ACCESS TO WATER AND SANITATION FACILITIES AND ASSOCIATED FACTORS AMONG HOUSEHOLDS IN THE SLUM AREAS OF JIGJIGA CITY, EASTERN ETHIOPIA

MSc Thesis

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ACCESS TO WATER AND SANITATION FACILITIES AND ASSOCIATED FACTORS AMONG HOUSEHOLDS IN THE SLUM AREAS OF JIGJIGA CITY, EASTERN ETHIOPIA: A CROSS-SECTIONAL STUDY DESIGN

MSC RESEARCH THESIS

BY MOHAMED SIYAD YUSUF

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A THESIS SUBMITTED TO DEPARTMENT OF ENVIRONMENTAL HEALTH SCIENCE, SCHOOL OF GRADUATE STUDIES, HARAMAYA UNIVERSITY, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER IN ENVIRONMENTAL HEALTH SCIENCE.

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HARAR, ETHIOPIA.

APPROVAL SHEET

Haramaya University

Postgraduate Program Directorate

As thesis research advisor, I hereby certify that I have read and evaluate this Thesis entitled "Access to water and sanitation facilities and associated factors among households in the slum areas of Jigjiga city, Eastern Ethiopia" Prepared under my guidance by Mohamed Siyad. I recommend that it will be submitted as fulfilling the thesis requirement.

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As a member of the board of examiners of the MSc thesis open defense examination, we certify that we have read and evaluated the thesis prepared by Mohamed Siyad and examined the candidate. We recommend that the thesis be accepted as fulfilling the thesis requirements for degree of master in Water Supply and Sanitation Management.

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Final approval and acceptance of the thesis is contingent upon the submission of its final copy to the council of graduate studies through the candidate's department or postgraduate program directorate.

DEDICATION

This thesis is dedicated to my beloved mother Nimo abdi and also my family who have been so inspirational during my time.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this thesis is my own work. I have followed all ethical principles of scholarship in the preparation, data collection, data analysis and completion of this thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every serious effort has been made to avoid any plagiarism in the preparation of this thesis.

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BIOGRAPHICAL SKETCH

The author was born on April 8, 1991GC in Degahbour town. He attended his primary school at Ugaas mahamoud Primary and Junior School. He attended his secondary and preparatory school at Degahbour Senior Secondary and Preparatory School. He then graduated from Aksum University, College of Agriculture in the department of water resources and irrigation management in 2014. Before joining the MSc program, He worked Somali water works construction enterprise, Somali design and supervision works Enterprise. Ethiopia Second urban Water supply and sanitation Project.

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LIST OF ABBREVIATIONS AND ACRONYMS

CSA	Central Statistical Authority
ETB	Ethiopian Birr
HHH	Head of Household
JMP	Joint Monitoring Programme
MDG	Millennium Development Goal
SPSS	Statistical Package for Social Science
UN	United Nations
WASH	Water, Sanitation, and Hygiene
WSS	Water Supply and Sanitation
EDHS	Ethiopian Demographic and Health Survey
JWSSA	Jigjiga Water Supply and Sewerage Authority
LPCD	Liter per capita per day
OD	Open Defecation
SSA	Sub -Saharan Africa
UNICEF	United Nations Children's Emergency Fund
WHO	World Health Organization
WWSDE	Somali Design Water Works Enterprise
JWSSA	Jigjiga Water Supply and Sewerage Authority
AOR	Adjusted Odds Ratio
CI	Confidence Interval
COR	Crude Odds Ratio

ABSTARCT

Background: Access to safe water and improved sanitation remains a major public health challenge in rapidly expanding urban slum areas of Ethiopia. However, there is limited empirical evidence examining both the level of access to improved water, sanitation, and hygiene (WASH) services and their associated determinants in informal settlements of emerging regional cities. This study assessed access to improved water supply and sanitation facilities and identified associated factors among slum households in Jigjiga City, Somali Regional State, Ethiopia.

Objective: To assess access to water supply and sanitation facilities and examine factors associated with improved water supply and sanitation among households in the slum areas of Jigjiga City, Somali Regional State, eastern Ethiopia, from 15 July to 31 August 2023.

Methods: A community-based cross-sectional study was conducted among 404 slum households in Jigjiga City from 15th July to 31st August 2023. 404 Households were selected using a systematic random sampling technique, whereby every 19*k*th household was chosen after a random starting point from a complete household list to ensure representative sampling. Data were collected from 404 selected households through face-to-face interviews using a structured questionnaire and an observational checklist to assess household water and sanitation conditions. Data were coded, cleaned, and entered into Epi-Data version 3.1 and exported to STATA version 13 for analysis. Model fitness was assessed using the log-likelihood ratio test. Bivariate and multivariable logistic regression analyses were performed to identify factors associated with access to improved water supply and sanitation. Adjusted Odds Ratios (AORs) with 95% confidence intervals (CIs) were used to determine associations, and statistical significance was declared at $p < 0.05$.

Results: Nearly all households (99.3%) reported access to a drinking water source; however, only 30.7% had piped water on premises, while the majority (69.3%) relied on water vendors, classified as unimproved sources. Female-headed households were 49% less likely to have access to an improved water supply compared with male-headed households (AOR = 0.51; 95% CI: 0.28–0.92). Households headed by individuals with secondary education (AOR = 2.48; 95% CI: 1.14–5.40) and those with diploma-level education or higher (AOR = 4.62; 95% CI: 1.85–11.54) had higher odds of having piped water on premises compared with households headed by illiterate individuals.

Compared with low-income households, middle and high-income households showed significantly higher odds of access to improved water supply (AOR = 3.42; 95% CI: 1.59–7.33 and AOR = 5.89; 95% CI: 2.67–12.97, respectively).
Households residing in semi-permanent (AOR = 0.29; 95% CI: 0.13–0.63) and temporary dwellings (AOR = 0.33; 95% CI: 0.15–0.70) were significantly less likely to have improved water access.

Access to improved sanitation facilities was reported by 30.9% of households. Household head education, household income, location of the water source, availability of handwashing facilities, and presence of soap or detergent were significantly associated with sanitation access. Households headed by individuals with diploma-level education or higher were more likely to have improved sanitation (AOR = 3.02; 95% CI: 1.20–7.62). Middle-income (AOR = 1.78; 95% CI: 1.01–3.16) and high-income households (AOR = 2.41; 95% CI: 1.09–5.33) had higher odds of improved sanitation compared with low-income households. Households using piped water off-premises were 52% less likely to have improved sanitation (AOR = 0.48; 95% CI: 0.22–0.97). Availability of handwashing facilities (AOR = 2.41; 95% CI: 1.08–5.37) and presence of soap or detergent (AOR = 2.76; 95% CI: 1.20–6.36) were also positively associated with improved sanitation.

Conclusion and Recommendations: Access to improved water supply and sanitation services in the slum areas of Jigjiga City remains limited and unevenly distributed, and is significantly associated with disparities in education, income, housing conditions, and gender. Strengthening water supply infrastructure, promoting community-based sanitation programs, implementing gender-sensitive WASH interventions, and expanding affordable piped water connections through public–private partnerships are important strategies for improving equitable WASH access in urban slum settings of Jigjiga City.

Keywords*: Water Supply, Sanitation, Improved, Slum area, Households, Jigjiga City, Ethiopia.*

1. INTRODUCTION

1.1. Background of the Study

Access to water, sanitation, and hygiene (WASH) services is a fundamental human right and a critical determinant of public health and socioeconomic well-being (Prüss-Ustün et al. & WHO, 2019). Inadequate access to safe drinking water and sanitation remains a major contributor to communicable diseases, particularly in densely populated and underserved environments (WHO & UNICEF, 2021). These challenges are most pronounced in urban slums, where overcrowding, poor housing conditions, and limited infrastructure substantially increase exposure to unsafe WASH conditions (UNICEF, 2023).

Recent evidence from the WHO/UNICEF Joint Monitoring Programme (JMP) indicates that residents of urban slums remain disproportionately underserved compared to those living in formal urban areas. Although overall urban coverage of improved water and sanitation services has increased globally, progress has been uneven, with many informal settlements continuing to rely on unimproved water sources and shared or unsafe sanitation facilities. JMP reports highlight widening intra-urban inequalities, placing slum residents at heightened risk of waterborne and sanitation-related diseases due to poor service quality, limited availability, and lack of safely managed sanitation services (WHO & UNICEF, 2021).

Urban slums are commonly characterized by insecure tenure, inadequate infrastructure, and poor environmental conditions. The World Health Organization has documented elevated rates of diarrheal diseases, parasitic infections, and other sanitation-related illnesses in such settings, particularly among children and other vulnerable populations. Reliance on shared sanitation facilities and intermittent water supply further exacerbates these health risks in informal settlements (UN-Habitat & Abebe et al., 2023).

In Ethiopia, despite gradual improvements in national WASH coverage, substantial disparities persist within urban areas, especially among poor and slum-dwelling populations. Recent JMP reports show that while urban households generally have better access to improved water and sanitation services than rural populations, significant intra-urban inequalities remain, with many informal-settlement residents lacking access to improved sanitation and basic hygiene facilities (Alemu et al. & Gebremariam et al., 2021).

Studies conducted in urban and peri-urban settings further demonstrate that socioeconomic status, housing conditions, and informal settlement status are key determinants of inadequate WASH access (Assefa et al. & Ayalew et al., 2023). These inequities undermine public health gains and contribute to preventable morbidity and economic losses (EPHI & WHO, 2022).

Therefore, research on access to water and sanitation facilities and associated factors among households in slum areas is urgently needed in Jigjiga City. As far as I am aware, limited studies have examined the level of access to improved water and sanitation services and their associated factors in these communities. This suggests that, in order to understand the magnitude of WASH service gaps in Jigjiga City, it is important to generate evidence on households' access to improved water and sanitation facilities. Such evidence will help minimize inequalities in WASH access and enable local authorities to take appropriate actions to improve services in slum areas.

2.4 Statement of the problem

Despite global and national efforts to improve access to water, sanitation, and hygiene services, WASH-related challenges remain a major public health concern, particularly in urban informal settlements. According to the WHO/UNICEF Joint Monitoring Programme, approximately 2 billion people worldwide still lack safely managed drinking water, and 3.6 billion lack safely managed sanitation services, with the burden disproportionately affecting low and middle-income countries, especially Sub-Saharan Africa (WHO & UNICEF, 2021).

Poor WASH conditions are strongly associated with adverse health outcomes, including diarrheal diseases, parasitic infections, and other communicable illnesses that continue to be leading causes of morbidity and mortality in low-income settings. In Ethiopia, WASH-related communicable diseases remain a major public health challenge, particularly among children and other vulnerable populations (Prüss-Ustün et al. & UN-WATER/WWAP, 2019).

Rapid urbanization has further intensified these challenges. The expansion of cities in Ethiopia has outpaced the development of adequate water and sanitation infrastructure, leading to the growth of informal settlements that are frequently excluded from formal service provision. As a result, urban slum households often depend on shared, unimproved, or costly alternative water sources and sanitation facilities, increasing both health risks and financial burdens for poor households (Dagdeviren & Robertson, 2011).

Evidence from selected Ethiopian cities, including Addis Ababa and Hosanna, demonstrates that slum households experience markedly lower access to improved water supply and sanitation services compared to non-slum urban residents. These findings suggest a broader pattern of WASH inequities affecting urban informal settlements across the country (Kidanie & Aydamo, 2023).

Jigjiga City has undergone rapid urban expansion, with informal settlements now constituting a substantial portion of the city's built environment. These settlements are characterized by inadequate water supply, poorly maintained sanitation facilities, and limited hygiene infrastructure, placing residents at increased risk of WASH-related diseases (Ismail, 2021). However, there is limited empirical evidence on household-level access to improved water and sanitation facilities in Jigjiga's slum areas, as well as on the factors influencing access in these settings.

Therefore, research on access to improved water supply and sanitation facilities is more urgently needed to identify the factors associated with access among slum households in Jigjiga City.

1.3. Significance of the study findings

This study is significant because it addresses the serious public health risks caused by poor access to water and sanitation in the slum areas of Jigjiga city, where diseases such as diarrhea and cholera are common. The direct beneficiaries are slum residents, who will gain from evidence-based interventions that improve access to safe water, sanitation, and hygiene, ultimately reducing disease risks and improving quality of life.

Policy makers and institutions such as the Somali Region Water Development Bureau, Jigjiga City Administration, and the City Water Supply and Sewerage Authority will also benefit from this research, as the findings provide critical information to design and implement equitable policies and infrastructure improvements. The health sector, development partners, and NGOs will gain reliable data to strengthen public health programs, prioritize funding, and advocate for marginalized groups.

Academic institutions and researchers will benefit from the new evidence generated, which fills gaps in knowledge about WASH in slum areas. Ultimately, the wider community and local economy will benefit from healthier, more productive populations and reduced health care burdens. By shedding light on the inequalities in water and sanitation access, this research ensures that the needs of vulnerable slum communities are recognized, prioritized, and addressed in future urban planning and policy-making.

1.4. OBJECTIVES

1.4.1 General objective

- To assess access to water supply and sanitation facilities and examine factors associated with improved water supply and sanitation among households in the slum areas of Jigjiga City, Somali Regional State, eastern Ethiopia, from 15 July to 31 August 2023.

1.4.2 Specific objectives

- To assess households access to improved water supply facilities in slum area of Jigjiga city.
- To assess households access to improved basic sanitation facilities in slum area of Jigjiga city.
- To identify factors associated with household's access to water supply facilities among in slum area of Jigjiga city.
- To identify factors associated with household's access to basic sanitation facilities in slum area of Jigjiga city.

2. LITERATURE REVIEW

2.2. Access to Improved Water Supply Facilities in Slum Areas

Access to improved water supply facilities in slum areas is widely recognized as a critical determinant of public health, social well-being, and economic productivity (UN-Habitat, 2021). Globally, rapid urbanization has expanded informal settlements, where basic infrastructure has not kept pace with population growth (UN-Habitat, 2021).

Evidence from low and middle-income countries consistently shows that slum residents disproportionately rely on unimproved or unreliable water sources, including public standpipes, boreholes, and water vendors, often at higher financial and time costs than formal urban households (UNICEF, 2023). Inadequate access to improved water supply in slum areas has been strongly associated with increased exposure to waterborne diseases, particularly diarrheal illnesses, which disproportionately affect children and other vulnerable groups (Prüss-Ustün et al. & WHO, 2019).

Empirical studies conducted in African and Asian cities demonstrate that direct household access to piped water in slum areas remains limited, with coverage frequently below 50% (UN-Habitat, 2021). Research from Nairobi, Kenya, and several Ethiopian cities indicates that the majority of slum households depend on shared or off-premises water sources, which are often intermittent, distant, or of uncertain quality (Chumo I, 2025).

These studies consistently indicate affordability, distance to water sources, infrastructure deficits, and governance failures as major barriers to improved water access. However, reported levels of access vary considerably between settings, suggesting substantial contextual differences in service provision and household coping mechanisms (UNICEF, 2023).

Despite the breadth of existing research, several gaps remain evident. Many studies focus primarily on coverage levels without adequately examining the underlying socio-demographic and economic factors influencing access to improved water supply (Adams et al. & Asfaw et al., 2022).

Moreover, the majority of Ethiopian studies are concentrated in major metropolitan areas, particularly Addis Ababa, leaving secondary and rapidly growing cities underrepresented in the literature (Worku et al., 2021). Limited attention has also been given to eastern Ethiopia, where

urban growth, climatic vulnerability, and infrastructural constraints may uniquely shape water access in slum settings (UNICEF, 2023).

Accordingly, this study addresses these gaps by assessing household access to improved water supply facilities in the slum areas of Jigjiga City and by identifying factors associated with access within this understudied urban context. By integrating socio-demographic, economic, and water supply-related variables, the study provides localized evidence to inform equitable urban water service planning.

2.3 Access to Improved Basic Sanitation Facilities in Slum Areas

Improved basic sanitation is essential for preventing fecal-oral disease transmission and for safeguarding human dignity and environmental health (UNICEF, 2023). Globally, a substantial proportion of the urban population living in slums lacks access to improved sanitation facilities, with many households relying on shared, unimproved, or unsafe sanitation options (UN-Habitat, 2021). Overcrowding, insecure land tenure, and limited investment in sanitation infrastructure exacerbate sanitation challenges in slum environments, resulting in persistent public health risks (UN-Habitat, 2020).

Studies across sub-Saharan Africa consistently report low levels of access to improved sanitation in slum areas, with coverage often below 40% (UNICEF, 2023). In Ethiopia, research conducted in Addis Ababa, Dire Dawa, Hawassa, Bahir Dar, and Adama reveals that a large proportion of slum households rely on shared pit latrines or practice open defecation due to the absence of private sanitation facilities (Alemu et al. & Gebremariam et al., 2021). These conditions contribute to recurrent outbreaks of sanitation-related diseases and disproportionately affect women, children, and other vulnerable populations due to safety, privacy, and hygiene concerns.

However, existing studies demonstrate considerable variation in reported sanitation coverage and in the identified determinants of access. While poverty, land tenure insecurity, population density, and weak municipal support are commonly cited barriers, the relative importance of these factors differs across settings (Worku et al., 2021).

Furthermore, many studies remain largely descriptive and do not sufficiently explore the interaction between sanitation access and other WASH components, such as water availability and hygiene facilities (Jenkins & Scott & Abebe et al., 2023).

This study contributes to the literature by systematically assessing access to improved basic sanitation facilities in the slum areas of Jigjiga City and by examining factors associated with sanitation access within a comprehensive analytical framework.

By focusing on a secondary city in eastern Ethiopia, the study fills a critical geographical and empirical gap and generates evidence relevant for localized sanitation planning and policy development.

2.4. Factors Associated with Access to Water Supply Facilities in slum areas

Access to water supply facilities in slum areas is influenced by a complex interplay of socio-demographic, economic, infrastructural, and institutional factors. Existing literature consistently identifies household income, educational status, housing tenure, and occupation as key determinants of water access (Mekonnen et al., 2024).

Low-income households often face financial barriers to obtaining private connections and are more likely to depend on expensive or unsafe water sources. In addition, inadequate infrastructure, high connection fees, and intermittent water supply services further limit access in informal settlements (UNICEF, 2023).

Spatial and environmental factors also play a significant role. Slums are frequently located in peripheral or environmentally vulnerable areas, where extending water distribution networks is technically challenging and costly. Governance-related issues, including weak utility management, limited political representation of slum communities, and exclusion from formal urban planning processes, further exacerbate inequities in water service delivery. Gender dynamics are also critical, as women and girls commonly bear the responsibility for water collection, exposing them to time burdens and safety risks (Garn et al. & WHO & UNICEF, 2023).

While these determinants are widely recognized, inconsistencies remain regarding their relative influence across different urban contexts. Moreover, few studies employ multivariable analytical approaches to disentangle the independent effects of these factors on water access. There is also limited empirical evidence from slum areas in eastern Ethiopia, where socioeconomic and environmental conditions differ from those in larger metropolitan centers (UN-Habitat, 2021).

The present study addresses these limitations by identifying factors associated with household access to water supply facilities in Jigjiga City's slum areas, using an analytical approach that accounts for multiple interacting determinants. This context-specific evidence is essential for designing targeted interventions that address the root causes of water access inequities.

2.5. Factors Associated with Access to Basic Sanitation Facilities in slum Areas

Access to basic sanitation facilities in slum areas is shaped by economic constraints, infrastructural deficiencies, socio-cultural norms, and governance-related factors. Poverty and unaffordability are consistently identified as major barriers, as the costs of constructing and maintaining improved sanitation facilities often exceed the financial capacity of slum households. Insecure land tenure further discourages investment in private sanitation facilities, while high population density limits available space for latrine construction (UN-Habitat & Abebe et al., 2023).

Social and behavioral factors, including educational status, hygiene awareness, gender norms, and cultural perceptions of sanitation, also influence sanitation access and utilization. Women and girls, in particular, face heightened risks related to privacy, safety, and menstrual hygiene management in settings dominated by shared or poorly maintained sanitation facilities. Inadequate access to water supply further undermines sanitation functionality and hygiene practices, highlighting the interdependence of WASH components (WHO & UNICEF, 2021).

Despite recognition of these factors, the literature reveals limited integration of sanitation, water, and hygiene determinants within a unified analytical framework. Many studies focus narrowly on latrine ownership or utilization without adequately considering hygiene facilities or environmental conditions. Furthermore, empirical evidence from secondary cities and peripheral urban centers remains scarce (Mekonnen et al., 2024).

By examining factors associated with access to basic sanitation facilities in the slum areas of Jigjiga City, this study responds directly to these gaps. The findings provide comprehensive, context-specific insights into the determinants of sanitation access and support the development of integrated WASH interventions tailored to urban slum settings.

2.6. Conceptual frame work

This conceptual framework illustrates the relationship between the dependent and independent variables identified in the literature review. It presents the factors associated with access to improved water supply and basic sanitation facilities among households in the slum areas of Jigjiga City (adapted from WHO & UNICEF, 2021; UN-Habitat, 2021; Mekonnen et al., 2024).

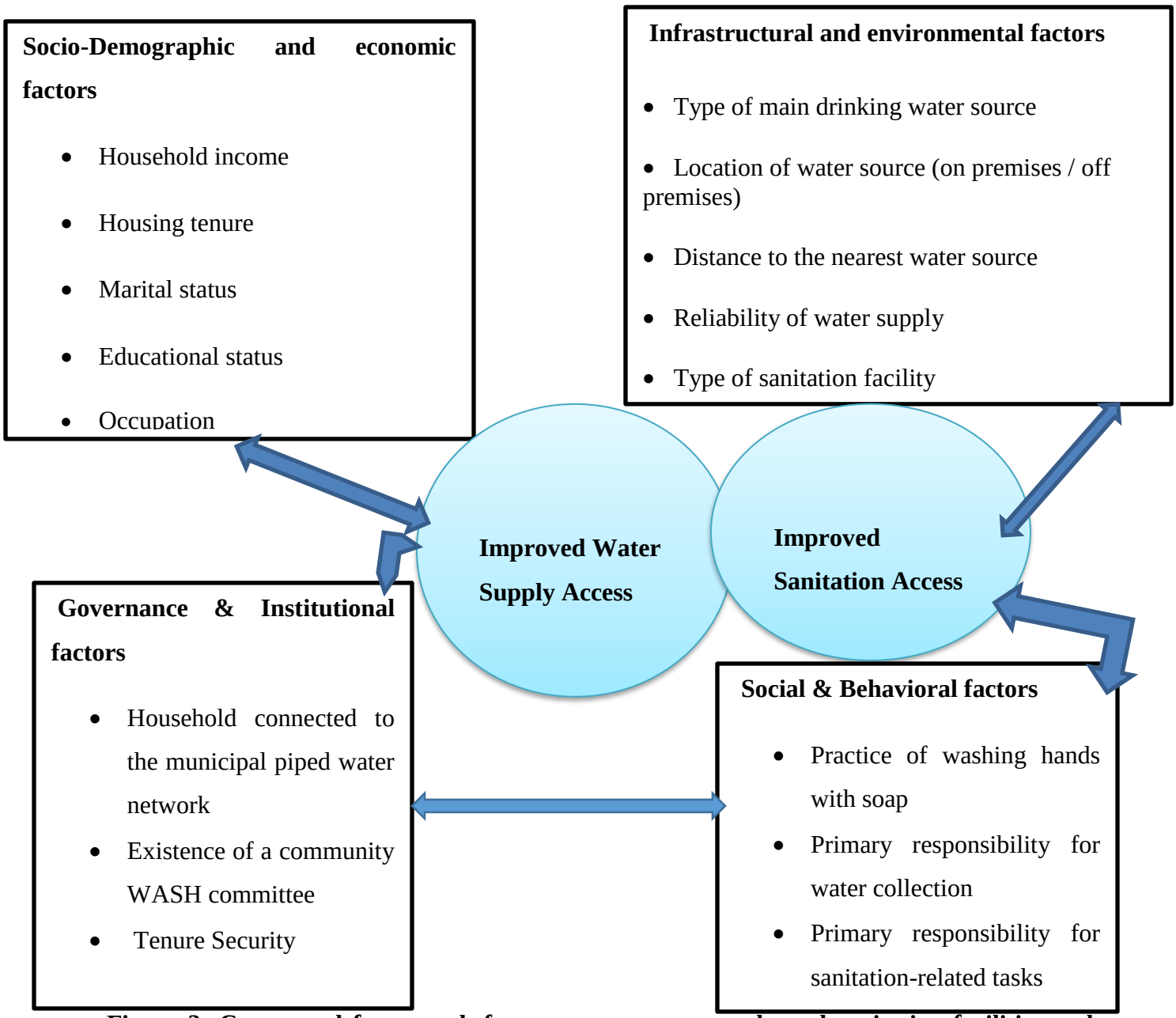


Figure 3: Conceptual framework for access to water supply and sanitation facilities and associated factors among households in the slum area of Jigjiga city, based on literature review, *(adapted from WHO & UNICEF, 2021; UN-Habitat, 2021; Mekonnen et al., 2024)*

3. MATERIALS AND METHODS

3.1. Study area and period

The study was conducted in the Jigjiga city administration from July 15 to August 31, 2023. This city is located in the Fafan zone of the Somali region, approximately 631 km from Addis Ababa. Jigjiga city had ten administrative kebeles before 2018. However, following an administrative reform in 2018, the town was restructured into twenty kebeles and four urban sub-cities: Karamardha, Garabcase, Qordheere, and Duda Hida. Based on the study criteria, the Qordheere, Garabcase, and Karamara sub-cities were selected for this study. These sub-cities are located in the central part of Jigjiga city and cover an area of approximately 25.18 km². According to the 2010 population census conducted by the Central Statistical Agency, the estimated population of these areas was about 7,635, of whom 3,984 were females and 3,651 males, with a population density of approximately 303 persons per km². Out of this population, there are a total of 1,272.5 households in the area, which is divided into three administrative kebeles.

The sample for this study was taken from specific slum areas, namely Godkuli, Suuq Yare, and Jaraaqato, which correspond to kebele 05, kebele 01, and kebele 12, respectively. According to the Central Statistical Agency's population estimation projection for 2020, Jigjiga has an estimated total population of 159,300, comprising 81,789 men and 77,511 women.

The living conditions of the people in these slum areas are quite similar; they are characterized by high population density, age, and crowding, making them representative of other slums. One unique feature of these slum areas, compared to others in the city, is that the residents are traditionally stigmatized as belonging to the lowest caste (Worku et al. & Asfaw et al., 2022).

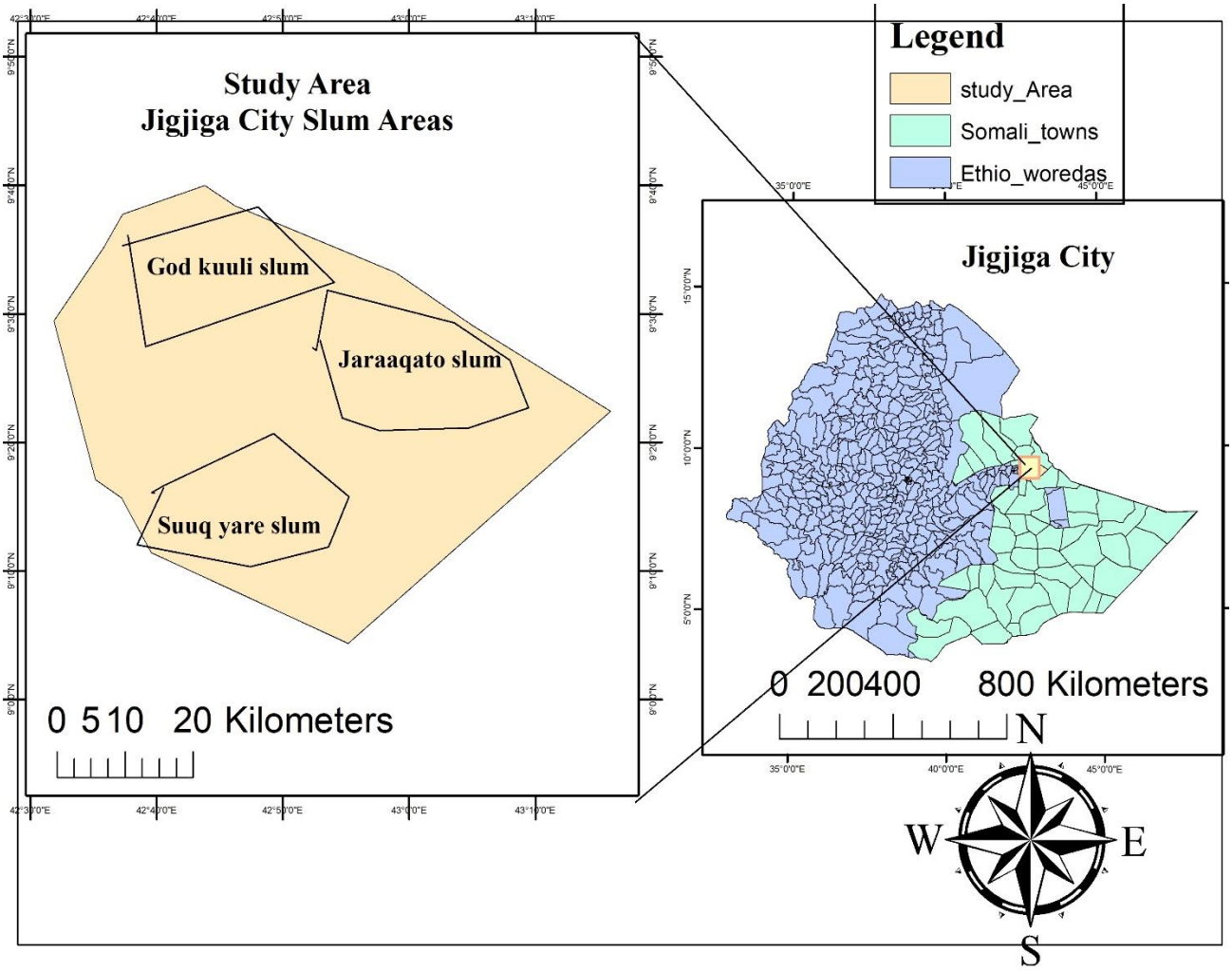


Figure 4: Location Map of Jigjiga City Slum Areas (Jigjiga City, Administration., 2021).

3.2. Study design

A community-based cross-sectional study was conducted from July 15, to August 31, 2023

3.3. Population

3.3.1. Source population

The source population for this study was all households in the slum area of Jigjiga City.

According to the data I obtained from the Jigjiga City Administration City Service Office and Jigjiga Water Supply and Sewerage Authority Office, the three slum areas of Jigjiga city, which are Godkuli, Suuq Yare, and Jaraaqato were identified based on their specific criteria: -

The selection criteria for the study area were based on their relevance to the research objectives. These criteria included: (I_,) the majority of the area is occupied by predominantly poor slum residents, (ii) the area is unplanned and has limited infrastructure to deliver water and sanitation services, and (iii) the language spoken in the area is familiar to the researcher, enabling effective communication and understanding of information.

Socioeconomic Conditions**:** These areas are characterized by high levels of poverty and overcrowding. The residents face significant challenges related to living conditions, which include inadequate housing and limited access to basic services (Jigjiga City, Administration., 2021).

Infrastructure Deficiencies: The selected slum areas are largely unplanned, lacking essential infrastructure such as proper roads, sanitation facilities, and a reliable water supply. This unplanned nature contributes to the challenges faced by the inhabitants (JCWSSA., 2020).

Population Density: The areas exhibit a high population density, making them representative of the broader challenges associated with urban slums. This density often leads to increased competition for limited resources and services, exacerbating the living conditions (Jigjiga City Municipality. , 2021).

3.3.2. Study population

The study population was all household heads living in the selected slum area of Jigjiga City Administration. Study units were household heads in those selected households that fulfilled the selection criteria.

3.4. Inclusion and exclusion criteria

3.4.1. Inclusion criteria

All household heads in the slum area who have living there before the interview in Jigjiga City were included.

3.4.2. Exclusion criteria

A very sick individual who cannot communicate during the data collection was excluded from the study.

3.5. Sample size determination

The total sample size was calculated using the single population proportion formula. The sample size was calculated using the single population proportion formula by considering P=urban water supply accessibility of the region. = 39% (Reddy,] Mekonnen Abdisa and R. Uttama, 2014), 95% confidence interval (CI) and a 5% margin of error. Accordingly, the sample size was 407. Since the source population (n=7,635) is below 10,000, a finite population correction was considered, and by adding the possible 10% nonresponse, the final sample size was 407 households. The systematic random sampling technique was used to select households from the slum area, and every 19 households were included. Every 19th household after that was then selected until the target sample size of 407 was reached. For households that did not fulfill the inclusion criteria, the next household was considered.

Sample size calculation for the 1st objective based on improved water supply facilities

Sample size calculation: The sample size was calculated using a single population proportion formula. Water supply accessibility of Awaday town is 39% in 2014. Let as Jigjiga city slum area accessibility is the same. P=39%, 95% confidence level, and 5% margin of error, Sample size calculation: Assuming an estimated proportion (p) of 39% for access to improved water supply, a 95% confidence level (z = 1.96), and a 5% margin of error (d = 0.05).

$n= Z^2 * P * (1-P)/E^2$

Calculating the components

Z^2= (1.96)2 =3.8146

P(1-P) =0.39*0.61=0.2379

E^2 = (0.05)2 =0.0025

Now substitute these values into the formula:

n = 3.8146*0.2379/0.0025 = 0.9145/0.0025 = 366

Now, adjust for the non-response rate of 10%:

$n_{adjusted}$ = n/1-0.10 = 366/0.90 = 407

The required sample size, accounting for a 10% non-response rate, is 407 individuals to achieve a 95% confidence level with a 5% margin of error for water supply accessibility in Jigjiga city slum areas, assuming it is the same as Awaday town (Reddy,] Mekonnen Abdisa and R. Uttama, 2014).

Table 1: Calculating 1st sample size based on Access to improved water supply facilities

No	Name of slum area	Household	Sample Size proportion	Sample size	Percentage	Research techniques for sample size	Data collection techniques
1	Jaraaqato	3,149	3149*407/7635	168	41.23%	Systematic sampling	Questioners
2	Suuq Yare	1,228	1228*407/7635	65	15.97%		
3	God kuuli	3,258	3258*407/7635	174	42.75%		
Total		**7,635 HH**		**407**	**100**		

Source: Developed by the Researcher,2023

Sample size calculation for the 2nd objective based on improved basic sanitation facilities

For this objective, the sample size calculation would be as follows:

Given: Population size (N) = 7635

Confidence level = 95% (z-value = 1.96)

Estimated proportion (p) = 0.5 (assuming 50% have access to improved basic sanitation)

Margin of error (d) = 0.05 (5%)

Using the formula for finite population size:

n = (z^2 * p * (1 - p)) / [(d^2 * (N - 1)) + (z^2 * p * (1 - p))]

Inserting in the values:

n = (1.96^2 * 0.5 * (1 - 0.5)) / [(0.05^2 * (7635 - 1)) + (1.96^2 * 0.5 * (1 - 0.5))]

n = 3.8416 * 0.5 * 0.5 / [(0.0025 * 7634) + 0.9604]

n = 0.9604 / (19.085 + 0.9604)

n = 0.9604 / 20.0454

n = 47.92

The sample size for this objective is 48 households (Adane, 2017).

Sample size determination for the 3$^{rd\ and\ 4rth}$ objectives Regression Analysis

For this objectives, the goal is to perform a regression analysis to identify the factors associated with access to water supply and sanitation facilities. The sample size calculation should be based on the desired statistical power and the number of independent variables to be included in the analysis. Here's the step-by-step approach:

- ✓ To Determine the number of independent variables: Let's assume we plan to include around 8-10 independent variables in the regression model, such as household size, income, education level, distance to water source, etc.
- ✓ To Decide on the desired statistical power: A common choice is 80% power, which means we want to be able to detect the associations with a probability of 80%.

- ✓ To Estimate the expected effect size: This can be based on previous studies or our best judgment. For this example, let's assume a medium effect size (Cohen's f^2 = 0.15).
- ✓ To Choose the significance level (α): Typically, a 5% significance level (α = 0.05) is used.

Using the G*Power software or the following formula, the sample size can be calculated:

n = 8 + (Zα/2 + Zβ) ^2 / f^2 Where: n is the required sample size

α is the significance level (0.05)

β is the desired power (0.20 for 80% power)

f^2 is the expected effect size (0.15 for medium effect size)

Inserting in the values: n = 8 + (1.96 + 0.84) ^2 / 0.15 n = 8 + 7.84 / 0.15 n = 8 + 52.27

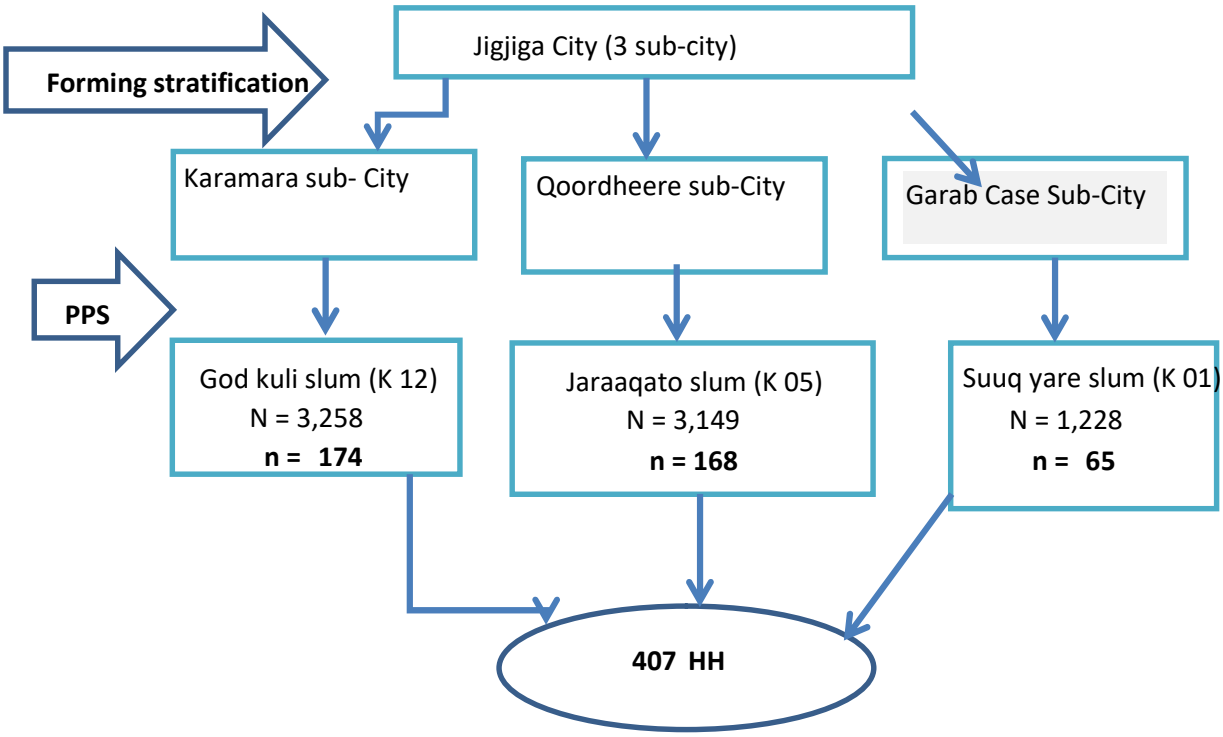
n = 60.27 The recommended sample size for this objectives are 60 households (Birhanu, 2018).

3.6. Sampling Procedure and technique

Stratified sampling technique was used to select the study population. First, four sub-cities of Jigjiga city were identified and further were stratified into three strata based on the identified slum areas of Jigjiga city. From each stratum, three sub-cities (Karamar Sub-city, Qoordheere Sub-city, and Garabcase Sub-city) were selected, and then three kebeles (Kebele 01 Suuq Yare slum, Kebele 05 Jaraaqato slum, and Kebele 12 Godkuuli slum) were randomly chosen for the study. Secondly, 407 households were randomly selected from the study slum area kebeles based on the population proportion of each kebele. Thirdly, the study unit was randomly chosen from the household list of each kebele's administration office, with the first study unit selected randomly from the first 19 listed households.

Systematic random sampling techniques were then employed for the subsequent study units, using the kebele population proportion for the assigned sample size. This method determined that every 19th household was selected, calculated as Kth = n/N (7635/407 = 19).

Figure 3. Sampling frame



3.7. Data Collection Methods

3.7.1. Data collection tools

In this study, different data collection methods were employed. These are questionnaires, interviews, and observation, the questionnaires were first prepared in English and it was translated into Somali and Amharic to make it easily understandable for the selected interviewees. Apart from these, the researcher had used field observation to assess water supply and sanitation facilities in the sampled slum areas. Five health Extension workers were collected the data using an interview and observation checklist. Two supervisors were involved to oversee the data collectors during data collection. To gain exact information, the head of the household, either the father, the mother, or a representative of the household was interviewed. In this study, both the primary and secondary data sources were used. Primary data was gathered from sample respondents of the selected slum households and Jigjiga City service office staffs. Secondary data were obtained from published and unpublished documents, including reports from the Central Statistical Agency, Jigjiga City Administration reports, the Jigjiga Water and Sanitation Service Office, and relevant academic literature such as journal articles, books, and previous research studies related to water, sanitation, and hygiene (WASH).

3.7.2. Data collectors/supervisors

Data collectors who were proficient in Somali and Amharic and were not employed at the study sites were recruited for the study. A two-day training was conducted by the principal investigator at Jigjiga City prior to the commencement of data collection. The training focused on the objectives of the study, the contents of the data collection instruments, procedures for collecting accurate data, and ethical approaches to interacting with participants, including explaining the purpose of the research and obtaining informed consent. During the training, each question in the questionnaire was discussed in detail to ensure that data collectors clearly understood the instruments and were able to approach participants with courtesy and respect during the data collection process.

3.7.3. Procedure for data collection

A structured questionnaire prepared in Somali and Amharic was pretested on 5% of the sample households in kebeles outside the study area one month before the actual data collection. The pretest was conducted to assess the clarity and relevance of the questions. Based on the results, necessary revisions were made, including rephrasing unclear questions and improving the translation of the questionnaire before the final data collection. The interviews were conducted utilizing a structured interviewer-administered technique. Therefore, the interview helped to understand the current status of water supply and sanitation facility conditions in Jigjiga city specifically in the three kebeles of slum areas. In addition, this was helped to found information about the water and sanitation policy and strategy that applied in the community. The interviews were conducted with the Jigjiga Water Supply and Sewerage Authority (JWSSA) experts, and Jigjiga city service administration experts. These methods were helpful to elaborate important information to the participants and to receive required enough information. Therefore, those who match the inclusion criteria were selected to participate and also, were interviewed in a private setting for an average of 35 minutes. The main investigator was providing daily on-site monitoring throughout the duration of data collection. A pre-test with 5% of the respondents was conducted in Jigjiga City outside the study kebeles to assess the questionnaire's clarity, content, and format. Jigjiga was selected because it has similar socio-demographic characteristics to the study area while avoiding inclusion of the actual study participants.

3.8. Study variables

3.8.1. Dependent variables

- Access to improved water supply facilities
- Access to improved sanitation facilities

The dependent or outcome variables of this study were access to improved water supply facilities and access to improved sanitation facilities among slum households in Jigjiga City.

Access to improved water supply facilities was defined according to the standards of the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP, 2017). Households whose main source of drinking water was from improved sources, including piped water into the dwelling, yard, or plot; public taps or standpipes; boreholes or tube wells; protected dug wells; protected springs; or bottled water, were categorized as having access to improved water supply. Households relying on unimproved sources such as unprotected wells, unprotected springs, surface water, or tanker/vendor-supplied water were categorized as not having access to improved water supply.

Access to improved sanitation facilities was also classified based on WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene standards (JMP, 2017). Improved sanitation included flush or pour-flush toilets connected to a sewer, septic tank, or pit latrine, and pit latrines with slabs or twin pits with slabs. Households using pit latrines without slabs, open pits, bucket toilets, or practicing open defecation were categorized as not having access to improved sanitation facilities.

Both dependent variables were coded as binary outcomes for analysis:

- Yes (1): Household has access to improved water or sanitation facilities.
- No (0): Household lacks access to improved water or sanitation facilities (unimproved).

3.8.2. Independent variables

The independent or explanatory variables of this study comprised a set of socio-demographic, economic, infrastructural, environmental, governance, and social-behavioral factors that are hypothesized to influence household access to improved water supply and sanitation facilities in slum areas.

1. Socio-demographic and economic variables

These variables describe the demographic and economic characteristics of households that may affect their ability to access improved water and sanitation services.

- Sex of household head (Male, Female)
- Age of household head (in years)
- Educational status of household head (Illiterate, Primary [1–8], Secondary [9–12], Higher [Diploma and above])
- Marital status of household head (Married, Single, Divorced, Widowed)
- Occupation of household head (Government employee, Merchant, Daily laborer, Self-employed, Unemployed)
- Monthly household income (<2500 ETB, 2500–5000 ETB, >5000 ETB)
- Housing tenure status (Owner-occupied, Rented, Informal/Shared)

2. Infrastructural and environmental variables

These variables relate to the physical availability, quality, and environmental context of water and sanitation services within slum settlements.

- Type of main drinking water source (Improved, Unimproved)
- Location of water source (Piped water on premises, piped water off premises) was identified as an important explanatory variable for predicting access to improved sanitation and handwashing facilities.
- Distance to the nearest water source (≤30 minutes, >30 minutes)
- Reliability of water supply (Continuous, Intermittent)
- Type of sanitation facility (Improved, Unimproved, Shared)
- Availability of handwashing facility near the toilet (Yes, No)
- Availability of soap or detergent at handwashing point (Yes, No)
- Household population density (Number of persons per room)

- Exposure to environmental risks (Flood-prone area, Poor drainage, Solid waste accumulation)

3. Governance and institutional variables

These variables capture the role of governance structures, service management, and institutional support in shaping access to water and sanitation services.

- Access to municipal water supply services (Yes, No)
- Participation in community-based WASH or sanitation programs (Yes, No)
- Presence of local water or sanitation management committees (Yes, No)
- Land tenure security (Secure, Insecure)
- Perceived political representation in local decision-making related to WASH services (Yes, No)

4. Social and behavioral variables

These variables reflect household practices, social norms, and behavioral factors that influence water use, sanitation, and hygiene behaviors.

- Handwashing practice at critical times (Adequate, Inadequate)
- Household hygiene practices (Good, Poor)
- Gender roles in water collection and sanitation management (Male-dominated, Female-dominated, Shared)
- Cultural beliefs influencing sanitation and hygiene practices (Yes, No)

5. Barriers and access-related challenges

These variables represent structural and economic constraints that may limit effective access to water and sanitation facilities.

- Affordability of water and sanitation services (Affordable, Not affordable)
- Time spent fetching water per trip (≤30 minutes, >30 minutes)
- Frequency of water supply interruption (Rare, Frequent)

3.9. Operational definition

Slum household: 'Any specific place, whether a whole city, or a neighborhood, is a slum area if half or more of all households lack improved water, improved sanitation, sufficient living area, durable housing, secure tenure, or combinations therefore The criteria (improved water, etc.) are defined in more detail (UN-Habitat, 2016)

Slum area: - Household or group of individuals in a slum area that lacks the following: durable housing of a permanent nature that protects against extreme climate conditions, sufficient living space, which means not more than 3 people sharing the same room, easy access to safe water in sufficient amounts at an affordable price, access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people. and security of tenure that prevents forced evictions (Corburn J, 2015).

Access to basic water supply: - Is the proportion of households getting drinking water from improved sources (piped water into dwelling, piped water to yard/plot, Tube well or borehole, Public standpipes, protected dug wells, protected springs, and Rainwater) and provided collection time is within 30 minutes or less minutes for a round trip, including queuing time (WHO/UNICEF, 2021).

Access to basic sanitation services: - Is the proportion of households using improved sanitation facilities, including flush/pour flush (to a piped sewer system, septic tank, and pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet, and does not share its facility with other households ((WHO & UNICEF, 2021).

Improved water source: One that is likely to provide safe water and it includes piped water into dwelling, plot or yard, public tap/standpipe, tube well/borehole, protected dug well, protected spring and rainwater collection (UNICEF, WHO, 2017).

Unimproved water source: Includes unprotected dug well, unprotected spring, cart with small tank/drum, bottled water, tanker-truck, Surface water (river, dam, lake, pond, stream, canal, irrigation channels (UNICEF, WHO, 2017).

Improved sanitation facility: It includes flush/pour flush to: (piped sewer system, septic tank, pit latrine), VIP latrine, pit latrine with slab and composting toilet (UNICEF, WHO, 2017).

Unimproved sanitation facility: It includes flush/pour flush to elsewhere, pit latrine without slab/open pit, bucket, hanging toilet/hanging latrine, and no facilities or bush or field (UNICEF, WHO, 2017).

Functional latrine: A latrine was considered as functional if it has a door, superstructure, slab cover, lid cover, and cleanable floor (UNICEF, WHO, 2017).

Proper latrine utilization: A latrine was considered as properly utilized if it fulfills the following: (if there are no feces and urine around the latrine and the house compound, if there is an observable fresh feces through the squat hole of the latrine, and if the footpath to the latrine is free from any barrier (UNICEF, WHO, 2017).

Hand washing at critical times: If the five critical moments of hand washing (after using a toilet, before eating, before food preparation, after cleaning children's bottom, and after environmental cleaning) were practiced (UNICEF, WHO, 2017).

Unsafe disposal of child faeces: If the faeces of the child were put or rinsed in to drain/ditch, thrown in to garbage, and left or buried in the open (UNICEF, WHO, 2017).

Time to collect water refers to the amount of time needed to get to the water source, obtain water, and return to the household. Socializing time was not included in the minute value given, unless it is done while queuing for water. The minute value is the time for one round trip, not the total time spent per day hauling water (Amare, 2020).

The Per capita water consumption rate is calculated by considering average daily household water consumption and family size.

Per capita water consumption = Average daily household water consumption

Family size

This formula is commonly used in water supply and sanitation studies (UNICEF, WHO, 2017)

Domestic water consumption rate: refers to drinking, cooking, personal hygiene and laundry. Various international standards exist for minimum volumes of domestic water required sustaining life and health, and are expressed in liters per capita per day (lpcd) (WHO and UNICEF, 2014).

3.10. Data quality assurance

Daily, the collected questionnaires were checked for consistency and completeness and cleaned to correct any errors. Data were encoded strictly based on the survey questionnaire. Double data entry, a quality control procedure in which two independent data clerks enter the same dataset separately, was carried out to detect and correct any discrepancies and ensure accuracy.

3.11. Method of data analysis

Data Entry and Cleaning: The collected data were visually checked for completeness, coded, and entered into Epi Data version 3.1. A random selection of responses was cross-checked for consistency, and cleaned data were transferred to STATA version 13 for analysis.

Descriptive Analysis: Descriptive statistics, including frequencies, percentages, and means, were used to summarize household characteristics and WASH-related variables. This provided an overall understanding of the study population and key outcomes.

Regression Analysis: Binary logistic regression was applied to assess associations between independent variables and the dependent variables: access to improved water supply, improved sanitation, and improved hygiene facilities. Bi-variable logistic regression identified candidate variables with $p < 0.20$, which were then included in the multivariable logistic regression to control for potential confounding.

Model Diagnostics: Model fitness was evaluated using the log-likelihood ratio (LLR) test, with $p > 0.05$ indicating good fit. Multi-collinearity was assessed using the variance inflation factor (VIF); variables with VIF > 10 were considered highly collinear.

Statistical Significance: Associations were considered statistically significant at $p < 0.05$, and findings were presented as odds ratios (ORs) with 95% confidence intervals (CIs).

3.12. Ethical considerations

Ethical clearance approval was obtained from the Institutional Health Research Ethics Review Committee (IHRERC) of the College of Health and Medical Sciences (CHMS), Haramaya University. Moreover, informed, voluntary, written and signed consent was obtained from each study participant. A supportive letter from the CHMS was written to Jigjiga city Administration Office. To ensure confidentially of respondents, the names and ID was not indicated on the questionnaire. All interviews were made individually to keep privacy.

3.12.1. Information dissemination

The finding of the research was submitted to school of graduate studies, and was distributed to different organizations. The main findings of the study were presented in an open defense at the School of Public Health Science of Haramaya University.

4. Results

4.1 Socio-demographic Factors

Out of the 407 households targeted for the study, 404 participants were included in the analysis, resulting in a response rate of 99.3%. The three households not included were either unavailable at the time of the survey or provided incomplete information, which made it impossible to use their data in the analysis. The vast majority of study participants, (89.11%), were of Somali ethnicity. The majority of participants, (93.81%), were married. Only a small 25 participants (6.1%), were single, divorced, separated, or widowed respectively.

In the study population, 272 households (67.3%) were female-headed, while 132 households (32.7%) were male-headed. This disproportion is not intentional; it reflects the actual distribution of household heads in the selected slum areas, where female-headed households are more common due to social and demographic factors such as widowhood, divorce, or male migration for work. In terms of occupation, the majority of study participants, (91.83%), were employed in the non-government sector.

A much smaller proportion, (8.17%), were government employees. The educational background of the participants showed a stark contrast - over half, (57.67%), were illiterate, while only a small fraction, (7.92%), had attained an education level of higher diploma or above. The mean monthly household income was 11,475.53 Ethiopian Birr (ETB), with a standard deviation of ±6,013.65 ETB (Table 2).

Table 2: Weighted descriptive statistics of socio-demographic characteristics in slum area of Jigjiga city, July 15 to August 31, 2023 [N=404]

Variables		Frequency	Percentage %
Sex of the Head of household	Male	132	32.67
	Female	272	67.33
Respondent	Household Head	376	93.07
	Spouse of Household Head	27	6.93
Age of Respondent	20-35	205	50.74
	>36-55	199	49.26
Ethnicity	Somali	360	89.11
	Non-Somali	44	10.89
Educational status of the head of household	Illiterate	233	57.67
	Primary (Grades 1-8)	111	27.47
	Secondary (Grades 9-12)	28	6.93
	Higher (Diploma and above)	32	7.92
Marital status of the household head	Married	379	93.81
	Widow	10	2.48
	Divorced	9	2.23
	Single	6	1.49
	House wife	3	0.74
Occupation of the household head	Self-employed/Merchant	59	14.60
	Government Employee	33	8.17
	Daily Labor	64	15.84
	Private employee /Non-government Employee	241	59.65
	Others(unemployed, retired, etc.)	4	0.99
Monthly income	500-5000	41	10.15
	5,500-10,000	204	50.5
	10,500-15,000	100	24.75
	15, 500-20,000	59	14.6
House ownership condition	Owner occupied	371	91.83
	Rented from individual	32	7.92
	Rented from kebele	1	0.25

4.2. Characteristics of Primary Water Supply Sources in Slum Areas of Jigjiga city

The analysis of primary water supply sources in the slum areas of Jigjiga city reveals significant insights into household access to water. As shown in Table 3, 65.35% of households relied on water vendors as their primary water source, while 19.31% used public stand taps. Only 10.15% of households had piped water in their dwelling, yard, or plot, and just 1.24% reported a private piped connection within their compound.

Overall, only 10.64% of households had a private piped water connection, whereas 89.36% lacked such access. Among those without connections, 90.86% cited service unavailability as the main reason. Water vendors were also the dominant secondary source, used by 94.31% of households.

Water supply reliability was poor: only 4.70% of households had continuous piped water, and 12.62% had intermittent supply, while 82.67% depended entirely on vendors. Spatial access was also constrained, with 88.62% of households relying on off-premises water sources.

In this study, 48.5% of households spent 15–30 minutes collecting water, 14.4% spent more than 30 minutes, and only 11.6% had water on premises. According to WHO/UNICEF guidelines (JMP, 2021), collection time ≤30 minutes is acceptable for basic water access, but on-premises availability represents the highest standard. Thus, while nearly half of households met the collection-time guideline, most did not have water on premises. Overall, these findings indicate substantial inequities in access to safe, reliable, and continuous water supply in the slum areas of Jigjiga City (Table 3).

Table 3: Weighted descriptive statistics of characteristics of primary water supply sources in slum area of Jigjiga city, July 15 to August 31, 2023 [N=404]

Variable	Category	Frequency (n)	Percentage (%)
Primary source of water supply	Water vendors	264	65.35
	Public stand taps	78	19.31
	Piped water in dwelling/yard/plot	41	10.15
	Hand-dug wells	16	3.96
	Private piped connection within compound	5	1.24
	Total	**404**	**100.00**
Availability of private piped water connection	Yes	43	10.64
	No	361	89.36
	Total	**404**	**100.00**
Reason for not having private piped water connection*)*	Service not available	328	90.86
	Service is expensive	70	17.33
	Unable to pay connection fee	3	0.74
	Not interested in the service	3	0.74
	Total	**404**	**100.00**
Secondary source of water supply	Water vendors	381	94.31
	Hand-dug wells	11	2.72
	Public stand taps	8	1.98
	Private piped connection	4	0.99
	Total	**404**	**100.00**

Access to drinking water	Yes	333	82.43
	No	71	17.57
	Total	**404**	**100.00**
Type of water supply	Continuous piped supply	19	4.70
	Intermittent piped supply	51	12.62
	Water vendors	334	82.67
	Total	**404**	**100.00**
Time when water is available	Morning	386	95.54
	Afternoon	15	3.71
	Evening	3	0.74
	Total	**404**	**100.00**
Availability of piped water in the last one week (Note: A one-week recall period was used to reduce recall bias while capturing typical patterns of piped water availability)	Never	320	79.21
	Once	10	2.48
	Twice	29	7.18
	Three or more times	45	11.14
	Total	**404**	**100.00**
Time taken to fetch water (round trip) ≤30 minutes collection time who standard	Water on premises	47	11.60
	< 15 minutes	103	25.49
	15–30 minutes	196	48.51
	30–60 minutes	52	12.87
	> 60 minutes	6	1.48
	Total	**404**	**100.00**
Location of water source	On premises	46	11.38
	Off premises	358	88.62
	Total	404	100.00

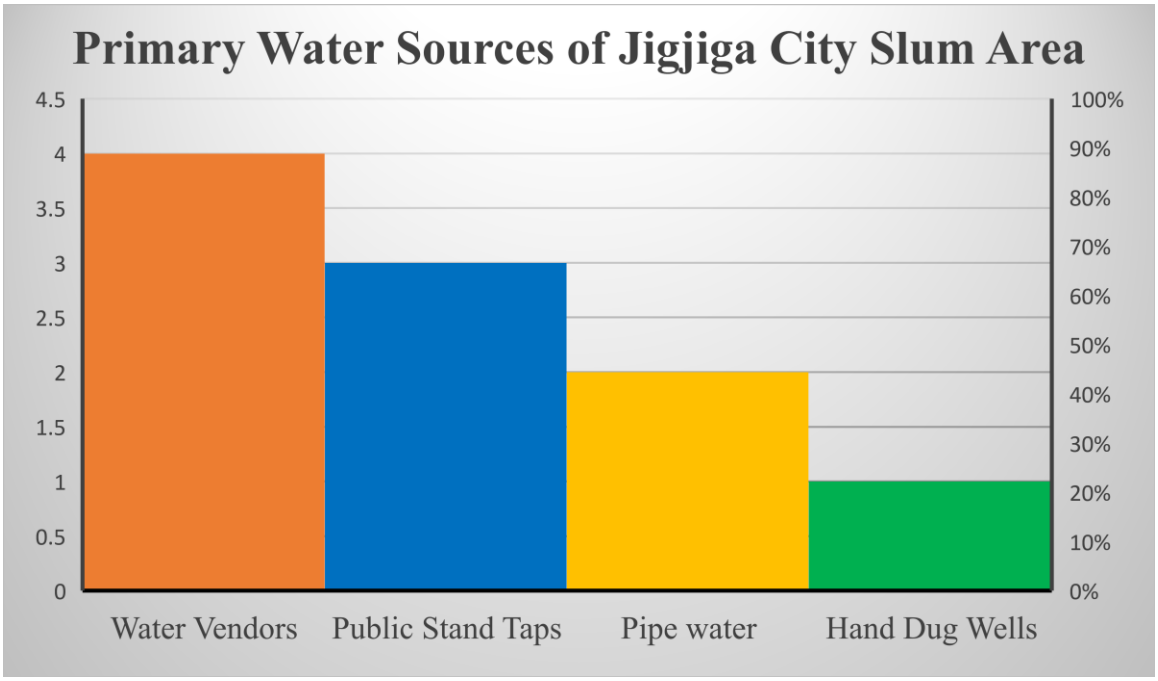


Figure 4: shows the primary source of water supply among slum households of Jigjiga City, 2023

4.3. Materials for Collecting Water supply

In most households, females were primarily responsible for fetching water (92%), while males and children were responsible in only a small minority of households (6% and 2%, respectively). Average household water consumption per day was approximately 162 liters, ranging from 0 to 400 liters. The average per capita water consumption was approximately 27.0 ± 9.7 L/person/day, ranging from 0 to 66.7 L/person/day. This reflects individual-level water availability within the households, which is below the WHO recommended minimum of 50 L/person/day for basic water needs.

The majority of households stored water in barrels (67.1%), followed by jerry cans (26.5%), tankers up to 5 m^3 (4.2%), and birkas (2.2%). This indicates that barrels are the dominant water storage container among the households surveyed.

These findings indicate that water collection is predominantly a female responsibility and that most households rely on simple, small-capacity containers for storing water, which may limit household water security and accessibility (Table 4).

Table 4: Weighted descriptive statistics of water storage characteristics of study participants in slum area of Jigjiga city, July 15 to August 31, 2023 [N=404]

Variable	Category	Frequency (n)	Percentage (%)
Person responsible for fetching water	Female	373	92.33
	Male	23	5.69
	Children	8	1.98
	Total	**404**	**100.00**
Average household water consumption (liters/day)	Mean ± SD	162.04 ± 58.33	-
	Minimum–Maximum	0–400	-
Water storage container used	Barrel	271	67.08
	Jerry can	107	26.49
	Tanker (up to 5 m^3)	17	4.21
	Birka	9	2.23
	Total	**404**	**100.00**

Households reported noticeable seasonal variation in water availability. The majority (83%) indicated that water availability increased during the rainy months (Hamlie/Nehase), while a smaller proportion reported decreased availability (13%) or no change (4%) compared to the dry season (Table 5).

Table 5: At home compare your current collecting practices on availability of water supply to your rainy season (Hamlie/Nehase) [N=404].

Variables	Frequency	Percentage %
Increased	335	82.92
Decreased	52	12.87
Stay the same	17	4.21
	404	100

4.5. Basic sanitation and hygiene facilities in the slum area of Jigjiga city

4.5.1 Toilet facilities for members of slum households in Jigjiga city

Most households in the study (72.77%) relied on unimproved sanitation facilities, while only 27.3% had access to improved sanitation facilities. Improved sanitation facilities include flush or pour-flush toilets connected to a sewer system, septic tank, or pit latrine; ventilated improved pit (VIP) latrines; pit latrines with slabs; and composting toilets. In contrast, unimproved sanitation facilities include pit latrines without slabs or platforms, open pits, bucket toilets, and the practice of open defecation (WHO/UNICEF JMP, 2021).

Pit latrines with slabs were the most common type of toilet (78%), followed by pit latrines without slabs (15%). Other facilities, including pour flush toilets, VIP latrines, and public latrines, were used by a small minority of households.

Regarding toilet location, the majority of households had toilets within their yard (88%), while only a few had them inside the dwelling (9%) or elsewhere (3%).

Nearly all households (93%) used private toilets, with only a small proportion sharing with other households or relying on public facilities

Overall, while improved sanitation coverage is relatively high, most households rely on basic pit latrines, which are simple pit latrines with a slab and sometimes shared. Although classified as improved sanitation by WHO/UNICEF JMP (2020), these facilities remain inadequate in terms of hygiene and privacy in the slum areas of Jigjiga City (Table 6).

Table 6: Weighted descriptive statistics of sanitation and hygiene facilities among slum households of Jigjiga City N=404].

Variable	Category	Frequency (n)	Percentage (%)
Access to latrine facility	Yes	397	98.27
	No	7	1.73
	Total	**404**	**100.00**
Sanitation status	Improved sanitation facility	110	27.3
	Unimproved sanitation facility	294	72.77
	Total	**404**	**100.00**
Type of toilet facility	Pit latrine with slab	315	77.97
	Pit latrine without slab	62	15.35
	Pour flush toilet	17	4.21
	VIP toilet	8	1.98
	Public latrine	2	0.50
	Total	**404**	**100.00**
Household toilet location	In yard	355	87.87
	Inside dwelling	37	9.16
	Elsewhere	12	2.97
	Total	**404**	**100.00**
Sharing status of toilet facility	Private (one household)	375	92.82
	Shared (>1 household)	24	5.94
	Public or communal	5	1.24
	Total	**404**	**100.00**
Shower room on premises	Have shower room	29	7.18
	No shower room	375	92.82
	Total	**404**	**100.00**
Handwashing facility (HWF) presence	Fixed or mobile place for HWF	63	15.59
	No HWF	341	84.41
	Total	**404**	**100.00**
Availability of water and soap at HWF	Yes	59	14.60
	No	345	85.39
	Total	**404**	**100.00**
HWF located near toilet	Yes	75	18.56
	No	329	81.44
	Total	**404**	**100.00**

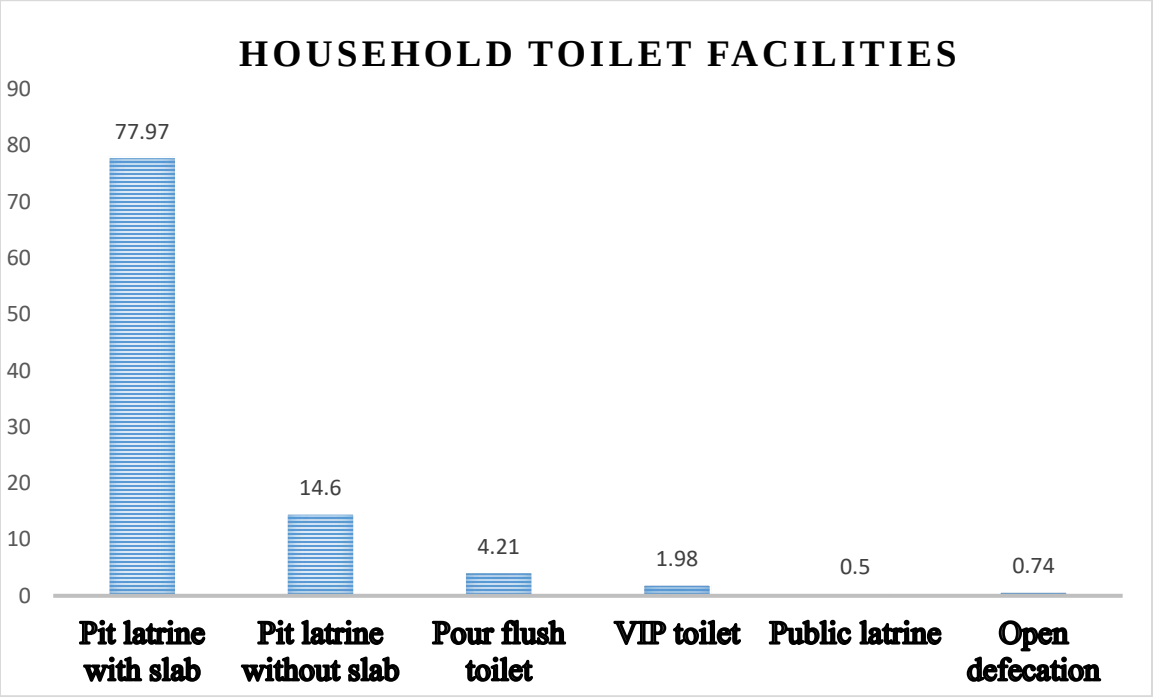


Figure 5. Shows Household Toilet facilities in the slum area of Jigjiga City 2023.

4.5.2. Hygiene facilities for members of slum households in Jigjiga city

Access to handwashing facilities was generally poor. Only 6.19% of households had a handwashing station, fewer than 15% had both water and soap, and less than 19% had facilities near the toilet. Overall, hygiene infrastructure in the slum areas of Jigjiga City remains inadequate (Table 6).

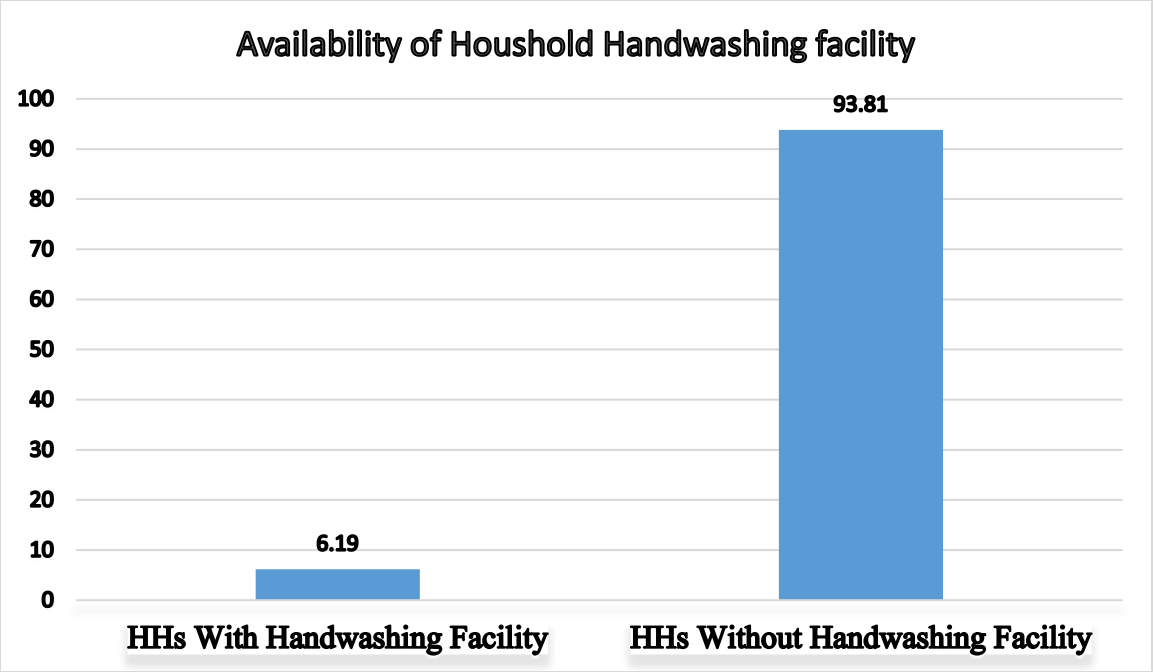


Figure 6. Shows households Handwashing Facilities in the slum area of Jigjiga City 2023.

4.6. Factors associated with Access to Improved Water Supply facilities on Slum households in the binary and multivariable logistic regression analysis

4.6.1. Bivariate logistic regression Analysis

In bivariate logistic regression, access to improved water supply was significantly associated with socio-demographic and economic factors, including sex of household head, educational level, occupation, monthly income, and type of dwelling. Female-headed households, those with lower educational status, unemployed individuals, and low-income households were less likely to have access to water supply.

However, variables such as marital status and house ownership were not significantly associated with access to water supply. Based on the bivariate analysis, variables with a *p*-value less than 0.25 which includes sex of the household head, educational level, occupation, house ownership, monthly income, and type of dwelling were selected for inclusion in the multivariable logistic regression model to control for potential confounding effects.

Before conducting the multivariable logistic regression analysis, the model's goodness of fit was tested using the log-likelihood ratio (LLR), which indicated that the model was a good fit for the data. The calculated P-value associated with the log-likelihood ratio was very small, which was .0044 (less than .05), indicating that the model was a good fit for the data (Table 7).

Table 7: Bivariate analysis of factors associated with Access to Improved Water Supply facilities on Slum households, July 15 to August 31, 2023 (N = 404)

Predictor variables	Category	Frequency (%)	Access to water supply		COR (95% CI)	P-value
			Yes (%)	No (%)		
Head of Household (Sex)	Male	272 (67.3)	224 (82.4)	48 (17.6)	RC	–
	Female	132 (32.7)	77 (58.3)	55 (41.7)	0.43 (0.26–0.70)	0.001*
Educational Level	Illiterate	233 (57.7)	191 (82.0)	42 (18.0)	RC	–
	Primary (1–8)	111 (27.5)	82 (73.9)	29 (26.1)	1.61 (0.94–2.76)	0.083*
	Secondary (9–12)	28 (6.9)	16 (57.1)	12 (42.9)	3.39 (1.45–7.91)	0.005*
	Higher (Diploma+)	32 (7.9)	12 (37.5)	20 (62.5)	7.15 (3.04–16.82)	0.001*
Marital Status	Married	379 (93.8)	288 (76.0)	91 (24.0)	RC	–
	Widow	10 (2.5)	6 (60.0)	4 (40.0)	2.07 (0.53–8.07)	0.298
	Divorced	9 (2.2)	7 (77.8)	2 (22.2)	0.89 (0.18–4.34)	0.883
	Single	6 (1.5)	5 (83.3)	1 (16.7)	0.64 (0.07–5.38)	0.678
Occupation	Farmer	3 (0.7)	3 (100.0)	0 (0.0)	0.00 (0.00–.)	0.998
	Merchant	59 (14.6)	34 (57.6)	25 (42.4)	2.42 (1.34–4.37)	0.004*
	Gov't Employee	33 (8.2)	15 (45.5)	18 (54.5)	3.94 (1.89–8.19)	0.001*
	Daily Labor	64 (15.8)	51 (79.7)	13 (20.3)	0.84 (0.43–1.65)	0.611
	Unemployed	241 (59.7)	194 (80.5)	47 (19.5)	RC	–

House Ownership	Owner	371 (91.8)	278 (74.9)	93 (25.1)	RC	–
	Rented	33 (8.2)	23 (69.7)	10 (30.3)	1.29 (0.59–2.81)	0.525
Monthly Income	Low income <2500 ETB	245 (60.6)	213 (86.9)	32 (13.1)	RC	–
	Middle income 2500–5000 ETB	100 (24.8)	61 (61.0)	39 (39.0)	4.30 (2.48–7.45)	0.001*
	High income >5000 ETB	59 (14.6)	27 (45.8)	32 (54.2)	7.60 (4.04–14.30)	0.001*
Type of dwelling	Permanent	46 (11.4)	46 (100.0)	0 (0.0)	RC	–
	Semi-permanent	94 (23.3)	68 (72.3)	26 (27.7)	0.15 (0.08–0.29)	0.001*
	Temporary	264 (65.3)	187 (70.8)	77 (29.2)	0.17 (0.09–0.30)	0.001*

Abbreviations: OR, crude odds ratio; RC, reference category. All variables with a P-value<.25 in the bivariate logistic regression analysis are presented in this regression table and included in the multivariable logistic regression analysis. *Variables significant at P-value<.05

4.6.2. Multivariable logistic regression Analysis

In the multivariable logistic regression analysis, after adjusting for confounders, access to water supply was significantly influenced by socio-demographic, economic and environmental factors: the sex of the household head, educational level, occupation, monthly income, and type of dwelling were significantly associated with access to water supply among slum households in Jigjiga City.

Female-headed households were 49% less likely to have access to water supply compared to male-headed households [AOR = 0.51; 95% CI: (0.29–0.91)].

Households whose heads attained secondary education were 2.48 times more likely [AOR = 2.48; 95% CI: (1.01–6.08)] and those with higher education (diploma and above) were 4.62 times more likely [AOR = 4.62; 95% CI: (1.78–11.96)] to have access to water supply compared with those headed by illiterate individuals.

Regarding occupation, merchants were 2.11 times more likely [AOR = 2.11; 95% CI: (1.02–4.36)] and government employees were 3.02 times more likely [AOR = 3.02; 95% CI: (1.29–7.09)] to have access to water supply compared with unemployed households.

Household income showed a strong positive association with access to water supply. Middle-income households (2,500–5,000 ETB) were 3.42 times more likely [AOR = 3.42; 95% CI: (1.74–6.71)], while high-income households (>5,000 ETB) were 5.89 times more likely [AOR = 5.89; 95% CI: (2.64–13.13)] to have access compared to low-income households (<2,500 ETB).

The type of dwelling was also found to be a significant determinant of access to water supply. Households living in semi-permanent dwellings [AOR = 0.29; 95% CI: (0.13–0.63)] and temporary dwellings [AOR = 0.33; 95% CI: (0.15–0.70)] were significantly less likely to have access to water supply compared to those residing in permanent dwellings (Table 8).

Table 8: Multivariable logistic regression analysis of factors associated with Access to Improved Water Supply facilities on Slum households, July 15 – August 31, 2023 (N = 404)

Predictor variables	Access to water supply		COR (95% CI)	AOR (95% CI)	P-value**
	Yes	No			
Head of Household (Sex)					
Male	224	48	RC	RC	–
Female	**77**	**55**	**0.43 (0.26–0.70)***	**0.51 (0.29–0.91)**	**0.021****
Educational Level					
Illiterate	191	42	RC	RC	–
Primary (1–8)	82	29	1.61 (0.94–2.76)*	1.34 (0.71–2.54)	0.364
Secondary (9–12)	**16**	**12**	**3.39 (1.45–7.91)***	**2.48 (1.01–6.08)**	**0.048****
Higher (Diploma & above)	**12**	**20**	**7.15 (3.04–16.82)***	**4.62 (1.78–11.96)**	**0.002****
Occupation					
Unemployed			RC	RC	–
Merchant	**34**	**25**	**2.42 (1.34–4.37)***	**2.11 (1.02–4.36)**	**0.043****
Government Employee	**15**	**18**	**3.94 (1.89–8.19)***	**3.02 (1.29–7.09)**	**0.011****
Daily Labor	51	13	0.84 (0.43–1.65)	0.91 (0.44–1.91)	0.810
Monthly Income					
Low income <2500 ETB	213	32	RC	RC	–
Middle income 2500–5000 ETB	**61**	**39**	**4.30 (2.48–7.45)***	**3.42 (1.74–6.71)**	**0.001****
High income >5000 ETB	**27**	**32**	**7.60 (4.04–14.30)***	**5.89 (2.64–13.13)**	**0.001****
Type of dwelling					
Permanent	46	0	RC	–	RC
Semi-permanent	**68**	**26**	**0.15 (0.08–0.29)***	**0.21 (0.10–0.45)**	**0.001****
Temporary	**187**	**77**	**0.17 (0.09–0.30)***	**0.26 (0.13–0.50)**	**0.001****

4.7. Factors associated with Access to improved sanitation Facilities in the binary and multivariable logistic regression analysis

4.7.1. Bivariate logistic regression Analysis

In the bivariate logistic regression model, access to improved sanitation facilities was significantly associated with socio-demographic, economic, and infrastructural/hygiene factors, including household head's educational level, monthly income, location of water sources, availability of handwashing facilities, and presence of soap or detergent.

However, variables such as sex of the household head, marital status, occupation, and house ownership were not significantly associated with access to improved sanitation facilities.

Based on the bivariate analysis, seven variables with a p-value less than 0.25 which includes sex of the household head, educational level, occupation, house ownership, monthly income, location of water sources, and availability of handwashing facilities were selected for inclusion in the multivariable logistic regression model to control for potential confounding effects.

Before conducting the multivariable logistic regression analysis, the model's goodness of fit was tested using the log-likelihood ratio (LLR), which indicated that the model was a good fit for the data ($P = 0.0035 < 0.05$) (Table 9).

Table 9. Bivariate analysis of Factors associated with Access to improved sanitation Facilities and location of water sources among slum households of Jigjiga City, July 15 – August 31, 2023 (N = 404).

Predictor Variables	Category	Frequency (%)	Access to Improved Sanitation		COR (95% CI)	P-value
			Yes (%)	No (%)		
Head of Household (Sex)	Male	132 (32.67)	84 (63.6)	48 (36.4)	RC	–
	Female	272 (67.33)	192 (70.6)	80 (29.4)	1.42 (0.89–2.27)	0.135*
Educational Level	Illiterate	233 (57.67)	138 (59.2)	95 (40.8)	RC	–
	Primary (1–8)	111 (27.47)	75 (67.6)	36 (32.4)	1.38 (0.81–2.34)	0.220*
	Secondary (9–12)	28 (6.93)	22 (78.6)	6 (21.4)	2.15 (0.92–5.02)	0.078*
	Higher (Diploma & above)	32 (7.92)	28 (87.5)	4 (12.5)	3.64 (1.52–8.70)	**0.004***
Marital Status	Married	379 (93.81)	262 (69.1)	117 (30.9)	RC	–
	Widow	10 (2.48)	6 (60.0)	4 (40.0)	0.72 (0.15–3.35)	0.671
	Divorced	9 (2.23)	5 (55.6)	4 (44.4)	0.65 (0.14–2.98)	0.577
	Single	6 (1.49)	5 (83.3)	1 (16.7)	1.25 (0.27–5.74)	0.779
Occupation	Farmer	3 (0.74)	1 (33.3)	2 (66.7)	RC	–
	Merchant	59 (14.60)	43 (72.9)	16 (27.1)	2.28 (0.41–12.64)	0.340
	Government Employee	33 (8.17)	28 (84.8)	5 (15.2)	3.94 (0.68–22.85)	0.124*
	Daily Labor	64 (15.84)	44 (68.8)	20 (31.2)	1.78 (0.33–9.43)	0.502
	Unemployed	241 (59.65)	160 (66.4)	81 (33.6)	0.95 (0.18–4.94)	0.953
House Ownership	Owner Occupied	371 (91.83)	261 (70.4)	110 (29.6)	RC	–
	Rented	33 (7.93)	15 (45.5)	18 (54.5)	0.52 (0.21–1.27)	0.152*

Monthly Income	Low income	245 (60.64)	147 (60.0)	98 (40.0)	RC	–
	Middle income	100 (24.75)	76 (76.0)	24 (24.0)	1.96 (1.12–3.45)	**0.018***
	High income	59 (14.60)	53 (89.8)	6 (10.2)	2.83 (1.37–5.86)	**0.005***
Location of Water Sources	Piped water on premises	46 (11.38)	40 (87.0)	6 (13.0)	RC	–
	Piped water off-premises	358 (88.61)	236 (65.9)	122 (34.1)	0.44 (0.21–0.91)	**0.027***
Availability of Hand Washing Facility	Yes	341 (84.41)	222 (65.1)	119 (34.9)	RC	–
	No	63 (15.59)	54 (85.7)	9 (14.3)	2.85 (1.34–6.07)	**0.006***
Availability of Soap or detergent	Yes	345 (85.39)	225 (65.2)	120 (34.8)	RC	–
	No	59 (14.60)	51 (86.4)	8 (13.6)	3.15 (1.42–6.99)	**0.004***

Abbreviations: OR, crude odds ratio; RC, reference category. All variables with a P-value<.25 in the bivariate logistic regression analysis are presented in this regression table and included in the multivariable logistic regression analysis. *Variables significant at P-value<.05

4.7.2. Multivariable logistic regression Analysis

In the multivariable logistic regression analysis, access to improved sanitation facilities among slum households in Jigjiga City was significantly associated with socio-demographic and economic factors including the household head's educational level and monthly income, and infrastructural and social/behavioral factors, such as the location of the water source, availability of a handwashing facility, and presence of soap or detergent. The sex of the household head, occupation, and house ownership were not statistically associated with sanitation access after controlling for other variables ($p > 0.05$).

Households headed by individuals with a diploma or higher education were three times more likely to have access to improved sanitation facilities compared to those headed by illiterate individuals [AOR = 3.02; 95% CI: (1.20–7.62)].

Regarding income, middle-income households were 1.78 times more likely [AOR = 1.78; 95% CI: (1.01–3.16)], while high-income households were 2.41 times more likely [AOR = 2.41; 95% CI: (1.09–5.33)] to have access to improved sanitation compared with low-income households.

The location of the water source was also significantly associated with sanitation access. Households using piped water off-premises were 52% less likely to have access to improved sanitation compared to those with piped water on-premises [AOR = 0.48; 95% CI: (0.22–0.97)].

Moreover, households with an available handwashing facility were 2.41 times more likely to have access to improved sanitation than those without [AOR = 2.41; 95% CI: (1.08–5.37)]. Similarly, households that had soap or detergent were 2.76 times more likely to have access to improved sanitation compared to those without [AOR = 2.76; 95% CI: (1.20–6.36)] (Table10).

Table 10. Multivariable analysis of Factors associated with Access to improved sanitation Facilities and location of water sources among slum households of Jigjiga City, July 15 – August 31, 2023 (N = 404).

Predictor Variables	Access to improved sanitation		CORE (95% CI)	AOR (95% CI)	P-value
	Yes	No			
Sex of Household Head					
Male	84	48	RC	RC	–
Female	192	80	1.42 (0.89–2.27)	1.26 (0.74–2.14)	0.392
Educational Level					
Illiterate	138	95	RC	RC	–
Primary (1–8)	75	36	1.38 (0.81–2.34)	1.25 (0.70–2.23)	0.445
Secondary (9–12)	22	6	2.15 (0.92–5.02)	1.89 (0.78–4.59)	0.159
Diploma & above	28	4	3.64 (1.52–8.70)	**3.02 (1.20–7.62)**	**0.019***
Occupation					–
Farmer	1	2	RC	RC	
Government Employee	28	5	3.94 (0.68–22.85)	2.45 (0.39–15.41)	0.337
House Ownership					
Owner Occupied	261	110	RC	RC	–
Rented	15	18	0.52 (0.21–1.27)	0.68 (0.26–1.73)	0.415
Monthly Income					
Low income	245	147	RC	RC	–
Middle income	100	76	1.96 (1.12–3.45)	**1.78 (1.01–3.16)**	**0.046***
High income	59	53	2.83 (1.37–5.86)	**2.41 (1.09–5.33)**	**0.030***
Location of Water Source					
Piped water on-premises	46	40	RC	RC	–
Piped water off-premises	358	236	0.44 (0.21–0.91)	**0.48 (0.22–0.97)**	**0.041***
Availability of Handwashing Facility					

No	63	54	RC	RC	–
Yes	341	222	2.85 (1.34–6.07)	**2.41 (1.08–5.37)**	**0.032***
Availability of Soap/Detergent					
No	59	51	RC	RC	–
Yes	345	225	3.15 (1.42–6.99	**2.76 (1.20–6.36)**	**0.017***

Abbreviation: AOR, adjusted odds ratio. All variables with a P-value<.25 in the bivariate logistic regression analysis were included in the multivariable logistic regression analysis. Only those variables with a P-value<.01 and <.05 in the multivariable logistic regression analysis are included in this regression table. The variable marital status of mothers/caregivers was excluded from the multivariable logistic regression analysis due to a multicollinearity effect on the sex of the head of household. *Variables significant at P-value<.05. **Variables significant at P-value<.01.

5. DISCUSSIONS

This study examined household access to improved water and sanitation facilities in the slum areas of Jigjiga City, focusing on socio-demographic, economic, infrastructural, and behavioral determinants. The findings reveal that nearly all households (99.3%) reported access to some form of water source; however, only 30.7% of households had piped water on premises. The majority of households relied on water vendors, which are considered unimproved sources.

These results indicate persistent inequities in access to safely managed water services within slum areas, despite the presence of urban water infrastructure. Such reliance on informal water provision reflects the broader conditions characterizing slum settlements in Jigjiga City, characterized by rapid and unplanned urban expansion, insecure land tenure, limited municipal coverage, and insufficient investment in water supply networks in peripheral neighborhoods. These structural challenges amplify the financial and time burdens on households, particularly among low-income and female-headed households, who are disproportionately affected by both limited access and the high cost of purchasing water from vendors.

The multivariable logistic regression analysis revealed that several socio-demographic and economic factors were significantly associated with access to improved water supply. Female-headed households were 49% less likely to have access to piped water compared to male-headed households [AOR = 0.51]. This finding aligns with evidence from other East African slum contexts, where women often face economic and social constraints that limit their capacity to secure household-level water connections (Ekumah, 2018)

In the slums of Jigjiga, gendered social norms assign women the primary responsibility for water collection, exposing them to travel long distances, safety risks, and a greater labor burden. Female-headed households may have limited decision-making power and financial resources to invest in piped connections or storage infrastructure, which exacerbates disparities in water access. These results underscore the critical importance of integrating gender-sensitive approaches into urban water planning and service provision.

Household head educational attainment emerged as another key determinant of water access. Households led by individuals with secondary education were 2.48 times more likely, and those led by individuals with higher education (diploma or above) were 4.62 times more likely, to have access to piped water on premises compared to households headed by illiterate individuals.

This association likely reflects a combination of factors. Educated household heads are generally more aware of the health risks associated with unimproved water sources, including waterborne diseases such as diarrhea, cholera, and typhoid, which are prevalent in slum settings. Higher educational attainment may also increase access to formal employment opportunities, thereby increasing household income and strengthening the financial capacity to afford improved services.

Additionally, educated individuals may have better knowledge of navigating bureaucratic processes to obtain water connections, engage with municipal authorities, or utilize alternative coping strategies, such as installing storage tanks or community-level water systems. These findings align with studies conducted in Addis Ababa, Hawassa, and other Ethiopian urban centers, which demonstrate that education consistently facilitates equitable access to water services (Birhanu & Alemu, 2018).

Household income was another significant predictor of water access in the slum areas of Jigjiga. Middle-income households (2,500–5,000 ETB) were 3.42 times more likely, and high-income households (>5,000 ETB) were 5.89 times more likely, to have access to improved water supply compared with low-income households (<2,500 ETB). This reflects the strong influence of affordability on WASH access, as slum households with limited financial resources often depend on vendors and off-premises water sources, which are not only costly but may also be unreliable or unsafe.

The findings demonstrate the dual nature of water access constraints in slum areas, wherein inadequate infrastructure intersects with socioeconomic disparities. This implies that municipal piped water supply network alone may not guarantee access to safe and affordable water for economically disadvantaged households. These results support previous research in Nairobi, Kenya, and Ethiopian cities, where household income was a consistent determinant of access to piped water in informal settlements (Kimani-Murage & Zeleke, 2020).

Housing characteristics also played a significant role in determining access to water. Households residing in semi-permanent or temporary dwellings were significantly less likely to have piped water connections compared to those living in permanent structures. This pattern is consistent with findings from Dire Dawa and Addis Ababa slums (Tegegne & Zeleke, 2020).

In Jigjiga, informal settlements are often built on unregistered or leased land, which discourages investment in household-level water connections due to legal insecurity. Municipal utilities may prioritize permanent or formally registered neighborhoods when extending infrastructure, leaving informal settlements underserved. The combined effect of temporary dwellings and off-premises water sources reinforces the vulnerability of households in slum contexts, limiting both convenience and hygiene practices.

Sanitation coverage in the slum areas was relatively low, with 27.3% of households reporting access to improved sanitation facilities. Pit latrines with slabs were the most common type of facility, followed by pit latrines without slabs. Multivariable logistic regression analysis revealed that several factors were significantly associated with access to improved sanitation: household head education, household income, location of the water source, and the presence of handwashing facilities and soap. Households relying on off-premises water were 52% less likely to have improved sanitation [AOR = 0.48], demonstrating the interdependence of water and sanitation. Moreover, households with handwashing facilities [AOR = 2.41] and soap or detergent [AOR = 2.76] were significantly more likely to maintain improved sanitation, highlighting the critical role of hygiene behavior and infrastructure in sanitation outcomes.

These findings align with the integrated WASH framework, which emphasizes that access to water, sanitation, and hygiene services is mutually reinforcing and that deficits in one area undermine the effectiveness of others (WHO & UNICEF, 2021).

The structural and social realities of Jigjiga slums help explain these associations. Informal settlements face chronic underinvestment in water and sanitation infrastructure, compounded by insecure land tenure, high population density, and limited municipal governance. Poorly maintained streets, absence of sewer systems, and inadequate drainage hinder the construction and maintenance of private sanitation facilities. Social and cultural norms also influence access: women, who bear primary responsibility for household hygiene, may prioritize water collection

over other tasks, while low literacy limits awareness of safe sanitation practices. These factors collectively shape how households interact with WASH services and determine whether they can adopt improved facilities.

Comparing these findings to national targets, the low coverage of piped water on premises and reliance on informal vendors indicate a significant gap in equitable WASH service provision in secondary cities such as Jigjiga city. The Ethiopian National WASH Implementation Framework aims for universal access to safe water and improved sanitation, yet these results suggest that secondary cities, particularly in the Somali region, lag behind metropolitan areas. While sanitation coverage appears relatively high, much of it consists of basic pit latrines, which may not meet safe management standards. This suggests that policy efforts must focus not only on increasing coverage but also on improving the quality and sustainability of services in slum areas.

The findings have several implications for practice and policy. First, interventions must integrate infrastructure expansion with socioeconomic support to ensure that low-income and female-headed households can access services. Second, education campaigns and community engagement programs can enhance hygiene awareness and encourage the adoption of improved sanitation. Third, municipal authorities should strengthen governance mechanisms to prioritize informal settlements, secure land tenure, and promote inclusive planning. Fourth, promoting handwashing stations and affordable on-premises connections will address the interconnected challenges of water, sanitation, and hygiene simultaneously. Collectively, these strategies are essential for achieving Sustainable Development Goal 6 and improving health outcomes in vulnerable urban populations.

Overall, this study highlights that access to water and sanitation in Jigjiga slums is influenced by a combination of socioeconomic, educational, infrastructural, and behavioral factors. The slum context, including insecure housing, limited municipal oversight, and gendered responsibilities, exacerbates inequities and constrains service provision. Policy and programmatic responses must therefore adopt a holistic, context-specific approach that addresses both physical infrastructure and the socioeconomic barriers faced by slum households. Improving WASH access in secondary cities like Jigjiga is not only critical for public health but also for advancing equity, urban resilience, and for supporting sustainable urban development in Ethiopia’s rapidly urbanizing regions by reducing health risks and improving living conditions in informal settlements.

6. STRENGTHS AND LIMITATIONS

6.1 Strength of the study

The primary strength of the study lies in its use of standardized questionnaires, which were developed through a comprehensive review of previous studies and relevant materials on the topic. This approach involved analyzing various research questionnaires, allowing the researchers to adopt best practices and incorporate key insights.

The advantage of this methodology is that the standard questionnaires were updated as needed, taking into account outcome factors and observations from previously published research and additional pertinent literature. Consequently, this rigorous process enhances the reliability of the data collected. As a result, the study facilitates easier comparisons of access to improved water supply, sanitation, and hygiene facilities in slum areas from both national and global perspectives, contributing to a better understanding of these critical issues.

6.2 Limitation of the study

The study was associated with a few limitations. One of the limitations was the cross-sectional nature of the study. Due to this nature of the study, it evaluates water, sanitation, and hygiene facilities, which reflects water, sanitation, and hygiene facilities, and practices existing only at the time of the baseline survey. The study determined factors associated with access to water supply and sanitation facilities among households in the slum area of Jigjiga city. Although the study measured different variables associated with the availability of water, sanitation, and hygiene facilities using an adjusted multivariable logistic regression model, there could be other unmeasured confounding factors that could affect the current association. Since this study was conducted in three specific slum areas of Jigjiga city Ethiopia, evidence obtained from this study can't be generalized across all slum and informal settlement areas in Ethiopia and other developing countries. This was another limitation of the study. Therefore, further studies are recommended in other urban slum and informal settlement areas in Ethiopia to generate additional evidence on access to water, sanitation, and hygiene (WASH) services and their associated factors.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

This study demonstrates that access to improved water and sanitation services in the slum areas of Jigjiga City remains limited and unevenly distributed, and is strongly influenced by socioeconomic, educational, infrastructural, and behavioral factors. Although most households reported access to some form of water source, reliance on unimproved sources, particularly water vendors, and the low coverage of piped water on premises underscores persistent gaps in safely managed water services.

Female-headed households, those with lower income and education, and households living in temporary or informal dwellings were significantly associated with lower access to improved services, highlighting possible influences of socioeconomic disadvantage, gender inequality, and insecure land tenure.

Sanitation coverage remained limited, and most available facilities were basic sanitation options such as pit latrines. Access to sanitation was also closely linked to water availability and hygiene practices, highlighting the interdependence of water, sanitation, and hygiene.

Overall, the findings demonstrate that persistent infrastructure deficiencies, compounded by deep-rooted social and economic inequalities, continue to undermine equitable access to WASH services in the slum areas of Jigjiga City.

Addressing these challenges requires integrated, context-specific interventions that combine infrastructure expansion with socioeconomic support, gender-sensitive planning, and strengthened urban governance to ensure inclusive and sustainable progress toward universal WASH access, defined as equitable access for all households to safely managed drinking water, improved sanitation facilities, and adequate hygiene services.

7.2. RECOMMENDATIONS

To address these challenges, the following recommendations are proposed:

To Jigjiga City Administration:

- Expand piped water and sanitation infrastructure in slum areas.
- Ensure continuous water supply through improved management and maintenance.
- Provide financial support (subsidies or microloans) for household WASH improvements.
- Promote hygiene through installation of handwashing facilities and awareness programs.
- Improve internal roads and public toilets to enhance service accessibility and sanitation.

To the Somali Regional Health Bureau

- Strengthen community-based hygiene promotion through health extension workers, particularly focusing on handwashing at critical times and safe water handling practices.
- Integrate WASH interventions with public health programs to reduce waterborne diseases in slum communities.
- Support community-led sanitation initiatives and behavior change campaigns to improve the use and maintenance of sanitation facilities.
- Collaborate with local authorities and the Jigjiga Water Supply and Sewerage Authority to ensure coordinated implementation of WASH and health programs in underserved settlements.

To Jigjiga Water Supply and Sewerage Authority:

- Reduce frequent water interruptions and extend pipelines to underserved settlements.
- Regulate water vendor prices to ensure affordability.
- Strengthen water quality monitoring and community participation in WASH planning.

To Development Partners and NGOs:

- Support integrated WASH programs focusing on infrastructure, hygiene promotion, and gender equity.

To Policymakers and Researchers:

- Incorporate slum-focused WASH strategies into urban development plans and conduct follow-up studies on intervention impacts.

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8. ANNEXES

8.1. PARTICIPANT INFORMATION SHEET AND INFORMED VOLUNTARY CONSENT FORM FOR HEADS OF HOUSEHOLD

My name is _____. I am working as a data collector for the study being conducted in the college of health and medical science by Mohamed Siyad who is studying for his Master's degree at Haramaya University, the College of Health and Medical Sciences. I kindly request you to lend me your attention to explain you about the study and being selected as the study participant.

The study title:

Assessment of access to water and Sanitation facilities and associated factors among slum households of jigjiga city, eastern ethiopia, 2023

Purpose: - The main purpose of this study is to write a thesis as partial requirement for the fulfillment of Master program in Water supply and Sanitation management. This study is also expected to increase the knowledge and understanding while also providing updated information on the slum water supply system serving the study area. The study outcome includes benchmark data for any further investigation with an overall goal of providing useful ideas that was enhance municipal water and sanitation provision in Jigjiga.

Procedure and duration:

You were answer a questionnaire to provide me with pertinent data that is helpful for the study. There are 42 questions to answer where you were fill the questionnaire by interviewing. The questionnaire was take about 30 minutes, so I kindly request you to spare me this time to respond the questionnaire.

Risks and benefits:

The risk of being participating in this study is very minimal, but only taking 30minutes from your time. There would not be any direct payment for participating in this study. But the findings from this research may reveal important information for domestic water management in Jigjiga town based on the information you provided us.

Confidentiality:

The information you were provide us was be confidential. There was be no information that was identify you in particular. The findings of the study were general for the study community and was not reflect anything particular of individual household.

Rights:

Participation for this study is fully voluntary. You have the right to declare to participate or not in this study. If you decide to participate, you have the right to withdraw from the study at any time and this was not label you for any loss of benefits which you otherwise are entitled. You do not have to answer any question that you do not want to answer.

Contact address:

If you have any questions or concerns about the research you can contact the concerned person with the following address given below.

Name	Address	Telephone/Mobile	E-mail
Mohamed Siyad Yusuf (researcher)	Jigjiga	0915064467	maxamedbbk@gmail.com
Haramaya University Collage of Health and Medical Science IHRERC	Harar	0254662011	P.O.POX 235 Harar

Declaration of informed Voluntary Consent:

I read/was read to me the information sheet and consent form. I have clearly understood the purpose of the research the procedures, the risk and benefits, issues of confidentiality, the right of participating and the contact address for any queries. I have had the opportunity to ask questions for things that may have been unclear and any questions that I have asked have been answered to my satisfaction. I understood that I have the right to withdraw from the study at any time without any precondition. Therefore; I declare my voluntary consent to participate in this study with my signature as indicated below.

Name and Signature of participant_____ Date ___/_____/_____

Name and Signature of the data collector_____ Date___/_____/_____

8.2. Data collection questionnaire

Topic: Access to water and sanitation facilities and associated factors among households in the slum areas of Jigjiga city, Eastern, Ethiopia.

Name of Data collector _____ Signature _____

Kebele: _____Serial Number: _____ Date _____

Start time _____ Finished time_____

Name of supervisor _____ Signature _____

PART A. Household Demographic and Socio-Economic Information

R.No	Questions	Responses	Remark
101	What is the Head of the household (sex)?	1. Male 2. Female	
102	What is the Type of household respondent?	1. Household head 2. Spouse of household head	
103	What is the Age of household respondent?	_____	
104	What is the Ethnicity of household?	1. Somali 2. Non-Somali	
105	What is the Educational level of the respondent?	1. cannot read and write 2. Can read and write 3.primery (1-8) 4. secondary (9-12) 5 Higher (diploma and above)	
106	What is the Marital status of the household head?	1. Married 2. Single 3. Divorce	

		4. Widow	
107	What is the Occupation of the household head?	1. Farmer 2. Merchant 3. Government employee 4. Daily laborer 5. Unemployed /not working/pensioned 6. Other specify_____	
108	What is the House Ownership condition?	1. Owner occupied 2. Rented from individual 3. Rented from kebele 4. Others specify_____	
109	What is the Number of Rooms in your house?	_____	
110	How many people are living in your house?	_____	
111	Are there less than five years of age children?	1. Yes 2. No If yes, how many_____	
112	What is your Average monthly household income (in birr)?	_____ birr	

PART B. Water supply and sanitation condition

R.No	Questions	Responses	Remark
201	What Is the primary (main) source of your water supply for the house hold?	1. Private pipe within the house 2. Private pipe within the compound 3. Public stand taps 4. Stream 5. Hand dug wells 6. Water vendors 7. Rain water 8. Others (please specify) ----------	
202	If you do not have private pipe connections, why don't you have?	1. Not wanting the service 2. Inability to pay the connection charges in advance 3. Service is expensive 4. Because the service is not available 5. Other reasons (please specify	
203	What is the secondary source of water for the household?	1. Private connection 2. Public pipe stand tap 3. Water vendors 4. Hand dug wells	

		5. Water vendors 6. Rain water 7. Others (please specify)	
204	Do you have access to basic drinking water supply in your household?	1. Yes 2. No	
205	What is the type of water supply?	1. Continuous 2. Intermittent 3. Others	
206	How many days was your primary pipe water supply available in the last one week?	1. 2. Never Once 3. Twice 4. Three or more times	
207	At what time is water from that source available to your household?	1. 2. Morning time Afternoon time 3. Evening time	
208	How often do you fetch water?	1. Daily 2. Every 2 days 3. Every 3 days 4. Weekly	
209	What is the average distance (in meters) of the water source from your home?	_____meters	

210	Who is responsible for fetching water in your family?	1. Children 2. Females 3. Males 4. others specify_____	
211	Averagely How long does it take you to collect water for home use?	---------- minutes	
212	How many liters of water would they fetch in a day?	----------liters	
213	What is (are) the storage capacity of container(s) you use most frequently for collecting water? (Indicate one or more)	Capacity in liters----------	
214	Daily Consumption of water by the household	_____liters	
215	What is the cost of water vendors?	1. High 2. low	
216	If high how much?	_____ ETB	
217	Compare your current collecting practices to your rainy season (Hamlie/Nahase) collecting practices. Does the volume of water collected:	1. Increased 2. Decreased 3. Stays the same	
218	Do you have shower room with tab?	1. Yes 2. No	
219	Do you have toilet?	1. Yes 2. No	

220	What kind of toilet does your household use? Only If yes for above question	1. 2. 3. 4.	Pour Flush toilet VIP toilet Pit latrine with slab Pit latrine without slab 5.Public latrine 6.Others
221	Where is the toilet location?	1. Indwelling 2. In yard 3. Else were	
222	Is the toilet private, share or public?	1. 2. 3. 4.	Private (one household) Shared (> one household) Public Other (specify)_____
223	Does your toilet construction cost?	1. High 2. Low	
224	If high how much?	_____ETB	
225	Does Your toilet ever been emptied?	1. Yes 2. No	
26	Does soap available in your house for hand washing?	1. Yes 2. No	
27	What is the cost for your soap affordability?	1. High 2. Low	

8.5. PARTICIPANT INFORMATION SHEET AND INFORMED VOLUNTARY CONSENT FORM FOR HEADS OF HOUSEHOLD FOR SOMALI VERSION

Waraaqda kaqaybgalayaasha xogta iyo ogolaanshaha foomka daraasadka kaqaybgalayasha.

Magacayguwaa: _____, waxaaan sameynayaa daraasad qayb ka mid ah,

Diyaarinta baahida biyaha iyo nadaafada bulsho ee Mohamed Siyad Yusuf kaalinta Mastar ka ee Jaamacadda Haramaaya. Diraasadan waxay ku saab santahay hab ka guriyaasha qurux san biyyaaha loo isticmaalo maariyeenteeda iyo sidoo kale hab isticmaaleed ee biyyo megaalada Jigjiga ee magaalooyinka ku harersan.

Magaca Daraasada.

ka qayb qaataan falanqaynta fikir ka daraasada ee maariyeenta reerka/xaafadeed abiyyaha sida loo isticmaalo cilmibaadhis kusaabsan weyyaan.

SababtaDaraasadkaa

Cilmibaadhistani waxaalooga baahanyahay Shahaadada Masteraydka Caafimaadka bulshada islamarkaana waxaa lagu eegayaa halka uutaaganyahay siday biyyo nadiifa u helaan oo naaguriyaha dhaxdeeda kaalinta amma hab ka biyyaha loo isticmaalo maariyeenteeda cilmibadhista kusaabsan sidaan master keyga ugadiyaariyyo weyyaan hadaf ka diraasadeydu.

Nidaamka iyo Wakhtiga

Manta, halkan waxaan ujoogaa in aanururiyo xogdheerada oo la xidhidha qaabk isticmaalka biyaha iyo nadaafada guryaha, xogtasi oo lagu dhamaystiri doono mudo 30 daqiiqa dood.waxaan kaacodsan doonaa inaad wakhtigaaga ii hurto.

Faa'iidada iyo khasaraha darasaadka

Ka qaybgalida darasadkan iyo jawaab cilinta daraasaad kani, kama heli doontaan faiido toos ah. SIkastaba ha ahaatee, wuxuu inaga caawin doonaa sidii kor loogu qaadi lahaa ka hortaga iyo xakamaynta dhibaatooyinka mujtamaca si loo siin lehaa war galin ku saabsan hawlehaa caafimaadka oo sifaaiido looga helo laakiin wax faayida oo aad ka heleysiin ka qeeb qaadashadan haba yaraatee majiraayo.

Qarsoonida

Ka qaybgalka Daraasadkan waa mid kusalaysan ikhtiyaar kaaga, Xilikasta waxaaad xaquleedahay in aadiskadayso ood Joojiso xog ururintan.Sikastaba Ha ahaate xog ta aad isiinayso oo dhan PI waxay ahaan doonaan kuwo aan hayn doono dhigina doono meel haboon oo qarsoon.Marka waxaa loobaahanyahay in aanad arintan iyada ah ka walwalin.

Uma baahn PI inaan magacaaga qorro mana qorayo magacaaga ama wax yaale kale waxaaan sheeg PI doona uun xogta saxda ah.

Xuquuqda (Rights)

Ka qeeb galka Daraasad kan PI waa mid ku salaysan akhtiyaar kaaga waxaaad xaq uleedahay in aad diido kaqayb galkaaga daraasadkan PI amaba waxaad xaquleedahay in aanad kajawaabin suaasha ayda ah hadii aanad kuq anacsanayn xog ururintan. Waxaaad xaq buuxa uleedahay in aad joojiso xogtan PI wakhti PI kasta. Haddii aad hayso wax su.aala ama wax la xidhiidha daraasadkan PI waxaaad laxidhiidhi kartaa qofka ay khusayso ood kaheli karto adhireeska hoosta ku qoran.

Magaca	*ciwaanka*	*Tilifoon*	*e-mail*
Maxamed siyad yuusuf	*jigjiga*	*0915064467*	*maxamedbbk@gmail.com*
Madaxa komiteega akhlaaqeed ee cilmi baadhista ururеed	*Harar*	*0254662011*	*P.O.BOX 235 HARAR*

Xaqiijinta ogolasho xog ururin

Waxaan si fiican u fahmay in ay ujeedada darasaadkan tahay ururin xog ku saabsan biyaha iyo nadaafada guryaha magaalada jigjiga

Waxaan xaqiijinaya in aan akhriyey qoraalka kor kuxusan oo dhan ama la IIakhriyey.Waxaana la isiiyey fursad aan su‟aalo kuwadiiyo wxaan garan waayey na la iga siiyey faafahin buuxda ismarkaasna la iiga jawaabay sifiican. Ka qayb qadashadayduna waxay ahayd mid kusallaysan rabitaan kayga Waxaana lay ogaysiiyey inaan xaq u leehay inaan kabix karo ka qaybqadashada daraasad kan markaan anu rabooon la igu qasbinin aan sii wado

Magacaeyoo Saxeexa Mulkiilaha xogtani_____ Bisha ___/_____/_____

Magaca iyo Saxeexa Xog ururiyaha _____Bisha_____/_____

Cilmi baadhistanWaxa la ii ga sheegey oo dhanwaanfahmey. Waxaan xaqiijinaya in aanakhriyeyqoraalkakorkuhoosan oo dhankuheeshiyyeyoonasaxeexeygakudhigeysideeynadoodugaimanmarkadambe.

Saxeexa----------maalinta----------

Maamulka jigjiga eqeebta guriyaaha ee biyyo isticmaalka maariyeenta ku saaabsan cilmi Baadhista foomsu'aal weydiina loo diiyyaariyyey

Qofka wax ururinaayyo----------saxeexiisa----------

8.6. household questionnaire for Somali version

Koodka/qoraalkasirta----------qabalaha/guddiga----------Maalinta----------

Saacaddu bilaabey----------saacaddu dhameestirey----------

Magaca superviserka/daba socdo----------saxeexiisa----------**Qeebta koobaad:arrimaha dhaqaalaha iyo mushtamaca**

Lumbarka	*Su'aal*	*Jewaab*	*Baadhista*
101	*Maamule guri*	1. *nin* 2. *gabadh*	
102	*Qofka wax la weydiiyey*	1. *nin* 2. *gabadh*	
103	*da'adaadu waa immisa?*	_____	

104	*Fassalka/dugsigaimmisaadyaaddhigattaa?*	1. *Wax ma baran* 2. *dugsiga1-5* 3. *dugsiga6-8* 4. *dugsiga9-10* 5. *>=11 dugsiga*	
105	*Ma qofguursadey miya?*	*1. meyaa* *2 .haa* *3. qofgeeriyoodey* *4. qof ka la tagey*	
106	*Shaqadaada rasmiga waamaxay?*	*1.beeraleey* *2.baaciy mushtari* *3.shaqaale dawladeed* *4.shaqaale maalimeed/xogsade* *5. tuurateenya/qofaanshaqeeneyn* *6.wax kale haddejiraansheeg--------* ----------	

107	*Arrimahagurigaakusaabsan*	1. *Guriqabale* 2. *Gurishaqsi ah* 3. *Gurishaqsi ah oo reerdaganyihin* 4. *Wax kale haddi u jirosheeg*_____	

108	*Guriguintaqol u leeyehey*	_____
109	*Gurikiraamiyaadleedihin*	1. *Haa* 2. *Meyaa* 3. *Igumasaabsano/magaranaayyo*

Lumbarka	*Su'aal*	*Jewaab*
110	*Mas'ulkareerka*	1. *Nin* 2. *Gabadh*
111	*Qofka la suaaley*	1. *Nin* 2. *Gabadh*
112	*da'adaaduwaaimmisaa*	_____
113	*Dugsiga/fasalkaimmisaad?*	1. *Qofwxaaanbaranin* 2. *Dugsiga 1-5* 3. *Dugsiga 6-8* 4. *9- Dugsiga 10* 5. *>=11 Dugsiga*
114	*Habguurkaaga*	*1.qof aanguursan* *2.qof guursadey* *3. qofgeeriyoodey* *4. qof is furey*

115	*Shaqadaadurasmigawaamaxay?*	*1 beeraleey* *2.baaciy mushtari*
		3.shaqaale dawladeed *4.shaqaale maalimeed/xogsade* *5. tuurateenya/qofaanshaqeeneyn* *6.wax kale haddejiraansheeg----------*
116	*Sided guriga aad ku Nooshehey*	1. *Waa qabale* 2. *Gurikirooshaqsiya* 3. *Guriishaqsiya* 4. *Wax kale haddi u jirosheeg----------*
117	*Guriguintamaqsin/qol u leeyehey*	_____
118	*Guri laakireeyyo maadleedahey*	1. *Haa* 2. *Meyaa* 3. *Igumasaabsano/magarenaayyo*
119	*Intaqofeesirasmiyaaugunoolgurigaawaaimmisa?*	_____
120	*Ilmo 5jir ka yar/ka hoosmiyeeykunoolyihiin*	1. *Haa* 2. *meyaa* 3. *igumasaabsano/magarenaayyo* *jewaabtaaduhaddieehaataheyinta caruureeyihinsheeg----------*

121	*gabi ahaanwixiidakhliiee kussoo gelaa in inteeweeyyaan?*	_____qarshi

Qeebta labaad: habka biyyo diyyaarinta iyo nadaafadda

Lumbarka	*Su'aal*	*Jewaab*	*Baadhista*
201	*Guriguhalkee bey biyyadiyyaarintaee ka helaan?*	1. *buwaanbeddaahaaneed shaqsi* 2. *biyyaha boonooga/lumbaradaiibsho lagu* 3. *wabi* 4. *biyyaahaceelka* 5. *biyyaha la iibsho* 6. *biyyaharoobka/cirka* 7. *wax kale haddee jiraan sheeg----------*	
202	*Guriga haddi aan buwaanbadleheensababtuwaamaxay?*	1. *isticmaalkiisaayyaananrabin* 2. *kartiaankugashadomalihi* 3. *isticmaalkisuwaaqaali* 4. *isticmaalkisusababtaaane jirin* 5. *wax kale haddi u jirosheeg--* ----------	

203	*Gurigusiwenaagsan/ halkee bey biyya diyyaarintaee ka helaan?*	1. *buwaanbeddashaqsiahaaneedbiyyahaboonooga/lumbar* 2. *ada laguiibsho* 3. *wabi* 4. *biyyaahaceelka* 5. *biyyaha la iibsho* 6. *biyyaharoobka/cirka* 7. *wax kale haddeejiraansheeg---* ----------	
204	*Biyyadiyyaarintuwaa side?*	1. *mar welba u jiraa* 2. *mar marumbujiraa* 3. *wax kale haddi u jiro*---------- -----	
205	*Todobaadadiihoree oo aansoodhaafney in inteeleeg aye biyyodiyaarintuidinka Joogsadeen*	1. *habayaraatteemarbanagamago'in mar 'un laba jeer* 2. 3. 4. *saddex jeer iyyo wax kabadn*	
206	*Bishhi horee dhaxdeeda*	1. *Haa*	

	biyyodiyaarintu ma sisaf ah/qofbasimaalindhaafaayyaalaguheleyyeymiyaa?	2. *meyaa* 3. *magarenaayoo*	

207	*Waqtiga / saacaddabiyyodiyyaarintainuujiro la heloowaagoormee?*	*ka----------ilaaiyyo----------* *----* *ka----------ilaaiyyo----------* *----*	
208	*Goormee biyyaha aad dhaamisaan?*	1. *maalinkasta* 2. *to dobaadkii* 3. *todobaadkiilabacishoo* 4. *todobaadkiisadaxcishoo* 5. *todobaadkii*	
209	*Biyyaha merkaad dhaamineysaan in tee leegayyuidin ka qaatta?*	1. *gurigaa dhaxdeeda u* 2. *fiicanyehey sijoogtaaheen/sinasiiba-------* *-----meetir*	
210	*Haafadda/gurigadhaxdeedabiyyahaayyaadhaamiyyaa?*	1. *Caruurtahablaha/hawweenka* 2. *raga/wiilesha* 3. 4. *wax kale haddeejiraansheeg--* *----------*	
211	*Biiyaa merkaad dhaamineysid in inteeleegayyuwaqtikaaqaattaa?*	*---------- daqiiqo*	
212	*Maalintii in inteeleeg oo biyyaadhaansattiin?*	*----------litter*	

213	*Waqtiga badan merkaadbiyyahaaururineysomexaadisticmaashaa?in inteeleegweeyyaanbadidu*	• *nuucu----------litir----------* *alaabtabadideedu----------* • *nuucu----------litir----------*	

		alaabtabadideedu----------	
214	*Reerkadhaxdeedamaalintii in inteeleegayyaabiyyaha la isticmaala*	1. *cabitaan---------- litircuntokaris------* 2. *------litirdharmeedhis----------litir* 3. 4. *jirmeedhis---------litir* 5. *kale haddejiraansheeg---------* *--------*	
215	*Reerkuwaqtigeebadinka biyyaha maalintii isticmaalan*	1. *Subax* 2. *galindambe/casserhabeen* 3.	
216	*Reerkuwaqtigabiyyahaeehelaanjiilaalka (hamleiyyonehase) merkaad la barbardhigtidwaa side?*	1. *uubiirauunaaqusa wax* 2. *isbadila male* 3.	
217	*Qol/kamineejir ka lagumeedho mu jiraa?*	1. *haajiraa* 2. *meyaamajiro*	
218	*Reer ka wixiikunool oo jir kiisamerwelbameedhowaaayyo/*	1. *caruurtareggahawweenka* 2. 3.	

		4. *duqaha/qofkaweeyn*	
219	*Kaminee/maqsuul ma leedi* *Hihiin*	1) *haa* 2) *meyaa*	
220	*Su'aashalambarka 029 jewaabteedahaddiaad tidhaatid nuuca maqsuush/kamineeguwaamaxey/waakee?*	3) *waakubiyyokushaqeeyyo* 4) *waatuunbooyiinka loo isticmaalo* 5) *waakaminee* 6) *wax kale haddi u jirosheeg----------* --	
221	*Su'aashalambarka 029 jewaabteedahaddiaad*	1. *shaqsii* 2. *wadajir*	
	tidhaatid nuucas maqsuush/kamineeguwaamaxey/waakee?	3. 4. *kushacaba wax kale haddi u jirosheeg----------*	

Qeebta saddexaad:hab biyyo diyyaarinta fiirada loo qaboo

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Lambarka	**Qiyaastataayyaada**	Fiican 1	Wax ba male 2	mafiicnoo 3	magarenaayyo 99
1)	*Nedaafadda*				
2)	*Qalin*				

3)	*Uris/dareen*				
4)	*Dhandhan*				
5)	*Caafimaadeed*				
6)	*Fiiradisuu/khaarinjintiisu(siwenaagsanoo loo soodiyyaariyyo)*				
302	*Xaafeddadhaxdeedabishhihoreeqofreer ka dhaxdeedashuban u kudhacaymiyujiraa?*		*Haa* *majiroomagarenaayyo*		

Waxaad nagu caawiseen oodhan waan idin ku mahad naqeynaa Mahadsanid!!!