentage change in variance (PCV), median OR (MOR) and deviance (−2 log-likelihood), which measure the variability between clusters in the multilevel models. The ICC explains the cluster variability, while MOR is used to quantify unexplained cluster variability (heterogeneity). The MOR was used to translate cluster variance into OR scale.[24–26] In the multilevel model, deviance can measure the total variation due to factors at the community and individual levels.[25 27]

Adjusted OR (AOR) with a 95% CI was reported with p value <0.05 was used to declare a significant association among covariates and outcome variables. A multicollinearity test was performed to rule out if there was a significant correlation between explanatory variables. If the values of variance inflation factor was lower than 10, then the collinearity problem was considered less likely.[28]

RESULTS
Socio-demographic characteristics of the study participants

A total of 16650 study participants were included in the study. The median (±SD) age of the household heads was 40 years (±16.22 years, range 15–95). Approximately, 7 out of 10 (69.94%) of the households had access to improved sources of drinking water and only one-fourth (25.36%) of households had access to improved sources of toilet facilities. Majority (98.37%) of respondents had

no formal education. About 68.55% of households were male-headed (table 1).

Regional distribution in terms of improved drinking water and toilet facility sources in Ethiopia

Among Ethiopian regions, nearly all households in Addis Ababa (99.40%) had access to improved sources of drinking water. On the contrary, Somali (56.52%) and Afar regions (51.39%) had the least access to improved sources of drinking water. Households in Benishangul-Gumuz and Amhara regions were lowest in access to toilet facilities with 4.30% and 6.31%, respectively, while households in Dire Dawa and Addis Ababa had the highest access to improved toilet facilities with 65.20% and 79.31%, respectively (online supplemental table S1) (table 1).

Factors associated with access to improved drinking water sources

The proportion of households which had access to improved sources of drinking water was 69.94% at (95% CI: 69.23% to 70.63%). Both individual-level and community-level factors had an impact on accessing improved drinking water sources in this study. Among individual-level factors; sex of the household head and from community-level factors; wealth index, time to get to drinking water sources, residence and region were significantly associated with access to improved drinking water sources.

Female-headed households were 1.18 (AOR=1.18, 95% CI: 1.01 to 1.37) times more likely to have access to improved drinking water sources than male-headed households.

Compared with poorest households, poorer (AOR=1.48, 95% CI: 1.26 to 1.74), middle-income (AOR=2.42, 95% CI: 2.03 to 2.90), richer (AOR=3.26, 95% CI: 2.68 to 3.97) and richest (AOR=6.97, 95% CI: 5.17 to 9.41) households were 1.48, 2.42, 3.26 and 6.97 times higher probability to have access to improved drinking water sources, respectively.

In contrast to households who got drinking water in <30 min, households who got drinking water ≥30 min were 35% less likely to have access to improved drinking water sources (AOR=0.65, 95% CI: 0.58 to 0.73).

The adjusted odds of access to improved drinking water sources in rural households was 94% less likely compared with urban households (AOR=0.06, 95% CI: 0.03 to 0.11).

The likelihood of access to improved sources of drinking water was 95% (AOR=0.05, 95% CI: 0.01 to 0.21) in Afar, 94% (AOR=0.06, 95% CI: 0.01 to 0.27) in Amhara, 92% (AOR=0.08, 95% CI: 0.02 to 0.35) in Oromia, 98% (AOR=0.02, 95% CI: 0.01 to 0.10) in Somali, 93% (AOR=0.07, 95% CI: 0.02 to 0.30) in Southern Nations, Nationalities, and People's Region (SNNPR) and 82% (AOR=0.18, 95% CI: 0.04 to 0.89) in Harari compared with access to improved water sources in Addis Ababa city (table 2).

Table 1 Socio-demographic characteristics of the study participants in Ethiopia, Ethiopian Demographic and Health Survey 2016 (n=16 650)

Variables		Frequency	%
Source of drinking water	Improved	11 645	69.94
	Unimproved	5005	30.06
Toilet facilities	Improved	4222	25.36
	Unimproved	12 428	74.64
Sex of household head	Male	11 413	68.55
	Female	5237	31.45
Age of household head (years)	13–30	4257	25.57
	31–40	4132	24.82
	41–56	4230	25.41
	≥57	4031	24.21
Education level of the household head	No education	16 378	98.37
	Primary education	93	0.56
	Secondary education	114	0.68
	Higher education	65	0.39
Current marital status of the household head	Never married	1046	6.29
	Married	12 064	72.50
	Widowed	2108	12.67
	Divorced	1423	8.55
Wealth index	Poorest	4676	28.08
	Poorer	2348	14.10
	Middle	2057	12.35
	Richer	2020	12.13
	Richest	5549	33.33
Time to get drinking water	≤30 min	9821	58.98
	>30 min	6829	41.02
Number of household members	1–3 members	6258	37.59
	4–6 members	7031	42.23
	7 members and above	3361	20.19
Residence	Urban	5232	31.42
	Rural	11 418	68.58
Region	Tigray	1734	10.41
	Afar	1220	7.33
	Amhara	1902	11.42
	Oromia	1988	11.94
	Somali	1564	9.39
	Benishangul-Gumuz	1280	7.69
	SNNPR	1897	11.39
	Gambella	1280	7.69
	Harari	1135	6.82
	Dire Dawa	1161	6.97
	Addis Ababa	1489	8.94

Factors associated with access to improved toilet facilities

The proportion of households with access to an improved sources of toilet facility was 25.36% at (95% CI: 24.69% to 26.03%). Individual-level factors such as educational level and marital status of the household head, and community-level factors such as wealth index, sources of drinking water, number of household members, residence and region were factors significantly impacting households' access to improved toilet facilities.

Compared with household heads that had no formal education, households with heads who attained higher education were 2.21 times more likely to have access to

Table 2 Multivariable multilevel logistic regression model of the effects of individual-level and community-level factors on improved drinking water sources in Ethiopia, Ethiopian Demographic and Health Survey 2016

Variables		Model 0	Model I AOR (95% CI)	Model II AOR (95% CI)	Model III AOR (95% CI)
Sex of household head	Male		1		1
	Female		1.13 (0.97 to 1.32)		**1.18 (1.01 to 1.37)***
Age of household head	13–30		1		1
	31–40		0.99 (0.85 to 1.14)		1.04 (0.89 to 1.22)
	41–56		1.07 (0.92 to 1.24)		1.13 (0.96 to 1.33)
	57		0.93 (0.80 to 1.09)		1.00 (0.85 to 1.17)
Education level of the household head	No education		1		1
	Primary		0.93 (0.50 to 1.73)		0.98 (0.52 to 1.83)
	Secondary		1.69 (0.82 to 3.49)		1.74 (0.83 to 3.65)
	Higher		1.51 (0.40 to 5.70)		1.37 (0.34 to 5.55)
Current marital status of the household head	Never married		1		1
	Married		0.74 (0.54 to 1.02)		1.02 (0.72 to 1.43)
	Divorced		0.71 (0.49 to 1.04)		1.01 (0.68 to 1.50)
	Widowed		0.72 (0.49 to 1.05)		0.98 (0.66 to 1.45)
Wealth index	Poorest			1	1
	Poorer			1.47 (1.25 to 1.73)**	**1.48 (1.26 to 1.74)***
	Middle			2.41 (2.01 to 2.88)**	**2.42 (2.03 to 2.90)***
	Richer			3.23 (2.66 to 3.92)**	**3.26 (2.68 to 3.97)***
	Richest			6.84 (5.07 to 9.22)**	**6.97 (5.17 to 9.41)***
Time to get drinking water	<30 min			1	1
	≥30 min			0.66 (0.58 to 0.74)**	**0.65 (0.58 to 0.73)***
Number of household members	1–3 members			1	1
	4–6 members			0.86 (0.77 to 0.97)*	0.88 (0.77 to 1.00)
	7 members and above			0.88 (0.76 to 1.01)	0.88 (0.75 to 1.04)
Residence	Urban			1	1
	Rural			0.06 (0.03 to 0.10)**	**0.06 (0.03 to 0.11)***
Region	Tigray			0.26 (0.06 to 1.18)	0.26 (0.06 to 1.17)
	Afar			0.05 (0.01 to 0.21)**	**0.05 (0.01 to 0.21)***
	Amhara			0.06 (0.01 to 0.27)**	**0.06 (0.01 to 0.27)***
	Oromia			0.08 (0.02 to 0.35)**	**0.08 (0.02 to 0.35)***
	Somali			0.02 (0.01 to 0.10)**	**0.02 (0.01 to 0.10)***
	Benishangul-Gumuz			0.39 (0.08 to 1.80)	0.39 (0.08 to 1.81)
	SNNPR			0.07 (0.02 to 0.30)**	**0.07 (0.02 to 0.30)***
	Gambella			0.30 (0.06 to 1.35)	0.29 (0.06 to 1.33)
	Harari			0.18 (0.04 to 0.88)*	**0.18 (0.04 to 0.89)***
	Dire Dawa			0.33 (0.07 to 1.64)	0.33 (0.07 to 1.63)
	Addis Ababa			1	1
Random effect	Community level variance (SE)	12.24 (1.13)**	12.05 (1.11)**	4.75 (0.42)**	4.73 (0.41)**
	ICC (%)	78.81	78.55	59.08	58.97
	MOR	9.05	8.96	5.64	5.62
	PCV	Reference	1.55%	61.19	61.36%
Model fit statistics	Log-likelihood	−5997.01	−5987.89	−5619.38	−5611.48
	Deviance	11 994.02	11 975.78	11 238.76	11 222.96

Significant at *p<0.05; **p<0.001.

AOR, adjusted OR; ICC, intraclass correlation coefficient; Model 0, empty (null) model; Model I, only individual-level explanatory variables included in the model; Model II, only community-level explanatory variables included in the model; Model III, combined model; both individual-level and community-level explanatory variables; MOR, median OR; PCV, proportional change in variance.

improved toilet facilities at (AOR=2.21, 95% CI: 1.12 to 4.36). The likelihood of access to improved toilet facilities was 25% (AOR=0.75, 95% CI: 0.57 to 0.98) lower in households with heads who were widowed compared with those who never married.

Compared with poorest households' access to improved toilet facilities, households with the following wealth indices have the following positive associations: poor households had a (AOR=3.97, 95% CI: 2.99 to 5.29) higher probability, middle households had a (AOR=5.82, 95% CI: 4.35 to 7.80) higher probability, richer households had a (AOR=8.58, 95% CI: 6.40 to 11.50) higher probability and richest households had a (AOR=23.94, 95% CI: 17.45 to 32.83) higher probability.

Households who had improved sources of drinking water were 1.37 (AOR=1.37, 95% CI: 1.12 to 1.66) times more likely to have access to improved toilet facilities compared with their counterparts.

Households with more members were less likely to have access to improved toilet facilities. Compared with households with one to three members, households with four to six members had a 24% (AOR=0.86, 95% CI: 0.75 to 0.98) lower probability to have access to improved toilet facilities.

In this study, a decrease in the probability of access to improved toilet facilities was observed for rural households contrary to urban households by 72% (AOR=0.28, 95% CI: 0.20 to 0.38).

About 72% in Tigray (AOR=0.28, 95% CI: 0.17 to 0.46), 63% in Afar (AOR=0.37, 95% CI: 0.21 to 0.67), 96% in Amhara (AOR=0.04, 95% CI: 0.02 to 0.06), 90% in Oromia (AOR=0.10, 95% CI: 0.06 to 0.17), 95% in Benishangul-Gumuz (AOR=0.05, 95% CI: 0.03 to 0.10), 80% in SNNPR (AOR=0.20, 95% CI: 0.12 to 0.33), 85% in Gambella (AOR=0.15, 95% CI: 0.09 to 0.26) and 60% in Harari (AOR=0.40, 95% CI: 0.24 to 0.66) households had a higher probability to have access to improved toilet facilities as compared with households in Addis Ababa city (table 3).

Random-effects analysis

The prevalence of access to improved drinking water sources varied across communities (community-level variance=12.24, p≤ 0.001) (table 2). The null model (Model 0) revealed that 78.81% of the total variance in the odds of access to improved drinking water sources was accounted by between-cluster variation of characteristics (ICC=0.7881). The inter-cluster variability declined over successive models, from 78.81% in the null model to 78.55% in the only individual-level, 59.08% in the only community-level and 58.97% in the final (combined) models. The proportional change in variance indicated that the addition of predictors to the empty model explained an increased proportion of variation in access to improved drinking water sources. The combined model showed that a higher PCV, that is, 61.36% of the variance in access to improved drinking water sources could be

explained by the combined factors at the individual-level and community-level factors.

In the final model (Model III) (table 3), ICC value of 0.2708 displayed that 27.08% of the total variation in access to improved toilet facilities is accounted for the community-level factors. The remaining 72.92% variation is therefore triggered by the individual-level and other unknown factors. The proportional change in variance indicated that the addition of predictors to the empty model explained an increased proportion of variation in access to improved toilet facilities. The combined model showed a higher PCV, that is, 85.91% of the variance in access to improved toilet facilities could be explained by the combined factors at the individual-level and community-level factors.

Model fit statistics

As shown in tables 2 and 3 (model fit statistics), the values of log-likelihood and deviance showed a subsequent reduction which demonstrated that each model represents a significant improvement over the previous model and it points to the goodness of fit for the final model built in the analysis.

DISCUSSION

In this study, we aimed to assess access to improved drinking water sources and toilet facilities and their associated factors in Ethiopia. Accordingly, the proportion of households' access to improved drinking water sources was 69.94% (95% CI: 69.23% to 70.63%). This finding is lower than reports from studies conducted in Ghana,[2] Viet Nam[16] and Eswatini.[14] Whereas, it is higher than a reported proportion from a study conducted in Nepal.[15] The proportion of households' access to toilet facilities was 25.36% (95% CI: 24.69% to 26.03%). This result is higher than the one reported from Ghana,[2] however, lower than studies from Nigeria[29] and Viet Nam.[16] The variation could be the disparities in gross domestic product (GDP) status and literacy rate among countries, study period and setting.

Individual-level factors were associated with both access to improved drinking water sources and toilet facilities in the present study. Female-headed households were 1.18 times more likely than male-headed households to access improved drinking water sources. Similar findings were reported from Ghana, Viet Nam and Nigeria.[2 13 16] Gender differences may play an important role in the work division in developing countries. Most of the time women have higher household responsibilities such as fetching water, cleaning compounds, childcare and food preparation. Therefore, this might be directly linked with water and sanitation in the sense that women may be preoccupied with other daily routines than WASH.

Those households with heads having better educational status were 2.21 times more likely to access improved toilet facilities. This study finding is supported by evidences from previous studies.[14 29 30] Households who are led by

Table 3 Multivariable multilevel logistic regression model of the effects of individual-level and community-level factors on improved sources of toilet facilities in Ethiopia, Ethiopian Demographic and Health Survey 2016

Variables		Model 0	Model I AOR (95% CI)	Model II AOR (95% CI)	Model III AOR (95% CI)
Sex of the household head	Male		1		1
	Female		1.01 (0.88 to 1.16)		1.03 (0.89 to 1.19)
Age of the household head	13–30		1		1
	31–40		0.99 (0.85 to 1.15)		1.04 (0.89 to 1.21)
	41–56		0.98 (0.84 to 1.15)		1.02 (0.86 to 1.20)
	≥57		0.98 (0.83 to 1.16)		1.08 (0.91 to 1.28)
Education level of the household head	No education		1		1
	Primary		1.34 (0.67 to 2.67)		1.19 (0.59 to 2.40)
	Secondary		0.74 (0.40 to 1.36)		0.75 (0.41 to 1.38)
	Higher		2.26 (1.13 to 4.54)		**2.21 (1.12 to 4.36)****
Current marital status of the household head	Never married		1		1
	Married		0.87 (0.71 to 1.08)		0.99 (0.80 to 1.22)
	Divorced		0.69 (0.52 to 0.91)**		0.82 (0.62 to 1.08)
	Widowed		0.66 (0.50 to 0.86)***		**0.75 (0.57 to 0.98)****
Household wealth index	Poorest			1	1
	Poor			3.99 (3.00 to 5.31)***	**3.97 (2.99 to 5.29)*****
	Middle			5.87 (4.39 to 7.86)***	**5.82 (4.35 to 7.80)*****
	Richer			8.65 (6.46 to 11.58)***c	**8.58 (6.40 to 11.50)**c
	Richest			24.76 (18.08 to 33.91)***	**23.94 (17.45 to 32.83)*****
Source of drinking water	Unimproved			1	1
	Improved			1.36 (1.12 to 1.65)c	**1.37 (1.12 to 1.66)**c
Household size	1–3 members			1	1
	4–6 members			0.88 (0.78 to 0.99)*	**0.86 (0.75 to 0.98)*****
	7 members and above			1.07 (0.91 to 1.26)	1.02 (0.86 to 1.22)
Place of residence	Urban			1	1
	Rural			0.28 (0.21 to 0.39)***	**0.28 (0.20 to 0.38)*****
Region	Tigray			0.27 (0.16 to 0.45)***	**0.28 (0.17 to 0.46)*****
	Afar			0.38 (0.21 to 0.68)***	**0.37 (0.21 to 0.67)*****
	Amhara			0.04 (0.02 to 0.06)***	**0.04 (0.02 to 0.06)*****
	Oromia			0.10 (0.06 to 0.17)***	**0.10 (0.06 to 0.17)*****
	Somali			1.33 (0.79 to 2.22)	1.32 (0.79 to 2.21)
	Benishangul-Gumuz			0.05 (0.03 to 0.10)***	**0.05 (0.03 to 0.10)*****
	SNNPR			0.20 (0.12 to 0.34)***	**0.20 (0.12 to 0.33)*****
	Gambella			0.15 (0.09 to 0.26)***	**0.15 (0.09 to 0.26)*****
	Harari			0.40 (0.24 to 0.66)***	**0.40 (0.24 to 0.66)*****
	Dire Dawa			1.13 (0.69 to 1.87)	1.14 (0.69 to 1.89)
	Addis Ababa			1	1
Random effect	Community level variance (SE)	8.66 (0.73)***	8.71 (0.74)***	1.21 (0.12)***	1.22 (0.12)***
	ICC (%)	72.46	72.58	26.95	27.08
	MOR	16.37	16.50	2.84	2.86
	PCV	Reference	−1.07%	86.03	85.91%
Model fit statistics	Log-likelihood	−5621.74	−5603.26	−5029.24	−5018.39
	Deviance	11 243.48	11 206.52	11 036.78	10 058.48

Significant at *p<0.05; **p<0.01; ***p<0.001.

AOR, adjusted OR; ICC, intraclass correlation coefficient; Model 0, empty (null) model; Model I, only individual-level explanatory variables included in the model; Model II, only community-level explanatory variables included in the model; Model III, combined model; both individual-level and community-level explanatory variables; MOR, median OR; PCV, proportional change in variance.

heads who have no education had a lower probability of access to improved toilet facilities. In sub-Saharan Africa, education is a resource factor of quality health outcomes, and educated people usually are more aware of the condition that guarantees their well-beings. This implies that educated household heads in this study may have used their resources to provide their households with improved toilet facilities.

In addition to individual-level factors, community-level factors were also a significant factor in determining access to improved drinking water sources and toilet facilities. Compared with households within the poorest category, households within the poor, middle, richer and richest wealth index category were 1.48, 2.42, 3.26 and 6.97 times more likely to have access to improved sources of drinking water and 3.97, 5.82, 8.58 and 23.94 times higher odds to access to improved toilet facilities, respectively. This result is consistent with results from previous studies.[13 14 31] People who have better incomes would intend to fulfil the necessities of life. Economically, the rich can afford the initial high cost of both water and sanitation facilities and the poor may be disproportionately underserved in the distribution of public utility, and hence consume poor quality water and use unimproved toilet facilities.

Compared with households that got drinking water <30 min, households which obtained drinking water ≥30 min were 35% less likely to access improved drinking water sources. Hence, the length of time to get drinking (proximity of a house to a drinking water source) water might make difference in access to improved sources of drinking water and coverage (%) with improved water supply (Household connection, public standpipes, protected underground water sources, rainwater collection). This is not surprising as physical distance is one of the reasons of WASH service inaccessibility.

The adjusted odds of access to improved drinking water sources and toilet facilities were 94% and 72% less likely among rural households as compared with urban households, respectively. The rural–urban disparity in access to improved sources of drinking water and toilet facilities have been reported by several other previous studies, too.[12 32 33] The disparity might be, in sub-Saharan Africa, most of the people live in rural areas and their economic status is poor. Therefore, they do not have adequate financial resources to acquire improved drinking water sources and toilet facilities.

Furthermore, households who had improved sources of drinking water were 1.37 times more likely to access improved toilet facilities. This study finding is consistent with an earlier study.[29] The possible explanation could be a lack of access to adequate sanitation is also linked to the limited access to water supply and households who had improved water sources may be practicing more in hygiene and sanitation.

Lastly, those households with four to six members were 24% less likely to have access to improved toilet facilities compared with households with one to three members. This is contrary to that of an earlier study.[2] The possible

explanation could be the highest number of household members, the fewer resources they could have to build improved toilet facilities.

The results of our study should be interpreted with the following limitations. Since the information is recorded retrospectively, it might be prone to recall bias, and the analyses were conducted using data collected in a cross-sectional survey, which prevents causal inferences.

CONCLUSIONS

The proportion of households' access to an improved sources of drinking water and toilet facilities was low in Ethiopia. Sex of the household head, household wealth index, time to get drinking water, place of household/ urban/rural residence and region were factors impacting access to improved drinking water sources. Educational level of the household head, household wealth index, marital status of the household head (widowed), sources of drinking water, number of household members, household or rural/urban residence and region were factors associated with access to improved toilet facilities. Thus, we authors recommend governmental and nongovernmental organisations working on WASH should consider a multifaceted policy approach that accounts for the regions and residence variations and other identified factors to ease up the problem.

Author affiliations
[1]Department of Environmental and Occupational Health and Safety, College of Medicine and Health Sciences, University of Gondar, P. O. Box 196, Gondar, Ethiopia
[2]Department of Women's and Family Health, School of Midwifery, College of Medicine and Health Sciences, University of Gondar, P. O. Box 196, Gondar, Ethiopia
[3]Department of Epidemiology and Biostatistics, Institute of Public Health, College of Medicine and Health Sciences, University of Gondar, P. O. Box 196 Gondar, Ethiopia
[4]Department of Human Physiology, School of Medicine, College of Medicine and Health Sciences, University of Gondar, P. O. Box 196 Gondar, Ethiopia
[5]Department of Medical Microbiology, School of Biomedical and Laboratory Sciences, College of Medicine and Health Sciences, University of Gondar, Gondar, Ethiopia

ORCID iDs
Zewudu Andualem http://orcid.org/0000-0002-4731-1696
Asefa Adimasu Taddese http://orcid.org/0000-0001-5506-8705
Baye Dagnew http://orcid.org/0000-0002-2397-5930
Yigizie Yeshaw http://orcid.org/0000-0003-4587-7925

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