EVALUATING COMMUNITY PERCEPTIONS OF WATER QUALITY AND HEALTH OUTCOMES IN OGBESON COMMUNITY, EDO STATE, NIGERIA.

BY

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AN UNDERGRADUATE PROJECT SUBMITTED TO THE DEPARTMENT OF ENVIRONMENTAL MANAGEMENT AND TOXICOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE, NIGERIA; IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF BACHELOR OF SCIENCE (B.Sc) DEGREE IN ENVIRONMENTAL MANAGEMENT AND TOXICOLOGY.

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CERTIFICATION

This is to certify that this research titled "**Evaluating Community Perceptions of Water Quality and Health Outcomes in Ogbeson Community, Edo State, Nigeria**" was carried out by "**Elect Eboselumen AIYEDUN**" and presented to the Department of Environmental Management and Toxicology, Faculty of Life Sciences, University of Benin, Benin City; in partial fulfillment of the requirements for the award of Bachelor of Science (B.Sc) in Environmental Management and Toxicology. It was conducted under suitable conditions, was carefully supervised and subsequently approved as having met the requirements for the award of Bachelor of Science degree in Environmental Management and Toxicology.

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DECLARATION

I **Aiyedun Elect Eboselumen** declare that is my own work and that all sources that I have used or quoted have been acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other University.

Aiyedun Elect Eboselumen

Date……

DEDICATION

This project is dedicated to God almighty,

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ABSTRACT

Access to safe drinking water is critical for achieving Sustainable Development Goal (SDG) 6, yet it remains a challenge in Nigeria, contributing to a high burden of waterborne diseases. This study aimed to evaluate the complex relationship between community perceptions of water quality and laboratory-confirmed health outcomes among residents in Ogbeson, a rural community in Edo State, Nigeria. The research employed a mixed-methods approach, combining socio-demographic and behavioral surveys with objective physicochemical and bacteriological analyses of drinking water samples. The population exhibited a relatively high educational level (49.5% with tertiary education) and moderate income. Water quality was assessed against World Health Organization (WHO) standards, and health status was determined through self-reported illness prevalence, particularly waterborne diseases.A major discrepancy was found between community confidence and actual water safety. A high proportion of respondents (78%) reported confidence in their main water source's reliability, often relying on sensory attributes (color, taste, odor) for quality assessment. This confidence directly contradicted laboratory findings of severe contamination, including pathogenic bacteria (*E. coli*, *Klebsiella pneumoniae*, *Bacillus cereus*, and *Pseudomonas* species) and chemical hazards like elevated nitrate (52.17 to 92.47 mg/L, exceeding the WHO limit of 50 mg/L) and acidic pH (4.43–6.37). The documented contamination correlated directly with a substantial acute disease burden: 42.7% of households reported water-related illnesses, with typhoid fever (55.7%) and diarrhea (42.3%) being the most prevalent. Despite high education and 74.1% of respondents treating water (predominantly by boiling), structural constraints undermined protective behaviors. Pervasive water supply intermittency (61.4% experiencing problems) and seasonal unreliability (94.2% during the dry season) necessitated unsafe water storage and increased recontamination risk. This was compounded by critical WASH infrastructure deficits, with 85.5% of the community lacking adequate facilities, particularly hand washing stations (87.1% lacking), alongside the near-total absence of community-based WASH programs (82.3% lacking). In conclusion, the Ogbeson community faces a public health emergency driven by the dangerous coexistence of high confidence in unsafe water sources, pervasive infrastructural failures, and an overwhelming burden of waterborne disease. Urgent, multisectoral interventions are required to resolve water supply intermittency, invest in foundational WASH infrastructure, and implement integrated community programs to align risk perception with objective reality, thereby achieving health equity and SDG 6 alignment

CHAPTER ONE

INTRODUCTION

1.1. Background to the study

Safe and clean drinking water is water which is safe to drink and does not cause any harm over a lifetime of consumption (WHO, 2017). Access to safe and clean drinking water is a major factor that influences the state of human and environmental health because the consumption of unclean and safe drinking water poses harm and leads to the occurrence of diseases known as waterborne diseases (WHO,2019). The availability of water with good quality is a critical aspect of the Sustainable Development Goal (SDG) 6 developed by UNICEF and WHO. SDG (6) focuses on water quality, sanitation and hygiene-a strategy that was derived and has been used since 1995 when child mortality rates were on the rise (United Nations, 2016). SDG 6 is the sustainable development goal that aims to ensure the availability and sustainable management of water and sanitation for all by the year 2030. The achievement of this SDG is extremely important as it is considered a human right and a basic human need which is essential for a healthy life and the eradication of poverty (JMP, 2025).

Water is regarded as one of the most important human resource on the planet due to its enormous usage and applications, it is used for drinking, hand washing, bathing, cooking amongst others.

Studies had shown that, SDG 6 is still far from being achieved at national and regional levels especially in developing countries despite efforts and the significant strides that have been made by organisations such as the WHO, UNICEF and a host of NGO's (UNICEF, 2019). Unsafe water leads to the risk of waterborne diseases such as diarrhea, dysentery, with cholera predominantly occurring (Curtis *et al.,* 2003). According to recent data on WASH over 1.4 million people die each year due to poor drinking water, sanitation and hygiene, unsafe water, sanitation and hygiene are responsible for the death of around 1000 children under five every day (UN WATER, 2021).

Access to clean drinking water, is still considered extremely poor with over 2.2 billion people in the world still living without safe drinking water and 115 million people relying on surface water as their

source of drinking water in the year 2023 (UN WATER, 2021). Predictions state that by the year 2050 at least one in four people is likely to live in a country affected by chronic or recurring shortages in fresh water while over 207 million people will spend 30 minutes per round trip to access an improved source of water this is estimated as a distance of 2-3kilometres (UN WATER, 2021).

This study focuses on the state of water, sanitation, and hygiene (WASH) in Ogbesan a rural community in the Ikpoba-Okha local government area of Edo state, Nigeria. In Nigeria as at 2021, a study according to WHO (2021) revealed that 23% of Nigerians do not have access to basic water supply services and data shows that only 10% of the population have access to basic water, sanitation and hygiene services combined. The state of water quality in rural communities is observed to be poor and unsafe leading to a plethora of illnesses and diseases, middle and low-income households are also observed to have poor access to safe drinking water, sanitation and hygiene.

The community under study has a population which consists of predominantly low income and middle income households leading to the chance of it lacking good WASH facilities and practices (Abubakar, 2019). Lack of good practices and facilities leads to the occurrence of illnesses, diseases, poor social, physical, emotional and mental well-being of the populace. This study seeks to access the quality of the drinking water in Ogbeson community, provide relevant and valid information on the state of its water supply facilities, household water drinking facilities and practices.

1.2. Aim of the study

The aim of this study is to evaluate community perceptions of water quality and the health outcomes in Ogbeson community.

The objectives of the study are to;

a. Investigate the physicochemical quality of sampled drinking water from Ogbeson community.

b. further investigate the bacteriological quality of drinking water samples from Ogbeson Community.

c. Assess the socio-demography of the residents of Ogbeson Community.

d. Evaluate the water availability of the community.

e. further evaluate the health status of the residents Ogbeson community.

CHAPTER TWO

LITERATURE REVIEW

2.1 Water Quality Evaluation

Water quality evaluation involves the systematic monitoring and analysis of physical, chemical, and microbiological parameters to determine the suitability of water for various purposes, primarily drinking and domestic use (Chidiac *et al*., 2023). The evaluation process provides essential information for decision-makers, water resource managers, and public health officials to implement appropriate interventions and protect community health. The concept of water quality evaluation has evolved significantly over the past decades, transitioning from simple parameter-by-parameter comparisons to comprehensive indexing systems. Modern water quality evaluation methodologies integrate multiple parameters into unified indicators that provide comprehensive evaluations of water safety and suitability (Babatunde, 2024). One of the most widely utilized tools in water quality evaluation is the Water Quality Index (WQI), which simplifies complex datasets by integrating various physical (e.g., temperature, turbidity), chemical (e.g., pH, dissolved oxygen, heavy metals), and biological parameters(e.g., coliform bacteria counts) into a single numerical score that reflects the degree of water pollution or purity (Chidiac *et al*., 2023). In Nigeria, water quality evaluation has gained increasing attention due to the deteriorating state of both surface and groundwater resources. Studies conducted across various Nigerian states have revealed alarming levels of contamination from both natural and anthropogenic sources (Isukuru *et al.,* 2024). Ighalo *et al.* (2020) conducted a comprehensive systematic review of water quality monitoring and evaluation in Nigeria over two decades, identifying persistent challenges including inadequate monitoring infrastructure, limited technical capacity, and insufficient regulatory enforcement. The review also highlighted that most water quality studies in Nigeria focus on urban centers, leaving rural communities such as Ogbeson underrepresented in the literature despite their heightened vulnerability to water quality issues. Recent advances in water quality evaluation include the integration of remote sensing technologies, geographic information

systems (GIS), and artificial intelligence to enhance monitoring efficiency and spatial coverage. Furthermore, participatory approaches involving community members in water quality monitoring have emerged as effective strategies for sustainable water resource management, enhancing local capacity and ensuring culturally appropriate interventions (Ugbah *et al.,* 2017).

2.2 Parameters for Evaluating Water Quality

2.2.1 Physical Parameters

Physical parameters constitute the observable and measurable characteristics of water that can be detected through sensory perception or basic instrumentation, these parameters provide the first line of evaluation for water quality and often serve as indicators of underlying chemical or biological contamination (Sensorex, 2022). According to Atlas Scientific (2025) the primary physical parameters include temperature, turbidity, color, taste, odor, total dissolved solids (TDS), electrical conductivity (EC), and salinity.

Temperature is a foundational physical parameter that influences numerous chemical and biological processes in water systems (Zhou *et al.,* 2022). Water temperature affects the solubility of gases and minerals, the rate of chemical reactions, and the metabolic activities of microorganisms. Elevated water temperatures can reduce dissolved oxygen levels, promoting anaerobic conditions that may lead to the proliferation of pathogenic organisms (Ogbeifun *et al*., 2019).

Turbidity measures the cloudiness or haziness of water caused by suspended particles such as clay, silt, organic matter, and microorganisms (EPA, 2021). High turbidity not only affects the aesthetic quality of water but also interferes with disinfection processes by providing shelter for pathogens and reducing the effectiveness of chemical treatments (Lalaoui *et al*., 2024). Turbidity is usually reported in Nephelometric Turbidity Units (NTU) or Formazin Nephelometric Units (FNU), measured using instruments called turbidimeters that etect scattered light at specific angles (Davies-Colley and Smith, 2001). Studies conducted in Nigerian water sources have reported turbidity values ranging from 0.35 to

5.38 Formazin Turbidity Units (FTU), with higher values observed in surface water during rainy seasons due to increased runoff and erosion (Ogbeifun *et al*., 2019).

Total dissolved solids (TDS) represent the combined content of inorganic salts and small amounts of organic matter dissolved in water (Butler *et al*., 2018). TDS measurements provide insights into the overall chemical composition and potential contamination sources affecting water quality. In Nigeria, groundwater TDS concentrations vary considerably based on geological formations and anthropogenic influences. Okolo et al. (2025) reported TDS values ranging from 2 to 850 mg/L in groundwater samples from Aba Metropolis, with elevated concentrations observed in areas with high population density and industrial activities. While the WHO guideline for TDS in drinking water is 1,000 mg/L, values exceeding 500 mg/L can impart unpleasant taste and may indicate potential contamination.

Electrical conductivity (EC) measures the ability of water to conduct electric current, which is directly related to the concentration of dissolved ions (Mitreh, 2025). EC serves as a proxy indicator for water salinity and mineral content, with high values suggesting contamination from anthropogenic sources such as sewage, industrial effluents, or agricultural runoff. Groundwater studies in Nigeria have documented EC values ranging from 12.85 to 101.94 µS/cm in relatively unpolluted areas, with significantly higher values in contaminated zones (Ogbeifun *et al*., 2019).

Color in water may result from dissolved organic matter, industrial effluents, or microbial growth, While color itself may not pose direct health risks, it often indicates the presence of other contaminants and affects consumer acceptability, similarly, taste and odor are important palatability factors that influence water consumption behavior, unpleasant taste or odor may arise from organic compounds, chlorination byproducts, or microbial metabolites, leading consumers to seek alternative water sources that may be less safe (Atlas Scientific, 2025).

2.2.2 Chemical Parameters

Chemical parameters encompass the wide range of inorganic and organic substances dissolved in water that may affect human health, ecological systems, and water utility infrastructure. The most critical

chemical parameters include pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), hardness, alkalinity, acidity, major ions (calcium, magnesium, sodium, potassium, chloride, sulfate, nitrate, phosphate), and heavy metals (Sensorex, 2022).

The pH of water, measuring its acidity or alkalinity on a scale of 0 to 14, represents one of the most important chemical parameters affecting water quality (Drisu, 2016). pH influences the solubility and toxicity of various chemical compounds, the effectiveness of disinfection processes, and the corrosiveness of water to distribution infrastructure (Aqualabo, 2024). The WHO recommends a pH range of 6.5 to 8.5 for drinking water (WHO, 2023). Studies conducted in Edo State, Nigeria, including evaluations of the Obazagbon River and boreholes in Benin City, have reported pH values ranging from 4.32 to 7.03, with some locations exhibiting acidic conditions below the recommended range (Ogbeifun *et al.,* 2019).

Dissolved oxygen (DO) indicates the amount of oxygen available in water for biological processes (EPA, 2025). Adequate DO levels are essential for maintaining aerobic conditions that support beneficial microbial communities and prevent the proliferation of pathogenic organisms. DO concentrations below 2 mg/L indicate poor water quality and potential organic pollution. Research on Nigerian water sources has documented DO levels ranging from 1.1 to 5.24 mg/L, with lower values observed in water bodies receiving organic waste and agricultural runoff (Abubakar *et al*., 2025).

Biological oxygen demand (BOD) and chemical oxygen demand (COD) are related parameters that quantify the amount of organic matter in water. BOD measures the oxygen consumed by microorganisms during the decomposition of organic material, while COD measures the total amount of oxygen required to chemically oxidize organic compounds (Penn *et al.,* 2011). Elevated BOD and COD values indicate organic pollution from sources such as sewage, agricultural waste, or industrial effluents (Lacalamita *et al.,* 2024).

Nutrient parameters, particularly nitrate (NO_3^-) and phosphate (PO_4^{3-}), play crucial roles in aquatic ecosystems but can cause significant problems when present in excessive concentrations (Misman *et al.,*

2023). Nitrate contamination of drinking water sources is a widespread concern in Nigeria, with sources including agricultural fertilizers, animal waste, and sewage infiltration. Borehole water evaluations in Kano State revealed nitrate concentrations ranging from 16.17 to 35.00 mg/L, generally within the WHO guideline of 50 mg/L but approaching concerning levels in some locations (Abubakar *et al*., 2025). Nitrate exposure above guideline values poses particular risks to infants, potentially causing methemoglobinemia (blue baby syndrome). Phosphate levels exceeding 10 mg/L were documented in multiple Nigerian water sources, with concentrations reaching 48.15 to 71.83 mg/L in some wells, indicating contamination from fertilizers and detergents (Abubakar *et al*., 2025).

Heavy metals are crucial chemical prameters in water quality evaluation due to their toxicity, persistence, and potential health risks (Dippong, 2024). These heavy metals include lead (Pb), cadmium (Cd), arsenic (As), chromium (Cr), mercury (Hg), and manganese (Mn) which can accumulate in human tissues, causing severe acute and chronic health effects, they represent one of the most serious chemical threats to water quality in Nigeria, particularly in areas affected by industrial activities, mining operations, and oil exploration Tsor *et al.,* 2022). In the Niger Delta region, where oil exploration activities dominate, heavy metal contamination of drinking water sources poses particular concerns. Similarly, evaluations of groundwater near waste disposal sites and industrial zones have revealed elevated concentrations of lead, cadmium, and other toxic metals, raising serious public health concerns (Nlemolisa *et al*., 2025).

2.2.3 Microbial Parameters

Microbiological parameters constitute the most critical component of drinking water quality evaluation from a public health perspective, as waterborne pathogens cause the majority of acute illness and mortality associated with unsafe water consumption. The primary microbiological parameters include indicator organisms (total coliforms, fecal coliforms, *Escherichia coli*), pathogenic bacteria (*Salmonella, Shigella, Vibrio cholerae*), viruses, and parasites (*Giardia*, *Cryptosporidium*) (WHO, 2023).

According to the WHO (2023) total coliform bacteria serve as standard indicators of fecal contamination and general water quality, these organisms originate from soil, vegetation, and the intestinal tracts of warm-blooded animals, making their presence indicative of potential pathogenic contamination, fecal coliforms, a subset of total coliforms, more specifically indicate

recent fecal contamination. *Escherichia coli* (*E. coli*), a member of the fecal coliform group, serves as the most reliable indicator of recent fecal contamination and the possible presence of enteric pathogens. According to WHO guidelines, drinking water should contain zero *E. coli* per 100 mL to be considered microbiologically safe (WHO, 2023).

Extensive research conducted across Nigeria has documented widespread microbial contamination of drinking water sources, particularly in rural and peri-urban communities. A systematic review and meta-analysis of packaged sachet water in Nigeria revealed that 53.27% of samples contained total coliforms and 12.38% contained fecal indicator bacteria, with *E. coli* contamination prevalence at 13.30% (Udoh *et al*., 2021). These findings suggest that treatment failures and post-production contamination contribute significantly to the poor microbiological quality of ostensibly treated water products.

Studies examining traditional water sources in Nigeria have documented even higher contamination rates. evaluations of well water in Funtua Local Government Area, Katsina State, revealed total coliform counts ranging from 0 to 93 cfu/100 mL and fecal coliform counts from 0 to 17 cfu/100 mL, all exceeding WHO standards (Odewade *et al*., 2025). The study identified bacterial isolates including *E. coli, Shigella dysenteriae,* and *Salmonella typhi*, organisms directly associated with waterborne disease transmission. Correlation analyses revealed strong positive relationships between proximity of water sources to pit latrines and elevated coliform counts, with wells located less than 30 meters from sanitation facilities exhibiting significantly higher contamination levels.

In Edo State, microbiological evaluations of boreholes in Benin City metropolis detected *E. coli* and coliform organisms in multiple samples, indicating vulnerability of groundwater to fecal contamination despite the protective geological formations (Ogbeifun *et al.*, 2019).

A comprehensive study in Enugu Urban, Nigeria, investigated waterborne infections in 403 households, revealing an overall prevalence of 85.4% for one or more waterborne pathogens (Okpasuo *et al*., 2020). E. coli emerged as the most prevalent organism, detected in the majority of infected individuals, followed by *Salmonella, Shigella*, and parasitic protozoa. The study demonstrated significant associations between water source type and infection risk, with users of public wells and borehole/vendor water exhibiting over twice the odds of infection compared to non-users. Interestingly, sachet water consumers showed approximately 70% reduced risk of waterborne diseases, highlighting the importance of water treatment and protective packaging (Okpasuo *et al*., 2020).

2.3. Health Contamination Effects of Drinking Contaminated Water

The consumption of contaminated water represents one of the leading causes of preventable disease and mortality globally, with disproportionate impacts on populations in low- and middle-income countries. Waterborne diseases arise from ingestion of water containing pathogenic microorganisms, toxic chemicals, or radioactive substances, each associated with distinct health outcomes and severity profiles. The WHO estimates that contaminated water causes over 505,000 diarrheal deaths annually, with 395,000 occurring in children under five years of age (WHO, 2023). In Nigeria, approximately 361,900 deaths per year are attributed to poor water and sanitation conditions, including 60,000 children under five who die from diarrhea (Akinde *et al*., 2019).

2.3.1 Microbial Waterborne Diseases

Diarrheal diseases represent the most common and widespread health consequence of consuming microbiologically contaminated water. These conditions result from infection with various bacterial, viral, and parasitic pathogens transmitted through the fecal-oral route. Major etiological agents include

E. coli, Vibrio cholerae (cholera), *Salmonella typhi* (typhoid fever), *Shigella* species (dysentery), *Campylobacter*, rotavirus, norovirus, hepatitis A virus, and parasitic protozoa including *Giardia lamblia* and *Cryptosporidium* species (Lin *et al.*, 2022; WHO, 2023).

Cholera, caused by the bacterium *Vibrio cholerae*, remains a significant public health threat in Nigeria, with recurrent outbreaks causing substantial morbidity and mortality. The disease is characterized by profuse watery diarrhea (rice-water stools), vomiting, and rapid dehydration, which can progress to hypovolemic shock and death within hours if untreated. In 2021, Nigeria recorded 816 deaths among 31,425 suspected cholera cases, with Katsina State experiencing widespread transmission affecting 25 of 34 local government areas (Odewade *et al.,* 2025). Funtua Local Government Area reported the highest case burden with 384 infections and 18 deaths. The epidemiology of cholera in Nigeria demonstrates clear associations with inadequate water supply, poor sanitation, flooding, and seasonal rainfall patterns that contaminate water sources through surface runoff.

Typhoid fever, caused by *Salmonella typhi*, presents as a systemic infection characterized by sustained fever, headache, abdominal pain, weakness, and relative bradycardia. The disease progresses over weeks and can lead to severe complications including intestinal perforation, encephalopathy, and death if not treated appropriately. Studies conducted in Yobe State documented 11,938 typhoid infections over a three-year period (2017-2019), with Nguru Local Government Area recording the highest burden at 37.18% of total cases (Ahmed and Kafayos, 2020). Gender-based analysis revealed higher prevalence in males (52.83%) compared to females (47.18%). The persistent high incidence of typhoid fever in Nigerian communities reflects continued reliance on unsafe water sources contaminated by human feces.

Dysentery, characterized by bloody diarrhea accompanied by abdominal cramping and fever, results from infection with *Shigella* species (bacillary dysentery) or *Entamoeba histolytica* (amoebic dysentery). Research in primary health centers across Funtua Local Government Area identified dysentery as one of the most commonly reported waterborne diseases, with 193 cases documented in

Goya ward alone (Odewade *et al*., 2025). The severity of dysentery, particularly in children and immunocompromised individuals, contributes significantly to malnutrition and mortality in affected populations.

Hepatitis A, a viral infection of the liver transmitted through contaminated water and food, causes symptoms including fever, nausea, loss of appetite, fatigue, abdominal pain, dark urine, and jaundice. While typically self-limiting in adults, the infection can cause severe acute hepatitis and, rarely, fulminant liver failure. The prevalence of hepatitis A in Nigeria correlates with poor water quality and inadequate sanitation, though comprehensive epidemiological data remain limited (Essiet *et al*., 2024).

Parasitic infections transmitted through contaminated water include giardiasis (caused by *Giardia lamblia*) and cryptosporidiosis (caused by *Cryptosporidium* species). These parasitic protozoa form cysts that resist chlorination and can survive for extended periods in environmental water. Giardiasis presents with diarrhea, abdominal cramps, bloating, nausea, and weight loss, while cryptosporidiosis causes similar symptoms but poses particular risks to immunocompromised individuals. Studies in South-South Nigeria documented varying prevalence rates of giardiasis associated with different risk factors, with contaminated water sources emerging as primary transmission routes (Essiet *et al.,* 2024).

2.3.2 Chemical Health Effects

Long-term consumption of water containing elevated concentrations of chemical contaminants leads to chronic health effects that may not manifest for years or decades after initial exposure. Heavy metals represent particularly insidious chemical threats due to their persistence in the environment, bioaccumulation potential, and multi-system toxicity.

Arsenic contamination of drinking water poses severe carcinogenic and non-carcinogenic health risks. Chronic arsenic exposure leads to characteristic skin lesions including hyperpigmentation and hypopigmentation, peripheral neuropathy, peripheral vascular disease, cardiovascular disease, and cancers of the skin, bladder, and lung (Egbinola and Olaniran, 2014; Nowicki *et al.,* 2023).

Lead exposure through contaminated drinking water causes numerous adverse health effects, particularly in children whose developing nervous systems exhibit heightened vulnerability. Lead toxicity impairs cognitive development, reduces intelligence quotient (IQ), causes behavioral problems, and affects virtually every organ system (WHO, 2024).

Cadmium accumulates primarily in kidneys and liver, causing renal tubular damage and potentially progressing to renal failure with prolonged exposure. Cadmium is also classified as a human carcinogen associated with lung and prostate cancers. Nigerian water quality evaluations have identified cadmium concentrations exceeding WHO guidelines in multiple river systems, with hazard quotients above 1.0 indicating potential health risks (Nwiyi *et al.,* 2020).

Mercury contamination, particularly prevalent in oil-producing regions of Nigeria, affects the nervous system, kidneys, and developing fetuses. Methyl-mercury, the organic form of mercury most commonly found in contaminated water and fish, crosses the blood-brain barrier and placenta, causing neurological damage and developmental abnormalities. Comparative studies of oil-producing and non-oil-producing communities in Rivers State revealed significantly higher mercury concentrations in oil-producing areas (Iwunze *et al.,* 2024).

Nitrate contamination poses specific risks to infants under six months of age, potentially causing methemoglobinemia (blue baby syndrome), a condition in which nitrate interferes with oxygen transport in the bloodstream. While groundwater nitrate levels in most Nigerian communities remain below WHO guidelines of 50 mg/L, some areas exhibit concentrations approaching this threshold, warranting continued monitoring (Abubakar *et al.,* 2025).

2.4 Water Quality in Nigeria

Nigeria's water resources face multiple pressures from rapid population growth, urbanization, industrialization, agricultural expansion, and inadequate infrastructure development. Despite abundant water resources estimated at 900 km², covering over 71% of available territory, access to safe drinking water remains limited, with only approximately 67% of the population accessing basic water services

(Adeoti *et al.,* 2023). The water quality crisis in Nigeria manifests through widespread contamination of both surface and groundwater resources, affecting millions of people across urban, peri-urban, and rural communities. Recent water quality evaluation studies in Nigeria commonly employ a combination of physico-chemical and microbial analyses to provide a holistic understanding of water safety.

Agwu *et al.* (2023) and Gbekley *et al.* (2023) describe evaluating parameters such as pH, temperature, electrical conductivity (EC), dissolved oxygen (DO), biochemical oxygen demand (BOD), total dissolved solids (TDS), and turbidity to determine water quality. Microbial indicators like total coliform count (TCC) and total viable count (TVC) are also routinely assessed to estimate pathogen presence. Research in Benue South, Nigeria, assessed water from streams, rivers, and wells, employing in situ measurements with multi-probe meters and laboratory analyses following American Public Health Association (APHA) standard procedures (Edegbene, 2025). This integrated approach facilitates identifying potential health risks posed to communities relying on these water sources.

The principal component analysis (PCA) used in several Nigerian studies helps identify key parameters influencing variation in water quality. Parameters like temperature, DO, EC, TDS, chemical oxygen demand (COD), and turbidity have been shown to explain significant variances in water quality among sampled locations, guiding targeted interventions.

The Water Quality Index (WQI) remains an important tool in Nigeria for summarizing complex water quality data into understandable metrics. Studies recommend using the Weighted Arithmetic Water Quality Index Method to relate sampled contaminant concentrations to regulatory standards (Edegbene, 2025).

Nigerian water quality evaluations also utilize Pollution Load Index (PLI) and contamination factors to gauge severity and sources of pollution, especially regarding heavy metals and microbial contamination (Edegbene, 2025).

2.5 Previous Studies on Drinking Contaminated Water Risk

Several investigations across Nigeria have examined the prevalence of microbiological contamination, water treatment practices, and risk perceptions associated with drinking water safety. For instance, research in Edo State reported significant detection of bacterial contaminants in boreholes and surface water sources, highlighting the vulnerability of groundwater to fecal contamination despite natural protection (Ogbeifun *et al.,* 2019; PBBJ, 2018).

A study conducted in Enugu State by Okpasuo et al., (2020) documents a waterborne infection prevalence of 85.4% underline the risks arising from dependence on untreated water sources. Risk factors such as proximity of wells to pit latrines, poor water storage practices, and inadequate sanitation infrastructure compound infection rates (Odewade *et al*., 2025).

Household water treatment, including boiling and chlorination, remains underutilized due to socio-economic constraints and knowledge gaps. Adoption of safe water practices is influenced by education, income, and community engagement levels (Idigbe *et al*., 2024; Abubakar, 2019).

Perceptions of water quality and waterborne disease risk impact water source choice and treatment behaviors. Community participation approaches improve awareness and encourage adoption of protective measures, enhancing water security and health outcomes (Ugbah *et al.,* 2017; Tufail *et al.,* 2025).

2.6. Sociodemographic Factors Influencing Water Contamination Risk

Household income, education, geographical location, household size, and sanitation facilities influence water contamination risk profiles in Nigerian communities. Poor rural households often lack access to improved water and sanitation, exacerbating health vulnerabilities (Abubakar, 2019).

Higher education correlates positively with awareness and adoption of water treatment practices, reducing contamination risks (Okpasuo *et al.,* 2020). Women's educational status particularly impacts household water quality management, as they typically handle water collection and storage.

Geographical disparities between urban and rural areas, and intra-urban inequalities between formal settlements and slums, affect both access to and quality of drinking water. Poorly constructed wells and

close proximities to pollution sources compromise water safety in vulnerable populations (Akinde *et al.,* 2019).

Sanitation infrastructure deficits—such as proximity of water sources to pit latrines and open defecation remain significant contributors to water contamination and waterborne diseases, emphasizing the need for integrated water, sanitation, and hygiene (WASH) interventions (Odewade *et al.,* 2025; Okpasuo *et al.,* 2020).

2.7 How Sociodemographic Factors Influence Public Health

Sociodemographic factors function as fundamental determinants of health inequalities in Nigeria. Income inequality, limited education, gender disparities, and poor access to healthcare create systemic barriers, leading to uneven disease burden and health outcomes (Ichoku and Nwosu, 2011; Adewole *et al.,* 2023).

Income disparities restrict access to safe water, healthcare, and sanitation, compounding disease risks and healthcare costs in disadvantaged populations (Adeniran and Onisanwa, 2023).

Educational attainment enhances health literacy, preventive behaviors, and healthcare utilization, improving individual and community health (Ezeaka *et al.,* 2024).

Gender norms influence water collection duties and access to health resources, affecting women’s and children's vulnerability to contaminated water and associated diseases (Okesanya *et al.,* 2024).

Policy recommendations emphasize targeting vulnerable populations, integrating water and sanitation improvements with socioeconomic development, empowering communities, and strengthening regulation enforcement to mitigate health disparities arising from water contamination.

CHAPTER THREE

MATERIAL AND METHODS

3.1 Study Area

The study area is Ogbeson settlement, Ikpoba-Okha local government area, Benin City, Edo state. It is situated in the southern part of Edo State, Nigeria with a coordinate of 6.36° to 6.40°N and 5.60° to 5.65° E respectively.

3.2 Research Design

The study utilized both quantitative and qualitative approaches. Quantitative data were collected through structured questionnaires administered to households to assess community perceptions, water usage patterns, and reported health outcomes.

Qualitative data included water samples collected from various water sources in the community for physicochemical and bacteriological analysis.

3.3 Survey

A structured questionnaire was developed and administered to members of households in Ogbeson community to assess community perceptions of water quality and self-reported health outcomes. The questionnaire included sections on demographic characteristics, water sources and usage patterns,

perceptions of water quality (including taste, odor, color, and safety), water treatment practices, and health symptoms potentially related to water quality.

The sample size for the survey was determined using standard sample size calculation methods for cross-sectional studies, taking into account the population size, desired confidence level (typically 95%), and acceptable margin of error (typically 5%). Systematic random sampling techniques were employed to ensure representativeness of the sample. A total of 220 number questionnaires were administered to residents of the Ogbeson settlement by simple random sampling. The questionnaires were administered

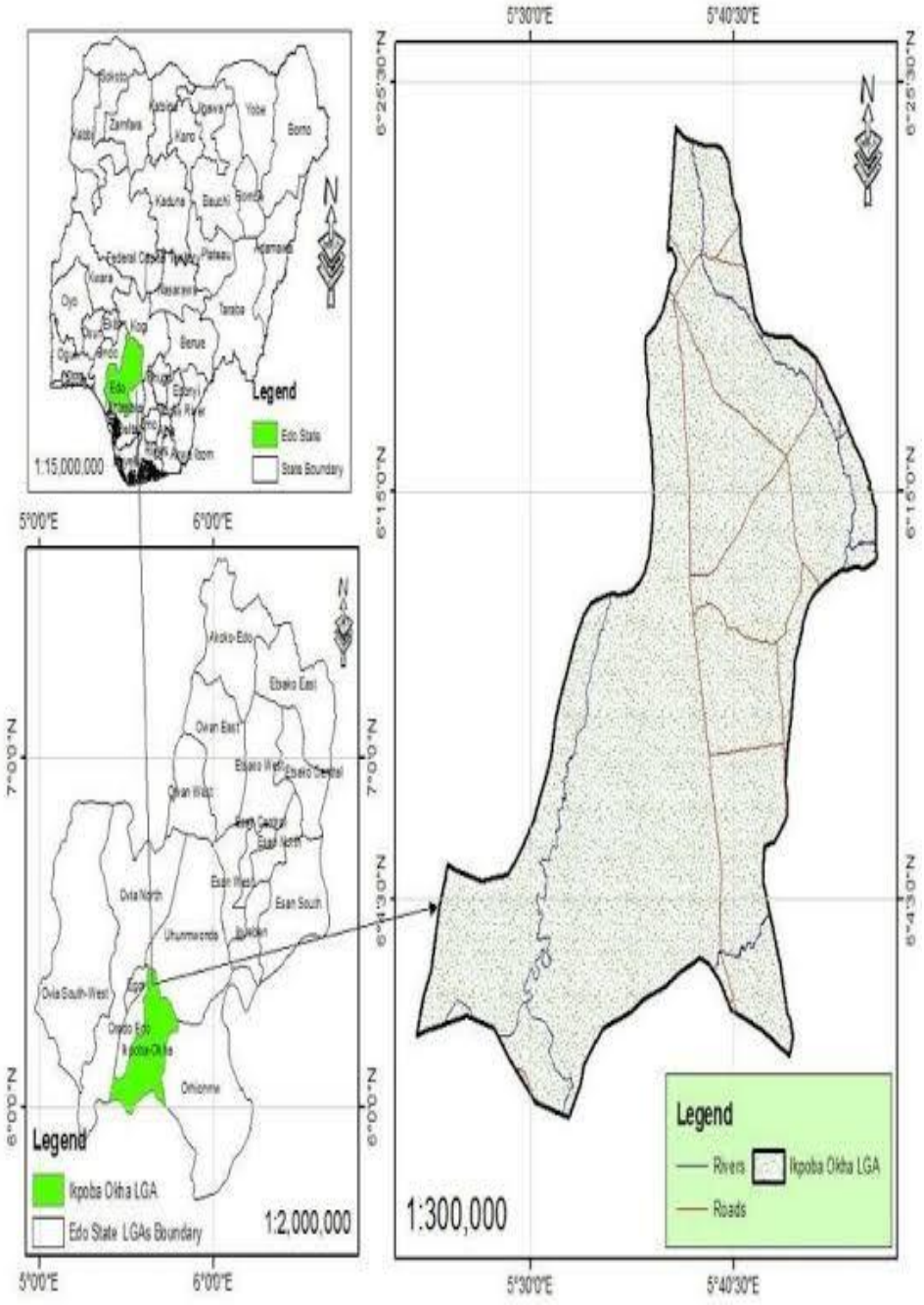

Fig 3.1 Map showing Ogbeson settlement

through face-to-face interviews to ensure clarity and completeness of responses. Data on perceptions were collected using Likert scales and binary (yes/no) responses to assess trust in water sources, perceived safety, satisfaction with water quality attributes, and concerns about health risks. The questionnaire also included open-ended questions to capture detailed information about specific concerns and experiences related to water quality.

All participants provided informed consent before participating in the survey, and confidentiality of responses was maintained throughout the study. The survey data were coded, entered into a database, and analyzed using appropriate statistical methods to describe the community.

3.4 Sample Collection

Water samples were collected from various water sources used by the community, including wells, boreholes, and stored household water. A random sampling method was employed to collect water representative of the different water sources in the community, sample collection was conducted following standard methods for water and wastewater examination as outlined by the American Public Health Association (APHA). Each water sample was identified by its collection site and the water source.

Samples were collected in sterile, non-reactive plastic bottles that had been properly cleaned, rinsed with purified water. Before sample collection, the sampling tap or point was allowed to flow for 2-3 minutes to flush out stagnant water in the pipeline. The bottles were opened just before sampling, and care was taken to avoid contamination of the bottle neck, cap, and inner surfaces.

Samples for physicochemical analysis were collected by rinsing the sampling bottle three times with the water to be sampled before final collection. The bottles were filled completely, leaving minimal air space to prevent oxidation and volatilization of constituents. Each sample bottle was properly labeled with essential information including sample identification number, location, date and time of collection, type of analysis required, and the name of the sample collector.

All samples were immediately placed in coolers containing ice packs, protected from sunlight to maintain a temperature between 1-10°C during transportation to the laboratory. A chain of custody form was maintained throughout the sampling process, documenting sample handling and transfer. Water samples were collected with the aid of clean and sterilized sample bottles which were appropriately labeled and dispatched to the Department of Chemistry laboratory at the University of Benin for physicochemical examination. Meanwhile, the duplicate samples were correspondingly transferred to the Department of pharmacy for bacteriological analysis. Samples for microbiological analysis were processed within 6 hours of collection, while samples for physicochemical analysis were analyzed within 24 hours or preserved appropriately according to standard methods.

3.5 Determination of Physicochemical Parameters

3.5.1 Hydrogen Ion Concentration (pH)

The pH of water samples was determined using a calibrated digital pH meter, Hanna HI9125 pH meter. The pH meter was first calibrated using standard buffer solutions of pH 4.0, 7.0, and 10.0 before measurements. The electrode was rinsed with distilled water and blotted dry with clean tissue paper

between measurements. The electrode was then immersed in the water sample, and the pH reading was recorded after the display stabilized. The acceptable pH range for drinking water is 6.5 to 8.5 according to WHO guidelines.

3.5.2 Electrical Conductivity

Electrical conductivity (EC) was measured using a digital conductivity meter, a TDS meter calibrated with standard potassium chloride (KCl) solutions. The conductivity probe was rinsed with distilled water and then immersed in the water sample. The meter was allowed to stabilize, and the reading was recorded in microsiemens per centimeter (µS/cm) at 25°C. Electrical conductivity provides an indication of the total dissolved ionic content in water and is directly proportional to the concentration of dissolved salts.

Plate 3.1: Source of water sample.

Plate 3.2: Source of water sample.

Plate 3.3: Source of water sample.

Plate 3**.4: Health center**

3.5.3 Nitrate

The HACH® colorimeter (DR/890) was used in the analysis of nitrate. 10mL of distilled water was measured into the blank cell. After entering the program number (54), the blank cell was used to zero the equipment by inserting it into the cell holder, replacing the cap and pressing the zero button. Samples were measured by filling the sample cell with 10mL of water samples and a reagent, one pack of NitraVer 5 nitrate powder pillow was added and mixed. The sample was allowed to stand for five (5) minutes. The nitrate concentration of the sample was then measured by inserting the sample cell into the cell holder and concentration is displayed on the screen in mg/L.

3.5.4 Total Dissolved Solids (TDS)

Total dissolved solids were determined using the gravimetric method (Method 2540 C, Standard Methods) by evaporation. A well-mixed sample of known volume (typically 50-100 mL) was filtered through a pre-weighed standard glass fiber filter (pore size 1.5-2.0 μm) to remove suspended solids. The filtrate was then transferred to a pre-weighed evaporating dish and evaporated to dryness in a drying oven at 180°C. After evaporation, the dish was cooled in a desiccator and weighed. The process of heating, cooling, and weighing was repeated until a constant weight was achieved.

The TDS concentration was calculated using the formula:

TDS (mg/L) = [(Weight of dish + residue) - (Weight of empty dish)] × 1000 / Volume of sample (mL)

Alternatively, TDS can be estimated from electrical conductivity measurements using a conversion factor (typically 0.55-0.8) specific to the water source.

3.5.6 Total Suspended Solids (TSS)

Total suspended solids were determined using the filtration method (Method 2540 D, Standard Methods). A pre-weighed standard glass fiber filter (nominal pore size 1.5 μm) was placed in a filtration apparatus. A well-mixed sample of known volume (typically 50-500 mL depending on the expected TSS concentration) was filtered through the pre-weighed filter under vacuum. The filter with the retained solids was carefully removed from the filtration apparatus and dried in an oven at 103-105°C for at least one hour until a constant weight was achieved. The filter was then cooled in a desiccator and weighed.

The TSS concentration was calculated using the formula:

TSS (mg/L) = [(Weight of filter + residue) - (Weight of filter)] × 1000 / Volume of sample filtered (mL)

The method is suitable for samples yielding total suspended solids of up to 200 mg for laboratory-scale analysis.

3.5.7 Calcium

Calcium concentration was determined by EDTA (ethylenediaminetetraacetic acid) titrimetric method (Method 3500-Ca B, Standard Methods). In this method, when EDTA is added to water containing calcium and magnesium at pH 12-13, it complexes first with calcium ions. At this high pH, magnesium is precipitated as magnesium hydroxide, and an indicator that combines with calcium only is used to detect the endpoint.

A measured volume of the water sample (typically 25-50 mL) was transferred to an Erlenmeyer flask, and the pH was adjusted to 12-13 using sodium hydroxide (NaOH) solution. Calcon indicator or a similar calcium-specific indicator was added to the sample. The solution was titrated with standardized EDTA solution (0.01 M) until the color changed, indicating that all calcium had been complexed with

EDTA. The calcium concentration was calculated from the volume of EDTA used and expressed as mg/L as calcium carbonate ($CaCO_3$).

3.5.8 Sodium

Sodium concentration was determined using flame photometry or flame atomic absorption spectrophotometry (FAAS) (Method 3500-Na B, Standard Methods). The flame photometer utilizes a low-temperature air/natural gas flame (approximately 1700°C) that excites sodium atoms, causing them to emit light at characteristic wavelengths (589.0 and 589.6 nm). The intensity of the emitted light is directly proportional to the sodium concentration in the sample.

Standard sodium solutions were prepared from sodium chloride (NaCl) at concentrations ranging from 0 to 20 mg/L to construct a calibration curve. The flame photometer was calibrated using these standard solutions. Water samples were appropriately diluted if necessary to bring the concentration within the calibration range. Each sample was aspirated into the flame photometer, and the emission intensity was measured. The sodium concentration was determined from the calibration curve and expressed in mg/L.

3.6 Procedure for Bacteriological Analysis

3.6.1 Sterilization of Materials and Apparatus

All glassware, media, and apparatus used in bacteriological analysis were properly sterilized before use to prevent contamination. Two main methods of sterilization were employed: autoclaving and dry heat sterilization.

3.6.1.1 Autoclaving: Culture media, glassware containing liquids, and heat-stable materials were sterilized using an autoclave. Materials were placed in the autoclave chamber and subjected to steam under pressure at 121°C (15 psi) for 15-30 minutes depending on the volume and type of material.

After the sterilization cycle, the autoclave was allowed to cool and depressurize before removing the sterilized materials.

3.6.1.2 Hot Air Oven: Empty glassware (Petri dishes, test tubes, flasks, pipettes), metal instruments (forceps, inoculating loops, spatulas), and materials that cannot withstand moist heat were sterilized using a hot air oven. Materials were placed in the oven and heated at 160-170°C for 60-120 minutes or at 180°C for 30 minutes. The oven was allowed to cool to room temperature before removing the sterilized materials.

3.6.2 Heterotrophic Plate Count Using Nutrient Agar

The heterotrophic plate count (HPC) method was used to estimate the total viable count of aerobic heterotrophic bacteria in the water samples. The pour plate technique using Standard Methods Agar or Nutrient Agar was employed (Method 9215, Standard Methods).

Sterile molten nutrient agar was maintained at 45-50°C in a water bath. Appropriate serial dilutions (10^{-1}, 10^{-2}, 10^{-3}) of the water sample were prepared using sterile distilled water or sterile phosphate buffer. One milliliter of each dilution was transferred aseptically to sterile Petri dishes in duplicate. Approximately 15-20 mL of molten nutrient agar was poured into each Petri dish containing the sample, and the contents were mixed by gentle swirling. The agar was allowed to solidify at room temperature.

The plates were inverted and incubated at 35-37°C for 48 hours. After incubation, colonies were counted on plates containing 30-300 colonies. The heterotrophic plate count was calculated as colony-forming units per milliliter (CFU/mL) by multiplying the number of colonies by the reciprocal of the dilution factor.

3.6.3 Coliform Plate Count Using MacConkey Agar

MacConkey agar was used for the isolation and enumeration of coliform bacteria (Method 9222, Standard Methods). MacConkey agar is a selective and differential medium containing bile salts and crystal violet that inhibit the growth of Gram-positive bacteria while allowing the growth of Gram-negative bacteria, particularly members of the Enterobacteriaceae family.

Water samples or appropriate dilutions were spread onto MacConkey agar plates using the spread plate technique or pour plate technique. For the spread plate method, 0.1 mL of the sample or dilution was dispensed onto the surface of pre-solidified MacConkey agar and spread evenly using a sterile bent glass rod. The plates were incubated at 35-37°C for 22-24 hours.

After incubation, colonies were examined for characteristic coliform appearance. Lactose-fermenting coliforms (such as *Escherichia coli* and *Klebsiella*) produce pink to rose-red colonies, often surrounded by a zone of precipitated bile, due to acid production from lactose fermentation. Non-lactose fermenters (such as *Salmonella*, *Shigella*, and *Pseudomonas*) produce colorless or pale colonies. The number of pink colonies was counted and expressed as coliform count per 100 mL of sample.

3.6.4 Phenotypic Identification of Bacteria from Samples

Bacterial isolates from the culture plates were subjected to phenotypic characterization to aid in their identification. Phenotypic identification included assessment of colony morphology and Gram staining.

3.6.4.1 Colony Morphology: Individual colonies were examined for various morphological characteristics including size (diameter in millimeters), shape (circular, irregular, filamentous), elevation (flat, raised, convex), margin (entire, undulate, lobate), texture (smooth, rough, mucoid), opacity (transparent, translucent, opaque), and pigmentation (color). These characteristics were recorded for each isolate.

3.6.4.2 Gram Staining: The Gram stain procedure was performed on bacterial isolates to differentiate bacteria as Gram-positive or Gram-negative (Method 9020, Standard Methods). A thin smear of bacterial culture was prepared on a clean glass slide and heat-fixed. The smear was stained with crystal violet (primary stain) for 1 minute, rinsed with water, and then covered with Gram's iodine (mordant) for 1 minute. The smear was decolorized with ethanol or acetone for 10-20 seconds, rinsed with water, and counterstained with safranin (counterstain) for 30-60 seconds. After rinsing and air-drying, the slide was examined under a light microscope using oil immersion (100× objective).

Gram-positive bacteria appeared purple or blue, while Gram-negative bacteria appeared pink or red. Cell morphology was also noted, including whether the bacteria were cocci (spherical), bacilli (rod-shaped), or other shapes, and their arrangement (single, pairs, chains, clusters).

3.6.5 Biochemical Tests

Biochemical tests were performed on isolated bacteria to further characterize and identify the organisms based on their enzymatic activities and metabolic properties. These tests include the following:

3.6.5.1 Triple Sugar Iron (TSI) Test

The Triple Sugar Iron (TSI) test was used to differentiate enteric bacteria based on their ability to ferment glucose, lactose, and sucrose, and to produce hydrogen sulfide (Method 8081, Standard Methods). TSI agar slants contain 0.1% glucose, 1% lactose, 1% sucrose, phenol red (pH indicator), sodium thiosulfate, and ferrous sulfate or ferrous ammonium sulfate.

A well-isolated bacterial colony was picked with a sterile inoculating needle and used to stab the butt of the TSI agar slant and then streak the surface of the slant. The tube cap was loosened to maintain aerobic conditions on the slant surface, and the tube was incubated at 35-37°C for 18-24 hours.

Results were interpreted as follows: Alkaline slant/Acid butt (K/A): Glucose fermentation only (e.g., *Shigella*, *Salmonella*), Acid slant/Acid butt (A/A): Lactose and/or sucrose fermentation (e.g., *E. coli*, *Klebsiella*), Alkaline slant/Alkaline butt (K/K): No fermentation (e.g., *Pseudomonas*), Black precipitate: Hydrogen sulfide (H_2S) production (e.g., *Salmonella*, *Proteus*), Gas production: Indicated by cracks or bubbles in the agar (e.g., *E. coli*).

3.6.5.2 Bile Esculin Test

The bile esculin test was performed to differentiate enterococci and Group D streptococci from other bacteria based on their ability to hydrolyze esculin in the presence of bile salts (4% bile). Bile esculin agar contains esculin, bile salts, and ferric ammonium citrate.

Bacterial isolates were streaked onto bile esculin agar and incubated at 35-37°C for 24-48 hours. A positive test was indicated by growth in the presence of bile and the development of a dark brown to black color in the medium, resulting from the reaction between esculetin (the hydrolysis product of esculin) and ferric ions. Enterococci and Group D streptococci typically produce positive results, while most other bacteria are either inhibited by bile salts or unable to hydrolyze esculin.

3.6.5.3 Citrate Utilization Test

The citrate utilization test was performed to determine the ability of bacteria to utilize citrate as the sole source of carbon and energy (Method 8090, Standard Methods). Simmons citrate agar slants containing sodium citrate (carbon source), ammonium phosphate (nitrogen source), and bromothymol blue (pH indicator) were used.

A bacterial colony was picked with a sterile inoculating loop and lightly streaked onto the surface of the citrate agar slant. The tube was incubated at 35-37°C for 24-96 hours. A positive test was indicated by growth on the slant and a color change of the medium from green to bright blue, indicating

alkalinization due to citrate utilization. Organisms such as *Salmonella*, *Klebsiella*, and *Enterobacter* are citrate-positive, while *E. coli* and *Shigella* are citrate-negative.

3.6.5.4 Hektoen Enteric Agar

Hektoen Enteric (HE) agar was used as a selective and differential medium for the isolation and differentiation of *Salmonella* and *Shigella* species from other enteric bacteria. HE agar contains bile salts (for selective inhibition of Gram-positive bacteria and some Gram-negative bacteria), lactose, sucrose, and salicin (fermentable carbohydrates), bromothymol blue and acid fuchsin (pH indicators), sodium thiosulfate, and ferric ammonium citrate (for detection of hydrogen sulfide production).

Water samples or bacterial suspensions were streaked onto HE agar plates and incubated at 35-37°C for 18-24 hours. After incubation, colonies were examined for characteristic appearance: *Salmonella spp.*: Blue-green colonies with or without black centers (indicating H_2S production), *Shigella spp.*: Green, transparent colonies, Lactose, sucrose, or salicin fermenters: Salmon-colored to orange-pink colonies (e.g., *E. coli*)

Presumptive identification based on colony appearance on HE agar should be confirmed by additional biochemical and serological tests.

CHAPTER FOUR

RESULT

The results from the questionnaire survey covering the socio-demographic data of the residents of Ogbeson, their perceptions towards water quality, accessibility and availability, their health status and their awareness level towards WASH practices is presented in tables 4.1, 4.2 and 4.3 respectively. A total of 220 persons responded to the questionnaires.

Table 4.1 shows the socio-demographic characteristics of Ogbeson survey respondents of which 41.4% were females while the majorities were males (58.6%). The highest percentage of respondents fell within the age range of 20 to 29 years (31.4%). Respondents had secondary level education (35.5%), primary level education (19.3%), tertiary education (49.5%), no level of formal education (7.3%), vocational education (6.8%), with quaranic education (0.5%) being the lowest. The occupation of most of the respondents were traders (30%). Majority of the respondents had a household size ranging between 4-6 persons (64.1%). Most respondents were married (44.1%) and Christian (82.7), whereas, the most prevalent monthly household income was N100,000-N150,000 (37.3%).

Table 4.2 shows the perception of respondents towards water quality, availability and accessibility. As shown in table 4.2, the main source of drinking water of most respondents in the area was borehole water (46.4 %) which was located within less than 100 meters of their homes (69.1 %). Meanwhile, 46.4 % of the respondents had access to clean drinking water. 74.1% of respondents treat their drinking water before use with boiling being the most prevalent method of water treatment used by respondents at 82.8%. 54.1% of respondents have faced issues with their water supply and intermittent supply was the most occurring problem (61.4%) and poor taste coming in second at 35.4%. Furthermore, 78% of respondents stated that their main water source was reliable throughout the year, while 21.4% experienced ir-reliability with this problem occurring mainly during the dry season (94.2%). In the case of problems with their main water source respondents have bottled water 48.2%, borehole 44.2%, well

25.1%, rain water 23.1%, river 9%. In addition, most of the respondents stored their water in a covered container (88.2%).

The results of health status and their awareness level towards WASH practices of respondents in Ogbeson are shown in table 4.3. 57.3% of respondents stated that the no member of their family had experienced illnesses after consuming water while 42.7% of respondents stated that they and members of their family have experienced the occurrence of illnesses upon the consumption of water. Data on water borne diseases experienced was collected, majority (55.7%) indicated that they had experienced Typhoid, 42.3% stated they or some of their family members had experienced Diarrhea, 7.2% stated that they and members of their family had experienced Dysentery, 8.2% stated that they and/or some of their family members has experienced Cholera, and 4.1% experienced other illnesses. 46.5% of respondents stated that they or some of their family members occasionally fell ill and 45.2% stated that they or some of their family members rarely fell ill. Respondents(16.3%) stated that there is a sanitation community program available in the community, well, 82.3% of the respondents disagreed, stating that there is no community WASH program available in the community. 16.8% of respondents have participated in WASH related programs while 82.3% stated that they have not participated in any of such programs. 18.6% stated that they were very aware of the importance of WASH practices, 33.2% stated that they were somewhat aware of the importance of WASH practices, 27.7% stated that they were not very aware of the importance of WASH practices, 18.6% stated that they were not aware at all of the importance of WASH practices. It was also observed that 78.8% of the respondents stated that they get their information regarding WASH from the Radio-TV/Social Media, 18.5% of respondents stated that their source of information is from community meetings, 28.2% stated that their source of information is from posters, flyers, school, while 6.2% of respondents stated that their source of information regarding WASH is from other sources. Result shows that respondents (85.5%) stated that the community laced adequate WASH facilities, while 13.6% of respondents disagreed, stating that the

community had adequate WASH facilities. The result show that on the WASH facilities lacked by the community 58.6% stated clean water supply, 75.8% for toilets, 87.1% for hand washing stations, 78.5% for waste disposal systems, 79% for public awareness programs and 3.21 for others. 91% of respondents and members of their family have access to healthcare and 9% do not. Majority of the respondents had the health center within less than 1-5km of their homes and 55.7% respondents rated the quality of care at the health center as good, 33.6% as fair, 4.5% as poor and 2.7% as excellent.

The results of the physicochemical quality of the water samples collected from water samples A - O are indicated in table 4.4 below. The pH of the water samples ranged from 4.43 (WSN) to 6.37 (WSE). The Electrical Conductivity (EC) ranged from 8.3 (WSF) to 126.8 (WSO) µS/cm, which is within the WHO standard of 400 µS/cm. The Total Dissolved Solids (TDS) from ranged from 4.57 (WSF) to 69.74 (WSO) mg/l. This range was within the WHO recommended standards (WHO, 2011). The Total Suspended Solids (TSS) concentrations ranged from 0.003 (WSD) to 0.008 (WSM) mg/l. Sodium concentration present in water samples were in varying concentrations, ranging from 0.2 (WSD) to 18.8(WSE) mg/l. Calcium concentrations were detected in all fifteen samples, ranging from 0.01 (WSC) to 0.04 (WSO) mg/l. Nitrate concentrations ranged from 52.17 (WSL) to 92.47 (WSO) mg/l. Iron (Fe) concentrations ranged from 0.01 (WSC) to 0.04 (WSO) mg/l.

The findings of the enumeration of the heterotrophic bacterial counts (THC) and total presumptive coliform counts (TPC) of the water samples are shown in table 4.5 below. For THC, the table indicates that the highest count was from Water sample K while several other water samples show zero coliform count. For TPC, the table indicates that the highest coliform count was found in Water sample E while while several other water samples show zero coliform count.

Table 4.5 shows the bacteria isolated from the water samples based on their cultural, morphological characteristics and biochemical tests. They are *Klebsiella pneumoniae, Bacillus subtilis, Bacillus cereus,*

Corynebacterium, Staphylococus aureus, Pseudomonas fluorescens, Pseudomonas fluorescens, Escherichia coli.

Table 4.1: Socio-demography of respondents in Ogbeson community

S/N	Parameters	Category/Option	Frequency(n)	Percent(%)
1.	**Sex**	Female	91	41.4
		Male	129	58.6
		Total	***220***	***100***
2.	**Age**	10-19	22	10
		20-29	69	31.4
		30-39	42	19.1
		40-49	42	19.1
		50-59	31	14
		60-69	10	4.5
		70-79	3	1.4
		80-89	1	0.5
		Total	***220***	***100***
3.	**Occupation**	Farmer	20	9.1
		Trader	66	30
		Student	46	20.9
		Civil servant	38	17.3
		Artisan	25	11.4
		Unemployed	17	7.7
		Other	8	3.6
		Total	***220***	***100***
4.	**Educational Level**	No formal education	16	7.3
		Vocational	15	6.8

		Quaranic	1	0.5
		Primary school	6	2.7
		Secondary school	78	35.5
		Tertiary education	109	49.5
		Total	***220***	***100***
5.	**Household Size**	1-3	47	21.4
		4-6	141	64.1
		7-9	26	11.8
		10-14	6	2.7
		Total	***220***	***100***
6.	**Marital status**	Single	100	45.5
		Co-habiting	8	3.6
		Married	97	44.1
		Separated	5	2.3
		Divorced	1	0.5
		Widowed	9	4.1
		Total	***220***	***100***
7.	**Monthly household Income**	Below N10,000	5	2.3
		N10,000-N50,000	12	5.5
		N50,001-N100,000	49	22.3
		N100,001-N150,000	82	37.3
		Above N150,000	73	33.2
		Total	***220***	***100***

8.	**Religion**	Christianity	182	82.7
		Islam	8	3.6
		Traditional religion	24	10.9
		Others	7	3.2
		Total	***220***	***100***

Table 4.2: Water access and availability in Ogbeson community.

S/N	Parameter	Category/option	Frequency(n)	Percent(%)
1.	What is your main source of drinking water ?	River/ stream	2	0.9
		Well	22	10
		Borehole	102	46.4
		Rainwater	7	3.2
		Piped water	1	0.5
		Bottled/Sachet water	86	39.1
		Total	***220***	***100***
2.	How far is the main source of drinking water from your home?	Less than 100 meters	152	69.1
		100-500 meters	57	25.9
		500-1000 meters	10	4.5
		More than 1000 meters	4	1.8
		Total	***220***	***100***
3.	How often do you have access to clean	Always	85	38.6

	drinking water?			
		Most of the time	102	46.4
		Sometimes	26	11.8
		Rarely	7	3.2
		Never	1	0.5
		Total	***220***	***100***
4.	Do you treat your drinking water before use?	Yes	56	25.45
		No	163	74.1
		Abstain from answering	1	0.45
		Total	***220***	***100***
5.	If "yes", what method do you use to treat your water?(Multiple choice question)	Boiling	53	82.8
		Filtration	11	17.2
		Chemical treatment	5	7.8
		other	3	4.7
6.	Have you ever faced any problems with	Yes	119	54.1

	your water supply?			
		No	101	45.9
		Total	***220***	***100***
7.	If “yes”, what kind of problems(Multiple choice question)	Contamination	34	26.8
		Intermittent supply	78	61.4
		Poor taste	45	35.4
		Bad odour	28	22
		High cost	36	28.3
		Other	1	0.8
8.	Is your main water source reliable throughout the year?	Yes	172	78
		No	47	21.4
		Abstained from answering	1	0.5
		Total	***220***	***100***
9.	If “no”, which seasons do you face water scarcity(Multiple	Dry season	49	94.2

	choice question)			
		Rainy season	6	11.5
10.	Do you have access to alternative water sources in case of main water source failure?	Yes	196	89
		No	23	10.5
		Abstained from answering	1	0.5
		Total	***220***	***100***
11.	If "yes", what are the alternative water sources?	River/Stream	18	9
		Well	50	25.1
		Borehole	88	44.2
		Rainwater	46	23.1
		Bottled/Sachet water	96	48.2
12.	How do you store your drinking water?	Covered container	194	88.2

Uncovered container	4	1.8
Other	19	8.6
Abstained from answering	3	1.4
Total	***220***	***100***

Table 4:3 Health status and their awareness level towards WASH practices of respondents in Ogbeson community.

S/N	Parameter	Category/Option	Frequency(n)	Percent(%)
1.	Have you or any member of your household experienced any illness after drinking water in the past year?	Yes	94	42.7
		No	126	57.3
		Total	***220***	***100***
2.	If "yes", what type of waterborne diseases	Diarrhea(Loose stools)	41	42.3
		Cholera	8	8.2
		Typhoid	54	55.7
		Dysentery(loose stools with blood)	7	7.2
		Other	4	4.1
3.	How often do you or your family	Rarely	98	45.2

	members fall ill?(Multiple choice questions)			
		Occasionally	101	46.5
		Frequently	13	6
		Very frequently	5	2.3
		Abstained from answering	3	1.4
		Total	***220***	***100***
4.	Are there any community programs focused on improving WASH in your area?	Yes	37	16.8
		No	181	82.3
		Abstained from answering	2	0.9
5.	Have you participated in any WASH-related programs or training	Yes	36	16.4
		No	182	82.7
		Abstained from answering	2	0.9

		Total	***220***	***100***
6.	How aware are you of the importance of WASH practices?	Very aware	41	18.6
		Somewhat aware	73	33.2
		Not very aware	61	27.7
		Not aware at all	41	18.6
		Abstained from answering	4	1.8
		Total	***220***	***100***
7.	How do you receive information about WASH practices?(Multiple choice question)	Community meetings	27	18.5
		Radio/TV-Social media	115	78.8
		Posters, flyers, school	43	28.2
		Other	9	6.2
8.	Do you think that your community has adequate WASH facilities?	Yes	30	13.6

		No	188	85.5
		Abstained from answering	2	0.9
		Total	***220***	***100***
9.	If “no”, what facilities do you think are lacking?(Multiple choice question)	Clean water supply	109	58.6
		Toilets	141	75.8
		Hand washing station	162	87.1
		Waste disposal systems	146	78.5
		Public awareness programs	147	79
		Others	6	3.21
10.	Do you or your family members have access to healthcare?	Yes	200	91
		No	20	9
		Total	***220***	***100***
11.	How far is the	Less than 1km	43	19.5

	nearest health care facility from your home?			
		1-5 km	96	43.6
		5-10 km	64	29.1
		More than 10km	16	7.3
		Abstained from answering	1	0.5
		Total	***220***	***100***
12.	How would you rate the quality of healthcare services available in your community?	Excellent	6	2.7
		Good	127	57.7
		Fair	74	33.6
		Poor	10	4.5
		Abstained from answering	3	1.4
		Total	***220***	***100***

Table 4.4: Physicochemical parameters of water samples collected from Ogbeson settlement

S/N	Studied location	Parameters							
		pH	**EC (µS/cm)**	**TDS (Mg/l)**	**TSS (Mg/l)**	**Na (Mg/l)**	**Ca (Mg/l)**	**NO3 (Mg/l)**	**FE (Mg/l)**
1.	WHO	6.5-8.5	400	1000	25	NS	75	50	0.3
2.	WSA(B_1)	5.15	68.7	37.79	0	4	0.2	81.21	0.01
3.	WSB(R_1)	5.81	76.6	42.13	0	4.4	0.9	63.83	0.01
4.	WSC(B_2)	5.4	94.8	52.14	0.01	11.4	1	77.12	0.01
5.	WSD(B_3)	5.75	9.7	5.34	0	0.2	0.1	54.62	ND
6.	WSE(S_1)	6.37	104.7	57.59	0.01	18.8	0.1	85	0.02
7.	WSF($R_{2)}$)	6.21	8.3	4.57	0	0.3	0.4	58.61	ND
8.	WSG(B_4)	5.04	94.1	51.76	0.01	11.2	0.2	79.88	0.01
9.	WSH(B_5)	5.15	105.8	58.19	0.01	12	0.9	78.45	0.02
10.	WSI(B_6)	5.29	115.9	63.75	0.01	12.5	1.2	80.91	0.02
11.	WSJ(B_7)	6.23	75.5	41.53	0	9.9	0.2	69.55	0.01
12.	WSK(B_8)	4.75	118.5	65.18	0.01	12.4	0.9	78.65	0.03
13.	WSL(S_2)	6.28	58.4	32.12	0.01	7.9	0.4	52.17	0.01
14.	WSM(B_9)	4.57	107.3	59.02	0.01	13.7	0.5	84.59	0.02
15.	WSN(R_1)	4.43	111.5	61.33	0.01	11.2	0.6	62.19	0.02
16.	WSO(B_{10})	4.51	126.8	69.74	0.01	16.8	0.4	92.47	0.04

Key: WSA (Water sample A), WSB (Water Sample B), WSC (Water Sample C), WSD (Water Sample D), WSE (Water Sample E), WSF (Water Sample F), WSG (Water Sample G), WSH (Water Sample H), WSI (Water Sample I), WSJ (Water Sample J), WSK (Water Sample K), WSL (Water Sample L), WSM (Water Sample M), WSN (Water Sample N), WSO (Water Sample O), R_1-R_2(Rainwater), B_1- B_{10}-(Borehole), S_1- S_2-(Sachet water), Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Sodium (Na), Calcium (Ca), Nitrate (NO3), Iron (Fe), NS (Not stated), World Health Organization recommended standards (WHO*).

Table 4.5: Enumeration of bacterial population in water samples collected from Ogbeson community.

Water Sample	Parameters	
	THC(cfu/100ml)	**TPC(cfu/100ml)**
WSA($S_{1)}$	$1.9x10^4$	0
WSB(S_2)	$1.75x10^4$	0
WSC(T_1)	$1.0x10^5$	$5x10^2$
WSD(T_2)	—	$5x10^2$
WSE(B_1)	$2.25x10^5$	$1.25x10^5$
WSF(B_2)	$1.75x10^5$	$1.35x10^3$
WSG(B_3)	0	0
WSH(B_4)	0	0
WSI(B_5)	0	0
WSJ(B_6)	0	0
WSK(B_7)	$2.9x10^5$	$5x10^4$
WSL(B_8)	$7.5x10^3$	$5x10^2$
WSM(B_9)	$1.25x10^3$	0
WSN(R_1)	$2.75x10^3$	0
WSO(R_2)	$7.5x10^4$	$1x10^3$

Keys: Total Heterotrophic count (THC), Total presumptive coliform count(TPC), WSA (Water sample A), WSB (Water Sample B), WSC (Water Sample C), WSD (Water Sample D), WSE (Water Sample E), WSF (Water Sample F), WSG (Water Sample G), WSH (Water Sample H), WSI (Water Sample I), WSJ (Water Sample J), WSK (Water Sample K), WSL (Water Sample L), WSM (Water Sample M), WSN (Water Sample N), WSO (Water Sample O),R_1-R_2(Rainwater), B_1- B_{10}-(Borehole), S_1- S_2-(Sachet water).

Table 4.6: Cultural and morphological characterization of isolates

Samples	Gram	Ox	Cit	Indole	Cat	Coup	Lact	Succ	Glu	Malt	Isolates
(R_1)	GNB	-	+	-	+	-	NR	NG	NG	NR	*Klebsiella pneumoniae*
	GPB	-	+	-	+	-	NR	NR	A	A	*Bacillus cereus*
(R_2)	GPB	-	+	-	+	-	NR	A	A	A	*Bacillus subtilis*
(B_1)	GNB	-	+	-	+	-	NR	NG	NG	NR	*Klebsiella pneumoniae*
(B_2)	GNB	-	+	-	+	-	NR	NG	NG	NR	*Klebsiella pneumoniae*
	GPB	-	-	-	+	-	NR	NR	A	A	*Corynebacterium*
(B_7)	GNB	-	+	-	+	-	NR	NG	NG	NR	*Klebsiella pneumoniae*
(B_8)	GNB	+	+	-	+	-	NR	NR	NR	NR	*Pseudomonas fluorescens*
(B_9)	GPB	-	+	-	+	-	NR	NR	A	A	*Bacillus cereus*
(T_1)	GNB	+	-	-	+	-	NR	NR	NR	NR	*Pseudomonas fluorescens*
(T_2)	GNB	+	-	-	+	-	NR	NR	NR	NR	*Pseudomonas aeruginosa*

(S_1)	GPC	-	-	-	+	+	A	A	A	A	*Staphylococcus aureus*
(S_2)	GPB	-	+	-	+	-	NR	NR	A	A	*Bacillus cereus*
	GPC	-	-	-	+	+	A	A	A	A	*Staphylococcus aureus*
($T_{2(2)}$)	GNB	-	+	-	+	-	A	A	NG	NG	*Escherichia coli*

Key: GNB(Gram-negative bacteria), GPB(Gram-positive bacteria), GPC(Gram-positive cocci), NR(Non-reactive), NG(No growth), A(positive), -(Negative), +(Positive).
Klebsiella pneumoniae, Bacillus subtilis, Bacillus cereus, Corynebacterium, Staphylococcus aureus, Pseudomonas fluorescens, Pseudomonas fluorescens, Escherichia coli

CHAPTER FIVE

DISCUSSION

The result of this study shows Ogbeson community to be a community with varying socio-demographic characteristics. The sample consisted of 58.6% males and 41.4% females, with the majority (31.4%) falling within the 20-29 years age range. The predominance of tertiary education level (49.5%) among respondents indicates a relatively educated population, which has significant implications for health behavior and perception of water quality. Higher education levels are typically associated with better health literacy and awareness of water safety risks (Nauges and Denny, 2009). However, despite this educational profile, the study demonstrated substantial gaps between perceived water quality and actual water quality conditions, suggesting that education alone is insufficient to translate knowledge into protective behaviors and accurate risk perception.

The socio-demographic data showed that 64.1% of households had 4-6 members, which is consistent with typical household sizes in rural Nigerian communities. Household size can influence water collection practices, storage methods, and the likelihood of waterborne disease transmission. Larger households with greater water demand may face increased challenges in accessing and storing sufficient quantities of safe water, thereby increasing the risk of contamination during storage and handling (Majuru et al., 2019). The predominant occupation of traders (30%) reflects the informal economy characteristic of many rural communities, which often correlates with variable and sometimes inadequate income. The most prevalent monthly household income bracket (N100,000-N150,000; 37.3%) suggests moderate income levels, yet this may still be insufficient for households to invest in alternative water sources such as bottled water during water supply disruptions.

The results demonstrated that 46.4% of respondents utilized boreholes as their primary drinking water source, with 69.1% located within less than 100 meters from homes. While the proximity to water sources is favorable, suggesting relatively good accessibility, the study revealed critical discrepancies between perceived and actual water quality. Importantly, only 46.4% of respondents reported always

having access to clean drinking water, indicating that while the water sources are physically available and accessible, they do not necessarily provide consistent access to potable water (Nauges and Denny, 2009; Ochoo *et al.*, 2024).

In this study, 74.1% of respondents reported treating their drinking water before consumption, with boiling being the predominant method (82.8%). This high prevalence of water treatment suggests that respondents perceive risks associated with their water sources, which aligns with research indicating that higher perceived risk motivates households to adopt protective behaviors (Nauges and Denny, 2009). Boiling is effective at reducing microbial contamination, with studies showing that boiling results in an average 1.8 $\log_{10}$ reduction in E. coli, representing a 98.5% reduction in bacterial contamination (Brown and Sobsey, 2012).

The study population demonstrated relatively high education levels and moderate income levels, yet these factors did not translate into optimal water management practices or accurate risk perception. This finding aligns with research indicating that socioeconomic factors influence but do not solely determine water quality perception and protective behavior adoption (Munene *et al.,* 2019). Studies have shown that higher income and education are sometimes associated with greater adoption of water treatment and testing behaviors, but these relationships are not consistently linear or universal (Munene *et al.,* 2019).

The prevalence of water boiling among respondents (74.1%) despite moderate awareness levels suggests that behavioral practices may be influenced by cultural norms, past experience with waterborne illness, or passive information dissemination rather than comprehensive health knowledge. Research indicates that observed behavior change in response to health risks can occur through various pathways, including health beliefs, social norms, and practical constraints related to water availability (Vosa *et al., 2025*).

However, the water quality challenges identified through laboratory analysis were substantial. The physicochemical analysis showed that while pH values ranged from 4.43 to 6.37, several samples fell

below the WHO recommended range of 6.5-8.5, indicating acidic water conditions (WHO, 2011). Notably, 55.7% of respondents reported experiencing typhoid fever among household members, while 42.3% reported diarrhea cases. These health outcomes are consistent with the microbiological analysis findings, which revealed the presence of pathogenic bacteria including *Klebsiella pneumoniae, Escherichia coli, Bacillus cereus,* and *Pseudomonas* species in water samples.

The study found that 54.1% of respondents had experienced problems with their water supply, with intermittent supply being the most frequently reported issue (61.4%). Importantly, 21.4% of respondents experienced unreliability of their main water source, predominantly during the dry season (94.2%). Water supply intermittency poses significant public health challenges. Research indicates that intermittent water supply is associated with increased water storage duration and unsafe handling practices, which facilitate microbial recontamination (Ercumen *et al.*, 2015; Wu *et al*., 2023). Studies from rural areas have demonstrated that households experiencing water intermittency exhibit a significantly increased probability of unhealthy status, with the probability increasing by 18.2% compared to those with continuous water supply (Wu *et al*., 2023).

In response to water supply unreliability, 89% of respondents maintained alternative water sources. The primary alternatives were bottled/sachet water (48.2%), boreholes (44.2%), and wells (25.1%). The reliance on bottled and sachet water as backup sources reflects a behavioral adaptation to perceived risk, which is consistent with findings from other developing contexts showing that communities respond to water quality violations through averting actions such as purchasing bottled water (Dewees and Vedavati, 2019). However, this coping strategy has significant economic implications for low-income households and may not represent optimal protective behavior in terms of environmental sustainability.

The overwhelming majority (88.2%) of respondents stored their drinking water in covered containers, indicating reasonable awareness of the importance of protecting stored water from environmental contamination. This storage practice aligns with WHO recommendations for preventing secondary contamination of stored water (Majuru *et al*., 2019). However, the presence of coliforms and other

pathogenic bacteria in water samples suggests that covered container storage alone may be insufficient without complementary practices such as appropriate water handling methods, hand hygiene, and proper container cleaning.

The health status findings revealed a substantial burden of waterborne disease in Ogbeson community. Among the 42.7% of respondents reporting water-related illnesses, typhoid fever (55.7%) was the most prevalent, followed by diarrhea (42.3%), cholera (8.2%), and dysentery (7.2%). The prevalence of typhoid fever is particularly concerning, as this disease is transmitted through contaminated water and indicates fecal contamination of water sources. Typhoid fever remains a significant public health burden in low- and middle-income countries, with an estimated 11-20 million cases annually worldwide, predominantly in regions with inadequate water and sanitation infrastructure (Bwire *et al*., 2019).

The significant proportion of respondents reporting waterborne illness (42.7%) demonstrates the acute public health challenge facing the community. Diarrheal diseases remain the second leading cause of death among children under five globally, and research indicates that approximately 1.7 to 5 billion cases of diarrhea occur annually worldwide (Bwire *et al*., 2019). The finding that 46.5% of respondents reported that household members occasionally fall ill and 45.2% reported rarely falling ill suggests a high frequency of acute illness episodes in the community. The seasonal variation in water supply reliability, with particular challenges during the dry season, likely contributes to seasonal variations in waterborne disease incidence.

Despite the educational profile of respondents, awareness levels regarding WASH practices demonstrated concerning gaps. Only 18.6% of respondents reported being very aware of the importance of WASH practices, while 33.2% were somewhat aware, 27.7% were not very aware, and 18.6% were not aware at all. This distribution indicates that approximately 46.3% of respondents lack adequate awareness of WASH importance despite living in a community with documented waterborne disease burden.

Critically, 82.3% of respondents reported that no community WASH programs were available, and only 16.8% had participated in any WASH-related programs or training. This absence of community-based WASH initiatives represents a major missed opportunity for behavioral change and health improvement. Research demonstrates that community-engaged WASH education programs can significantly improve water handling practices, latrine coverage, and personal hygiene behaviors (Derib *et al*., 2020). The WHO reports that hand washing with soap can reduce diarrhea incidence by 47%, while sanitation interventions can achieve 36% reduction in diarrhea, and water quality interventions can achieve 19% reduction (WHO, 2012).

The study revealed that media outlets were the predominant source of WASH information, with 78.8% of respondents reporting radio/TV/social media as their primary information source. In contrast, only 18.5% received information from community meetings, and 28.2% from posters, flyers, and schools. Media-based communication, while reaching a wide audience, is often limited by its one-way nature and lack of participatory engagement. Research indicates that while mass media campaigns can raise awareness and influence attitudes, they are rarely sufficient as standalone interventions without reinforcement through participatory communication methods involving health workers or community promoters . A comprehensive WASH campaign in Ghana that combined mass media and community events achieved a 30% increase in WASH practices, with television having greater impact than radio alone (Njuguna *et al*., 2019).

The findings revealed critical infrastructure deficits in Ogbeson community. While 91% of respondents reported having access to healthcare facilities, the assessment of WASH infrastructure showed concerning gaps, 85.5% of respondents stated that the community lacked adequate WASH facilities. Among the specific deficiencies identified, hand washing stations were most lacking (87.1%), followed by waste disposal systems (78.5%), public awareness programs (79%), toilets (75.8%), and clean water supply (58.6%). These infrastructure gaps represent fundamental barriers to WASH practice implementation and disease prevention.

The absence of adequate hand washing stations is particularly significant given that hand hygiene is one of the most effective interventions for preventing waterborne and other infectious diseases. The WHO estimates that hand washing with soap can reduce diarrhea incidence by 47%, yet this intervention remains inaccessible to much of the Ogbeson community (WHO, 2012). Similarly, inadequate waste disposal systems and toilet facilities perpetuate fecal-oral transmission pathways and contribute to environmental contamination of water sources.

The study found that 91% of respondents had access to healthcare, with 43.6% having healthcare facilities within 1-5 km of their homes. Notably, 57.7% of respondents rated the quality of care as good, and 33.6% as fair.

The physicochemical analysis provided objective measures of water quality that explained reported health problems. Total coliform and E. coli detection in water samples confirmed fecal contamination and a breach in drinking water safety. The isolated bacterial species, including *Klebsiella pneumoniae, E. coli,* and *Bacillus cereus,* are established waterborne pathogens and fecal indicators. Klebsiella species are known to cause nosocomial and community-acquired infections, while E. coli, particularly pathogenic strains, causes diarrheal disease and dysentery (Taiwo *et al.,* 2025). Pseudomonas species, detected in several samples, are opportunistic pathogens that can cause severe infections, particularly in immunocompromised individuals (Wong *et al.,* 2011).

The presence of elevated nitrate concentrations (ranging from 52.17 to 92.47 mg/L) in several samples is concerning, as the WHO guideline for nitrate in drinking water is 50 mg/L. Elevated nitrate levels may indicate agricultural runoff or sewage contamination and pose particular risks to infants (causing methemoglobinemia) and potentially to adults with emerging evidence suggesting associations with colorectal cancer and thyroid disease (Aleku *et al.,* 2024)).

A critical finding of this study is the discrepancy between community members' perceptions of water quality and actual laboratory-confirmed contamination. While respondents reported high confidence in their water sources (78%) believed their main source was reliable throughout the year), the

microbiological analysis revealed pathogenic contamination in multiple samples. This perception-reality gap has significant implications for behavior change and health promotion interventions.

Research indicates that this gap is common in developing countries and is influenced by multiple factors including education level, information sources, past health experiences, and sensory characteristics of water (Jaji *et al.,* 2007)). The gap can be explained by the fact that water contamination, particularly microbial contamination, is not visible to the naked eye, whereas respondents often assess water quality based on sensory attributes such as color, taste, and odor. Intervention studies have demonstrated that providing objective water quality information can shift perceptions among households initially optimistic about their water quality, particularly those with lower education and socioeconomic status (Vosa *et al.,* 2025).

CONCLUSION

This study has completely evaluated community perceptions of water quality and their relationship to health outcomes in Ogbeson community, the evaluation of community perceptions of water quality and health outcomes in Ogbeson community reveals that while community members demonstrate reasonable knowledge and awareness levels, substantial gaps exist between perceived and actual water quality, between knowledge and behavioral practice, and between community need and available WASH infrastructure. The findings reveal a complex situation characterized by significant gaps between perceived water quality and actual contamination, insufficient WASH awareness and infrastructure despite reasonable educational levels, and a substantial burden of waterborne disease affecting the community. The significant burden of waterborne diseases, particularly typhoid fever and diarrhea, reflects these gaps and indicates an urgent need for comprehensive interventions addressing water supply infrastructure, WASH facilities, and community engagement in behavior change and advocacy. Addressing these challenges requires multisectoral collaboration involving water service providers, health authorities, community leaders, and community members in participatory planning and implementation of integrated WASH interventions. The ultimate goal should be achievement of universal access to safe water, adequate sanitation, and hygiene as fundamental requirements for human health and dignity, and as essential steps toward attainment of Sustainable Development Goal

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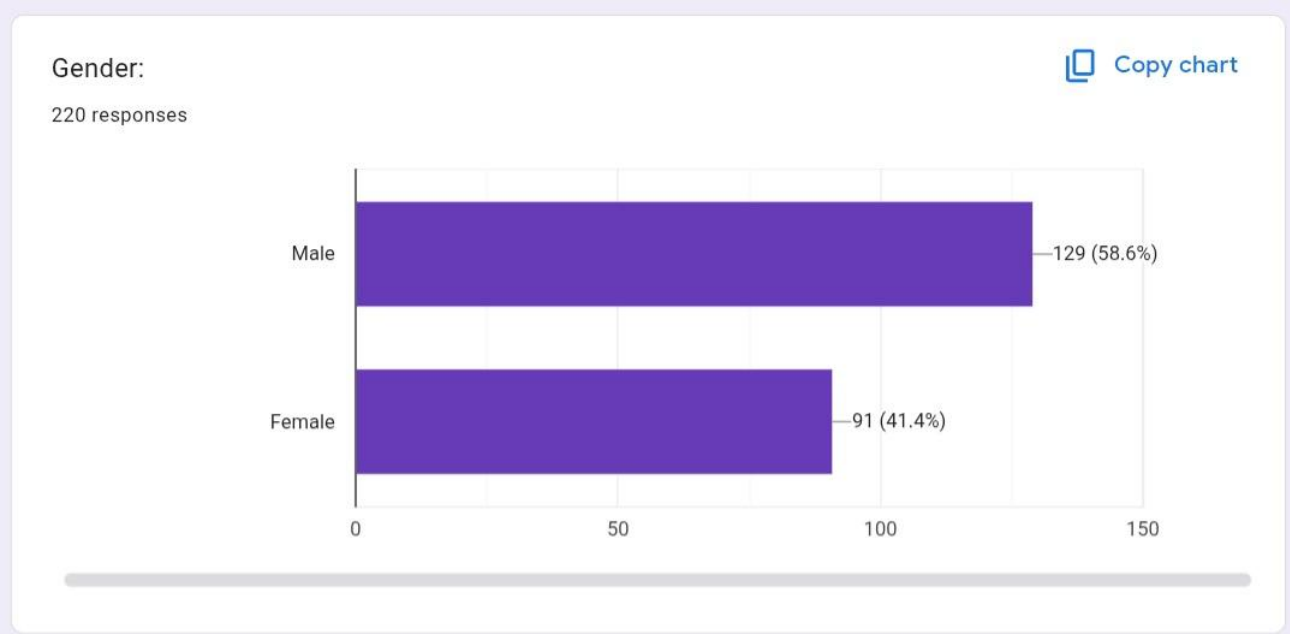
APPEDICES

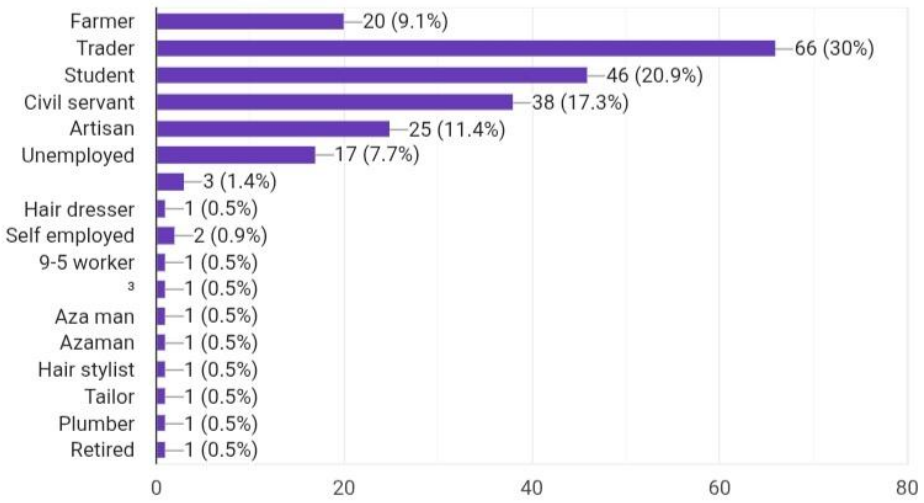


Appendix 1.1: Graph of Gender distribution

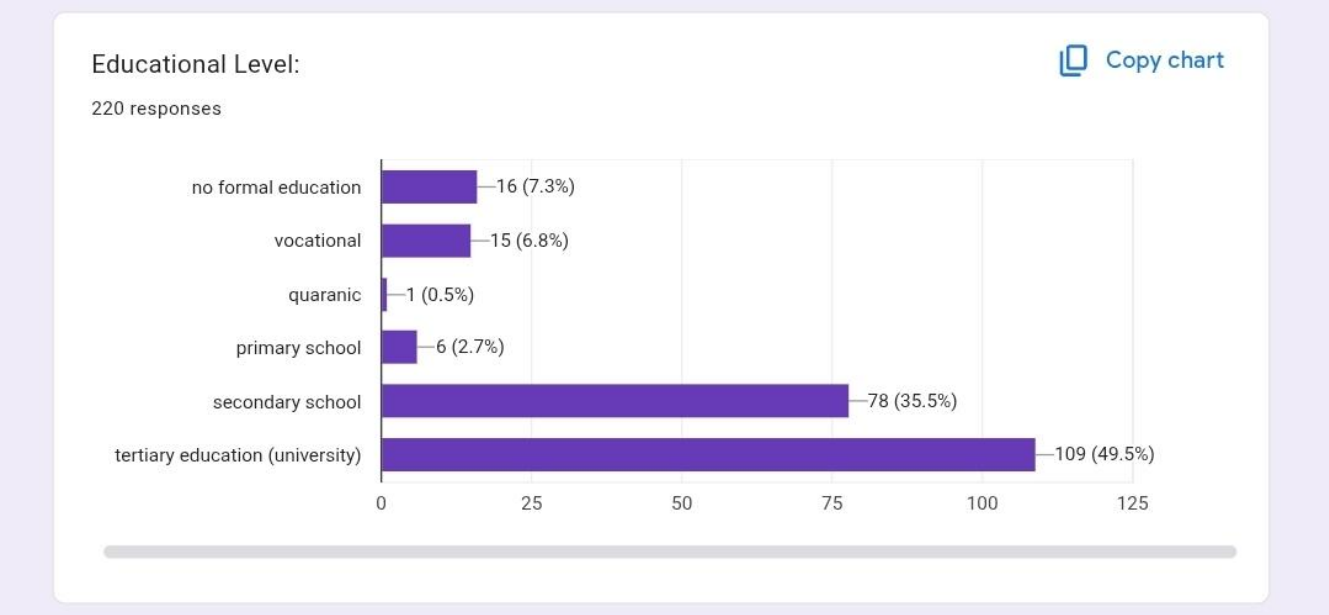
Occupation:

Copy chart

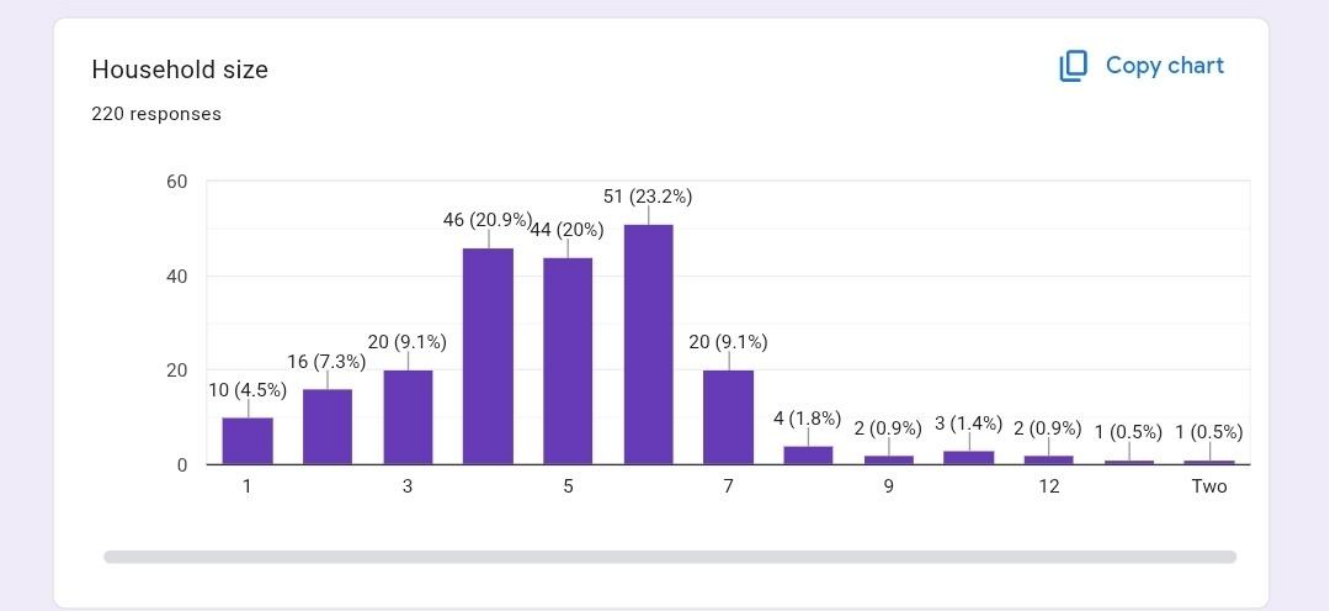
220 responses



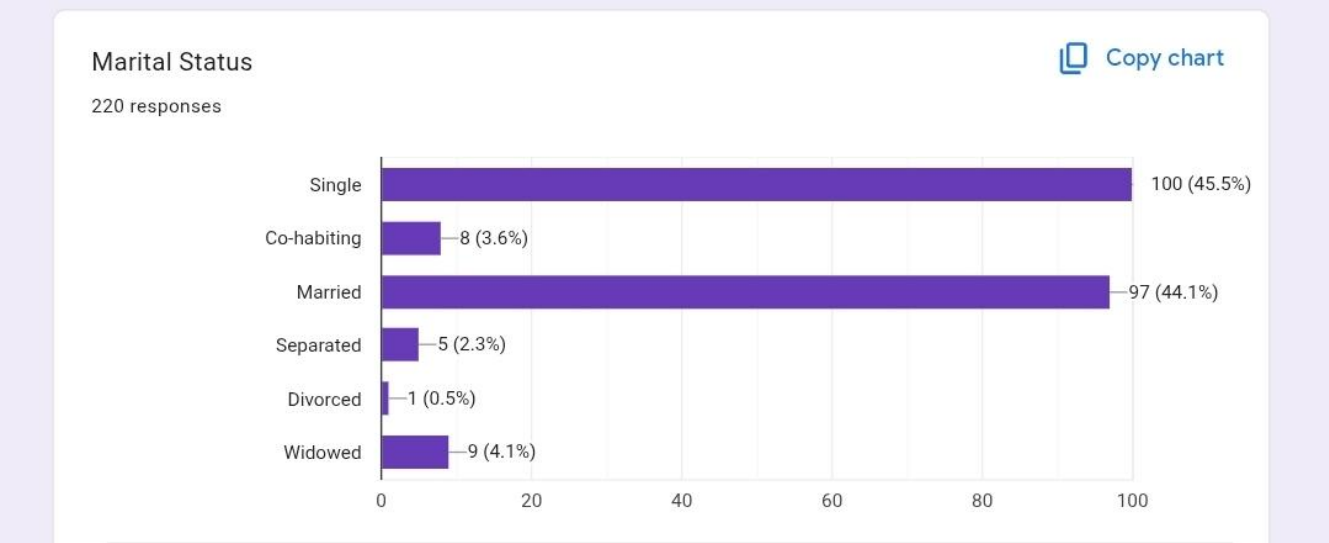
Appendix 1.2: Graph of occupation distribution



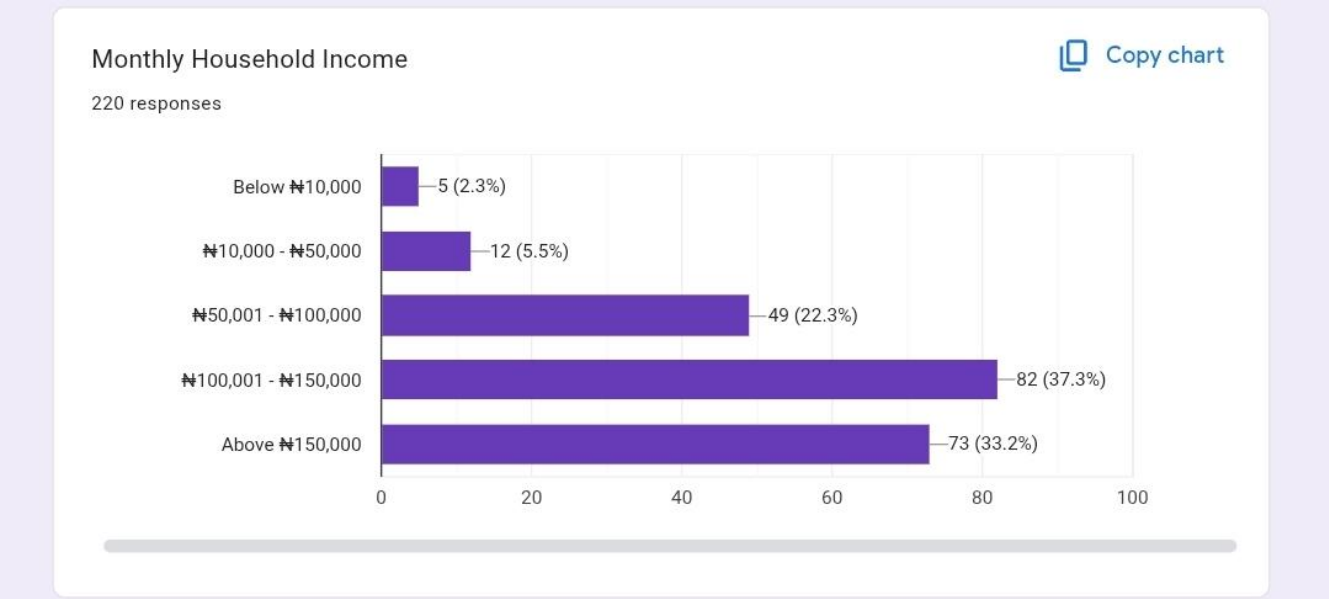
Appendix 1.3: Graph of Educational level distribution



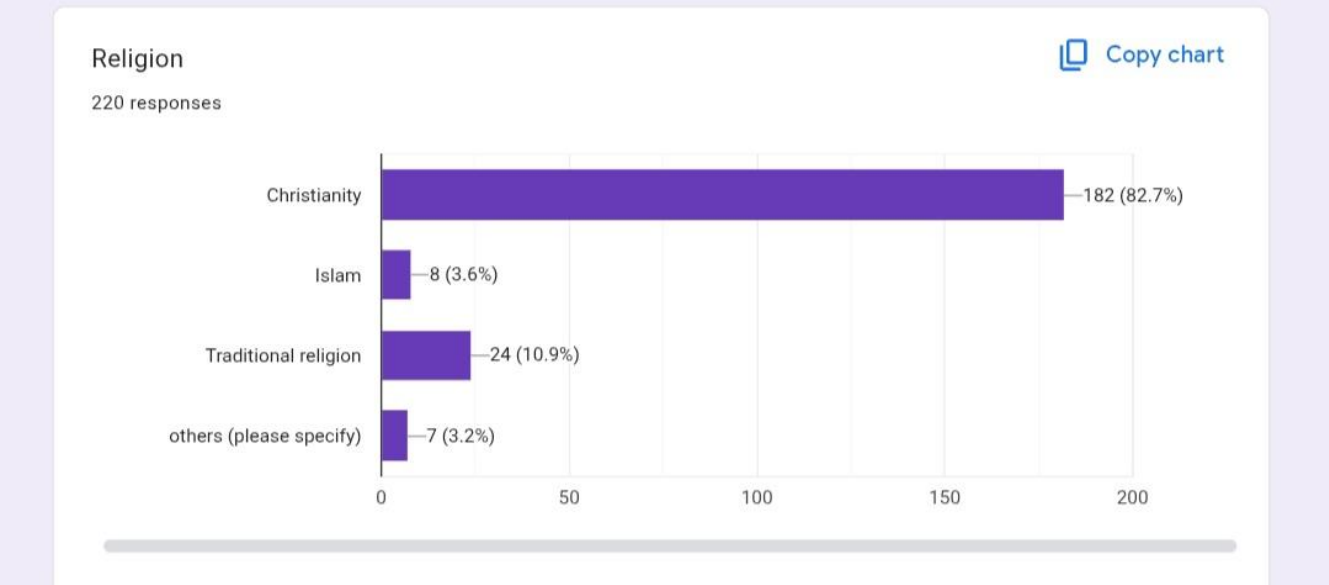
Appendix 1.4: Graph of Household size distribution



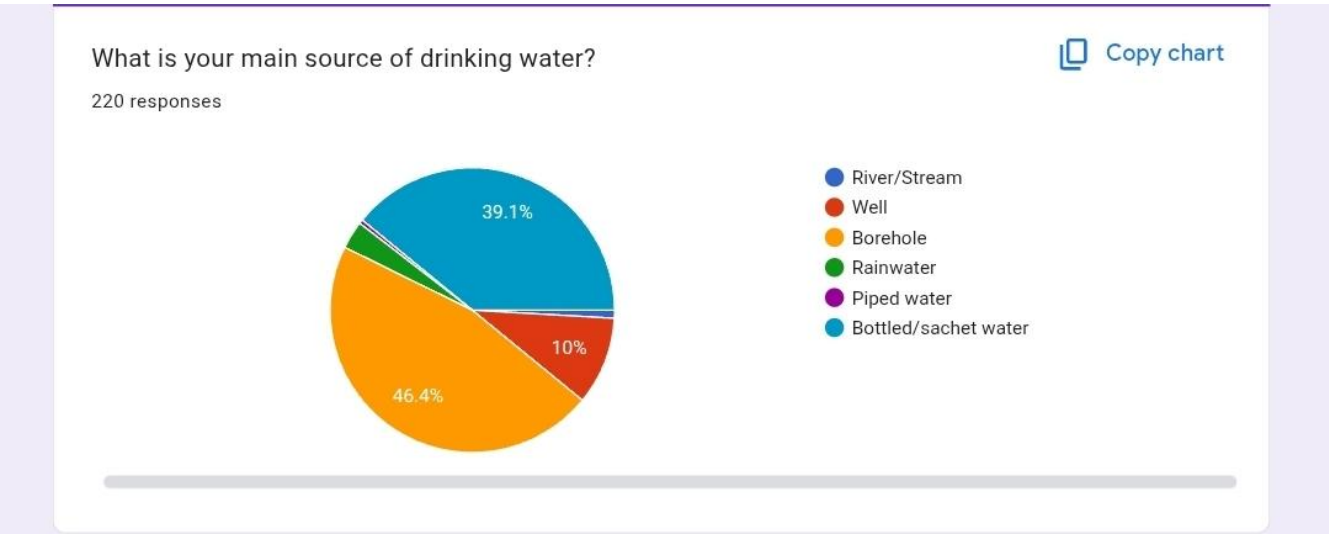
Appendix 1.5: Graph of Marital Status distribution



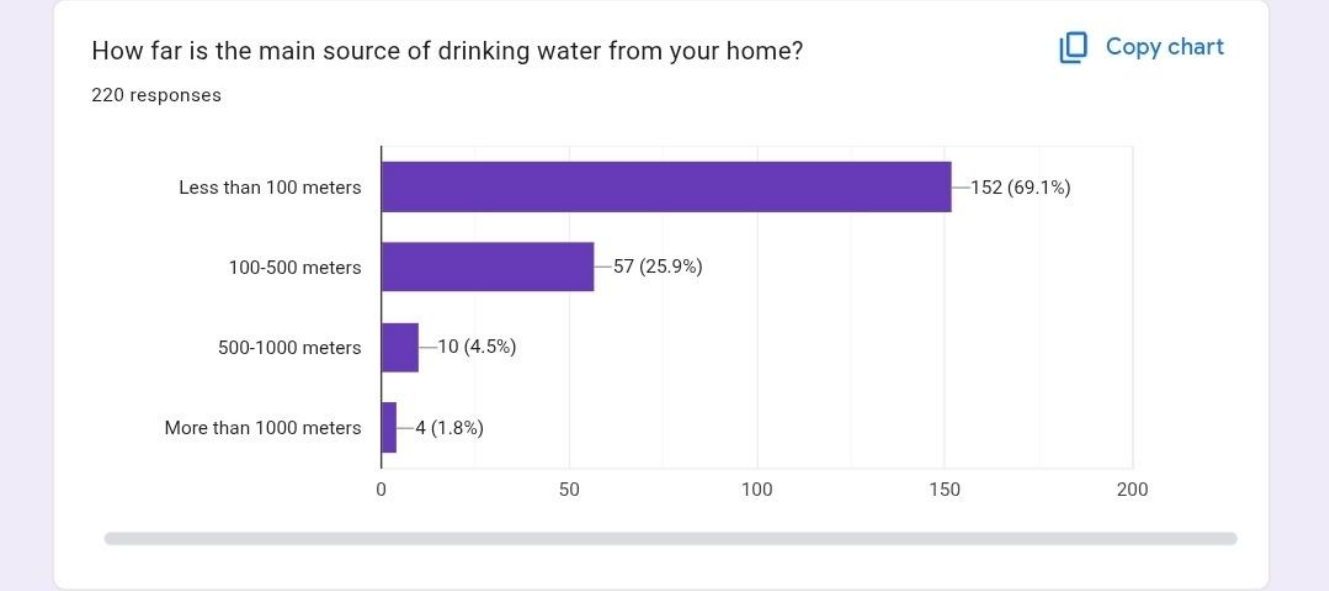
Appendix 1.6: Graph of monthly household income distribution



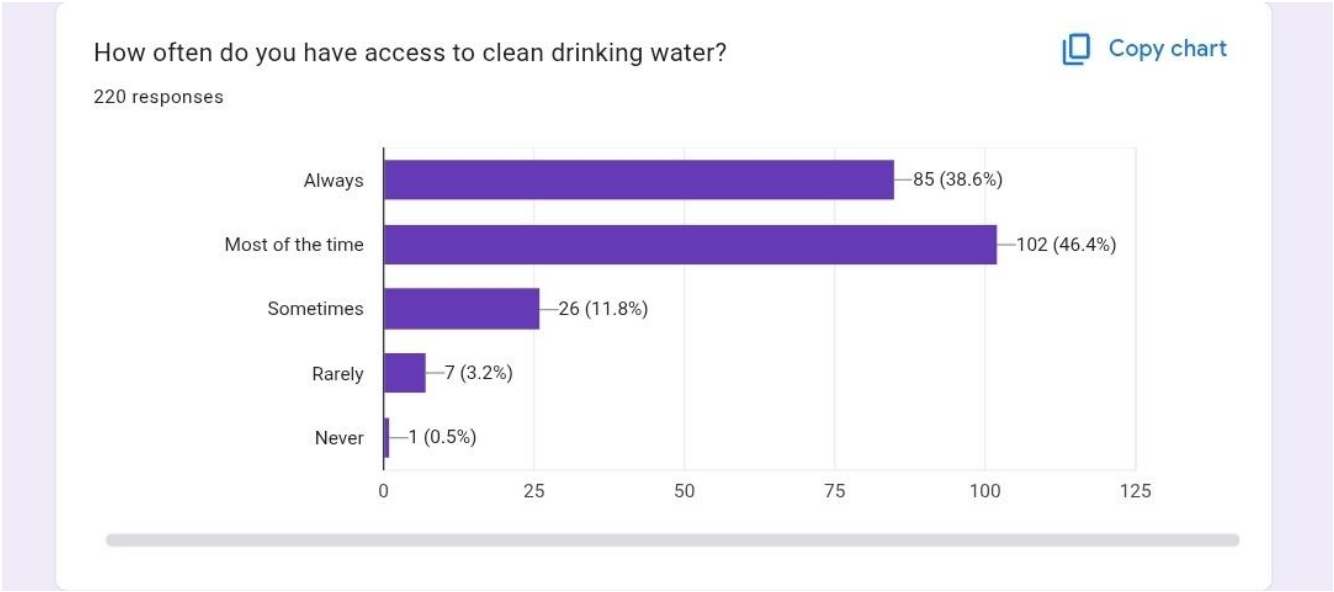
Appendix 1.7: Graph of religion distribution



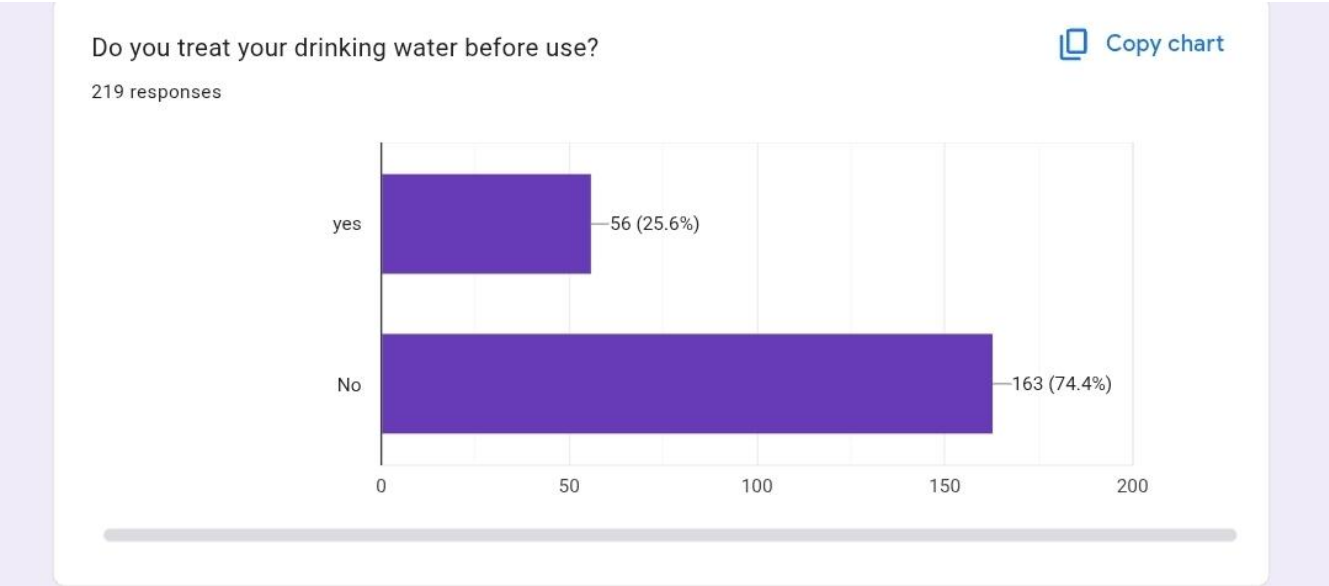
Appendix 1.8: Main source of drinking water distribution



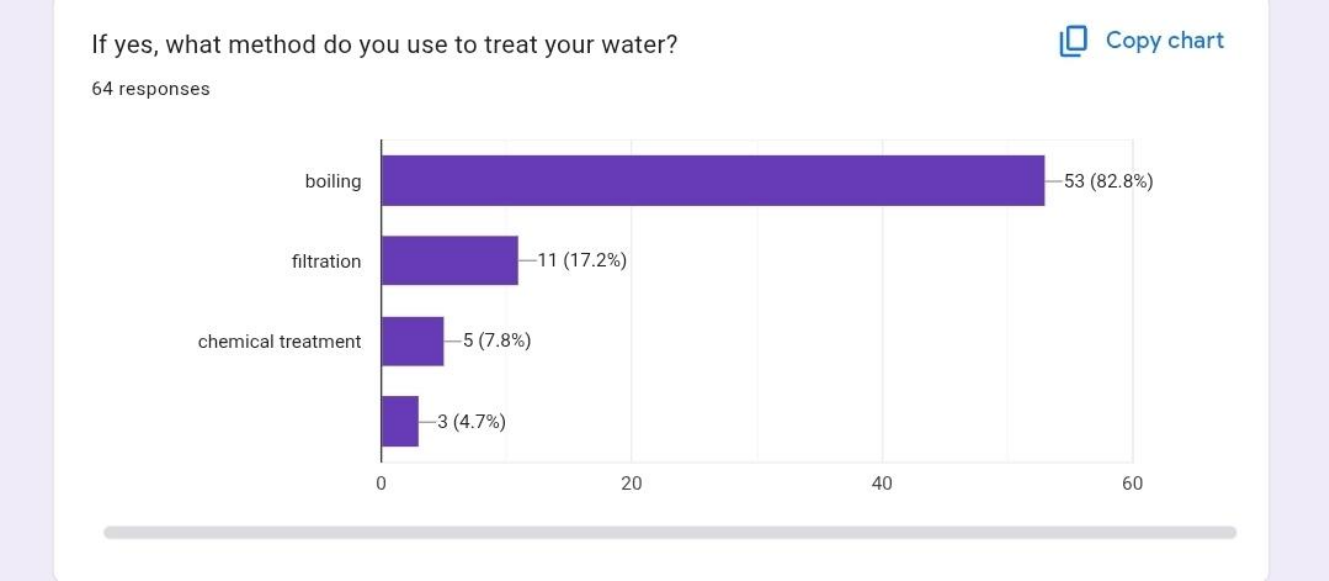
Appendix 1.9: How far is the main source of drinking water from your home



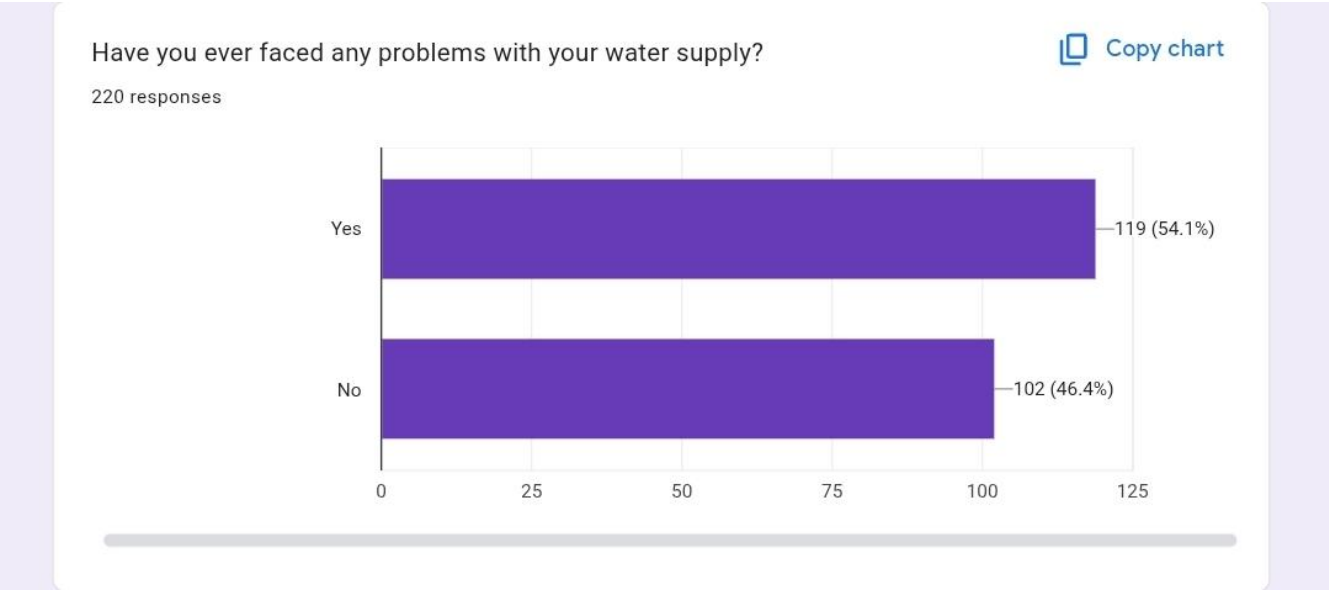
Appendix 1.10: How often do you have access to drinking water



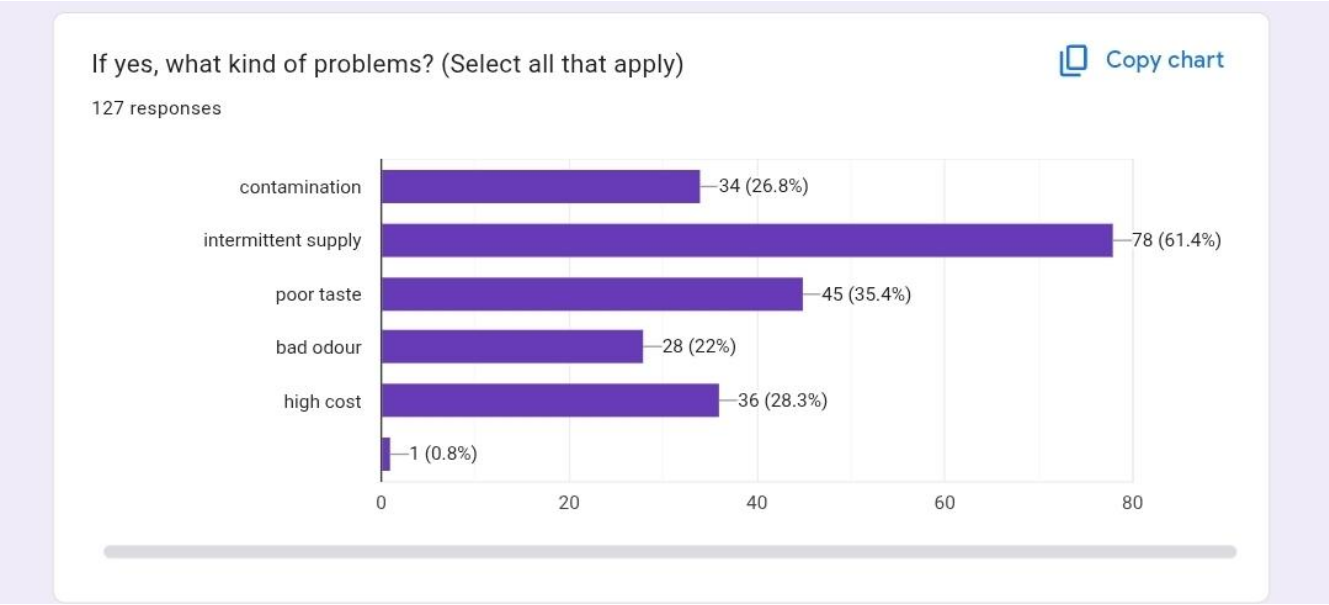
Appendix 1.11: Do you treat your drinking water before use?



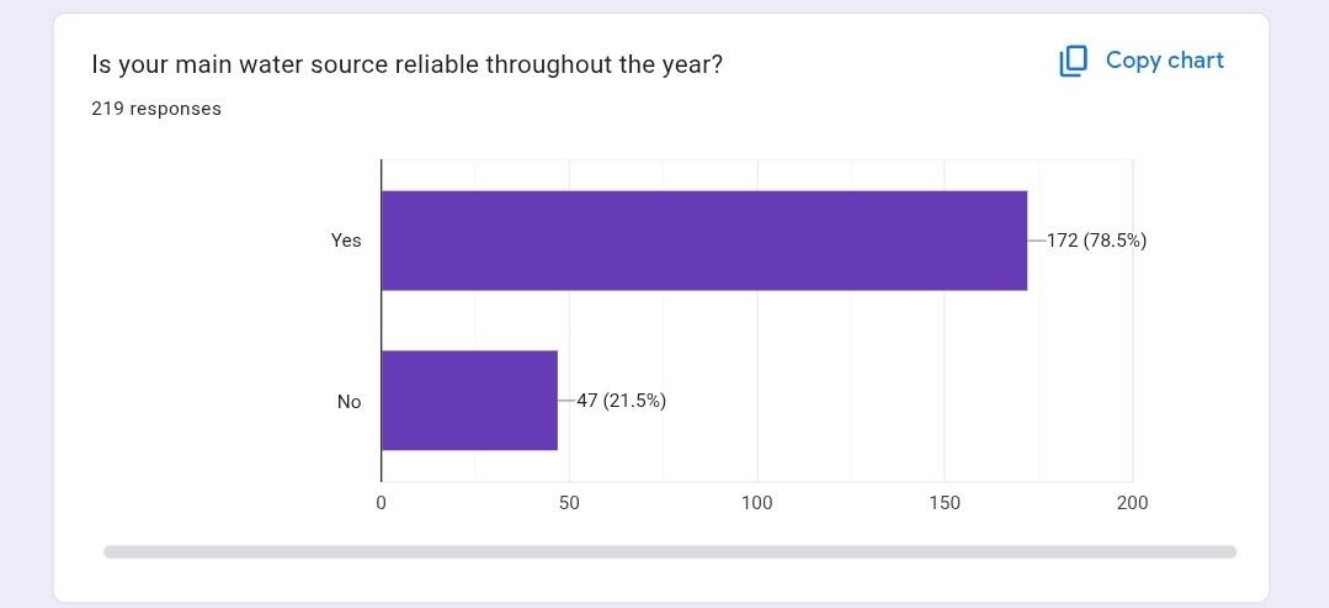
Appendix 1.12: If yes what method do you use to treat your water



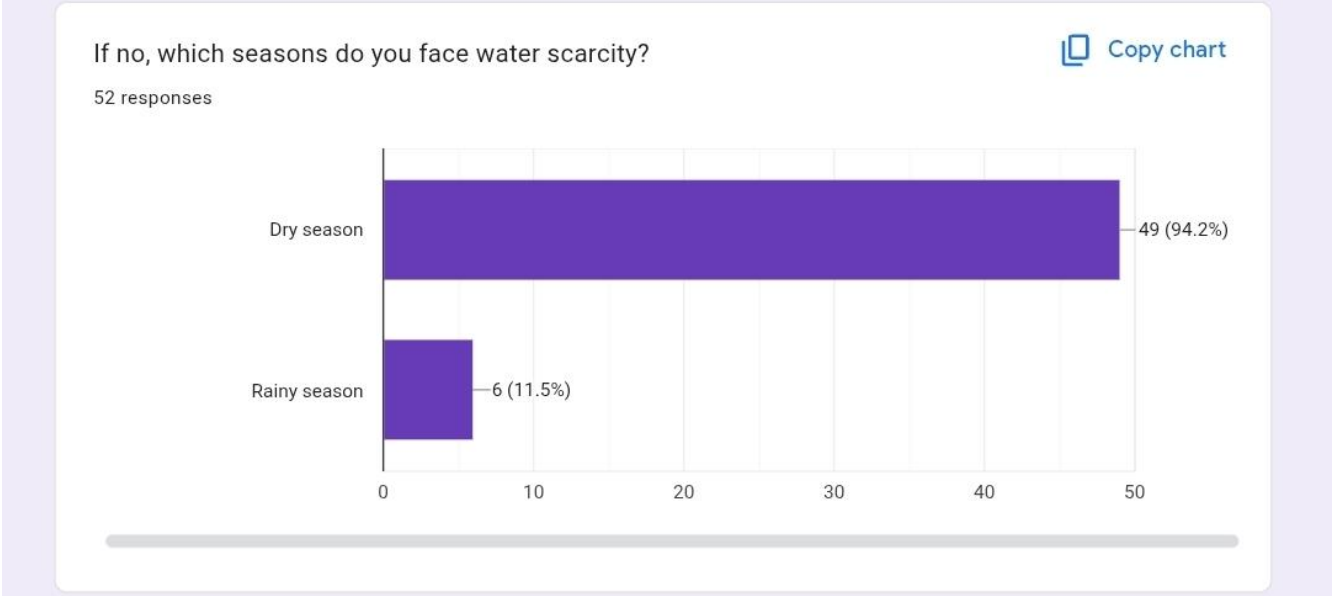
Appendix 1.13: Have you ever faced any problems with your water supply



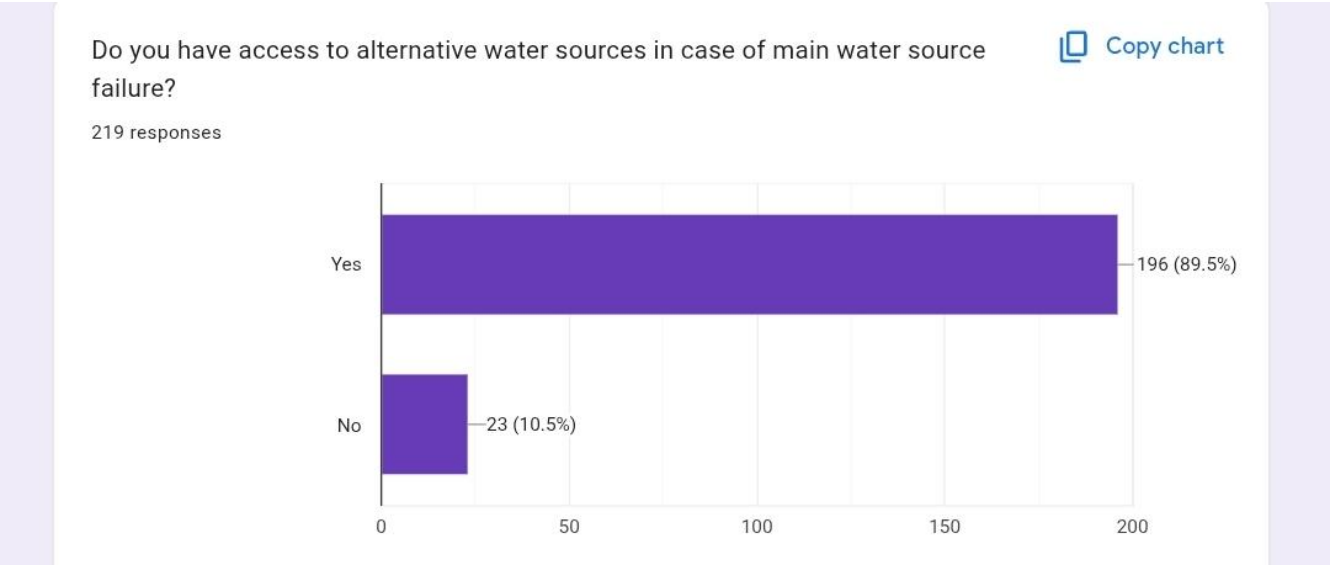
Appendix 1.14: If yes, what kind of problems?



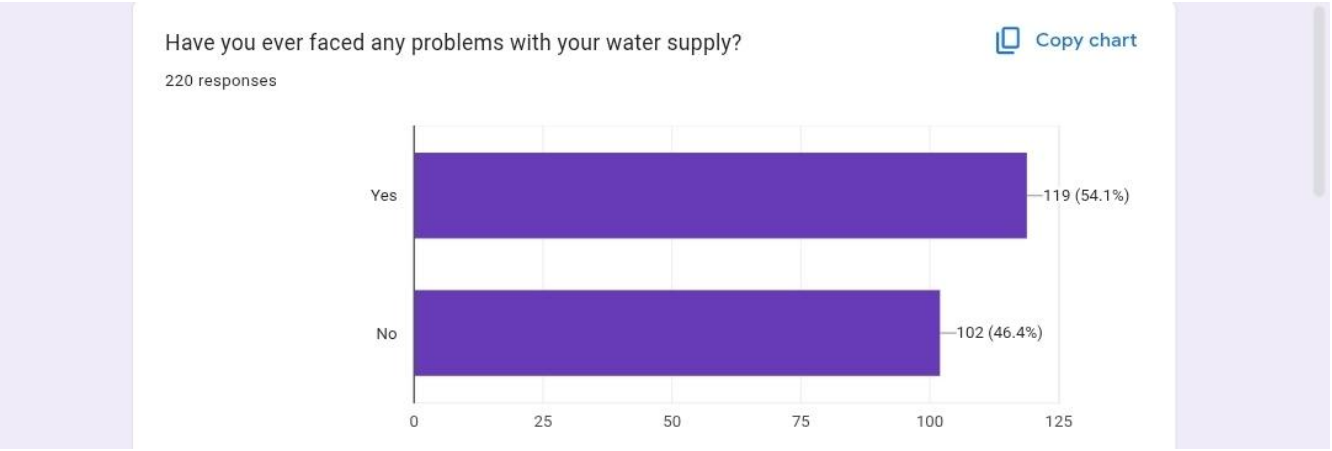
Appendix 1.15: Is your main water source reliable throughout the year?



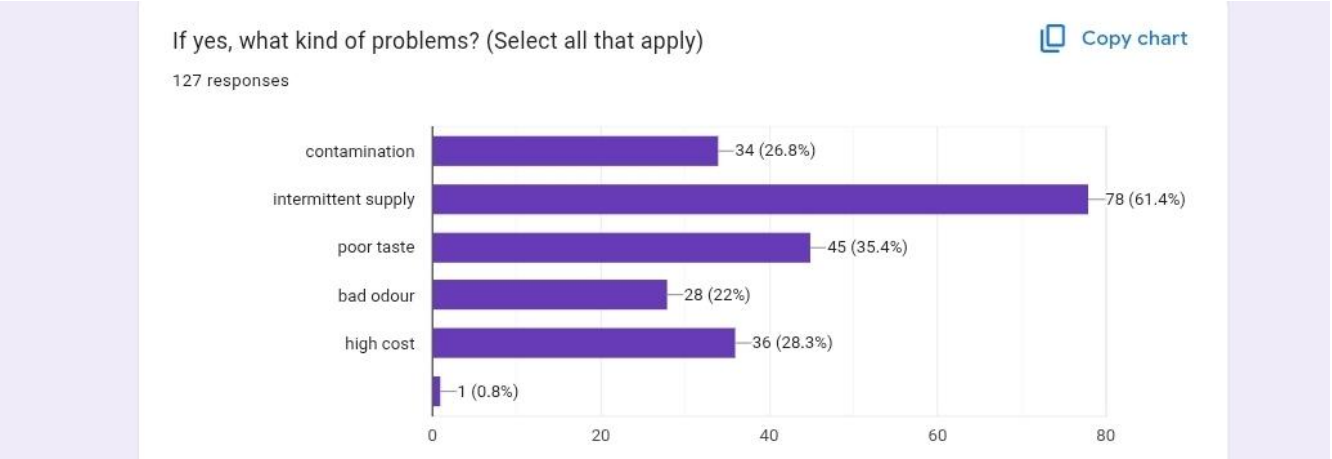
Appendix 1.16: If no, which seasons do you face water scarcity?



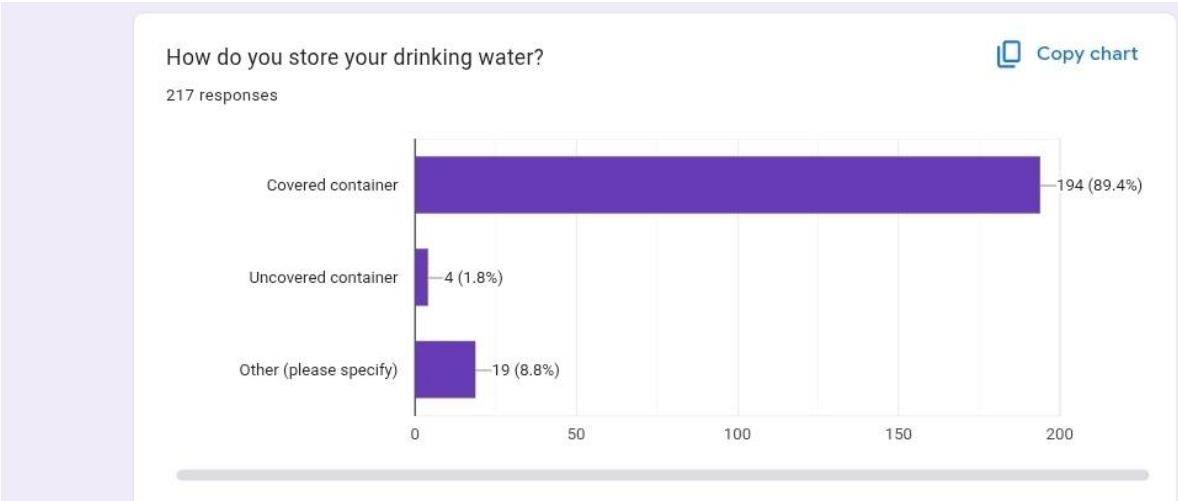
Appendix 1.17: Do you have access to alternative water sources in case of main water source failure?



Appendix 1.18: Have you ever faced problems with your water supply?



Appendix 1.19: If yes, what kind of problems?



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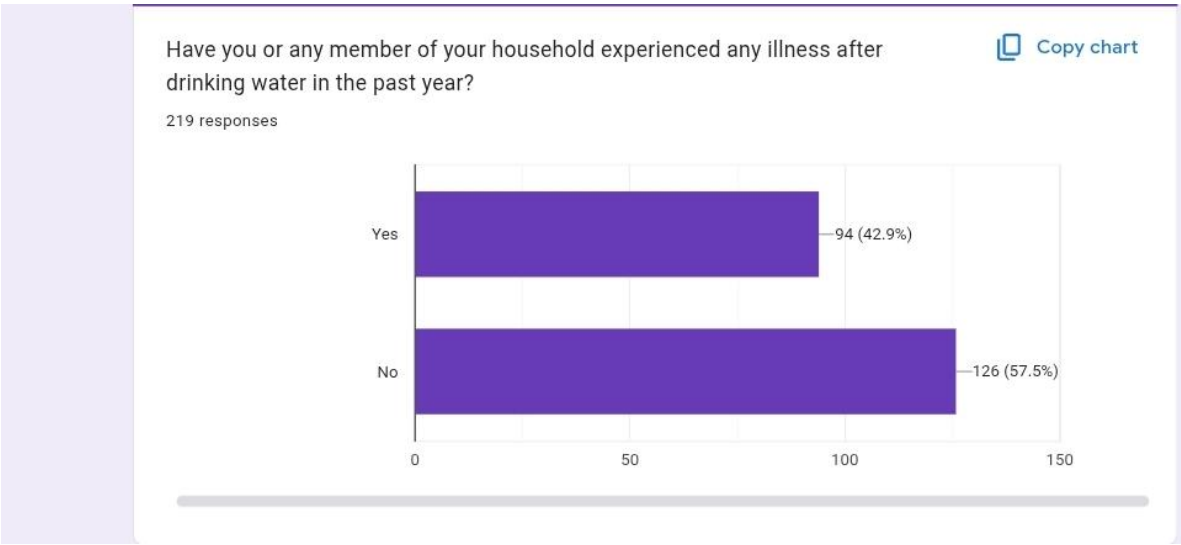

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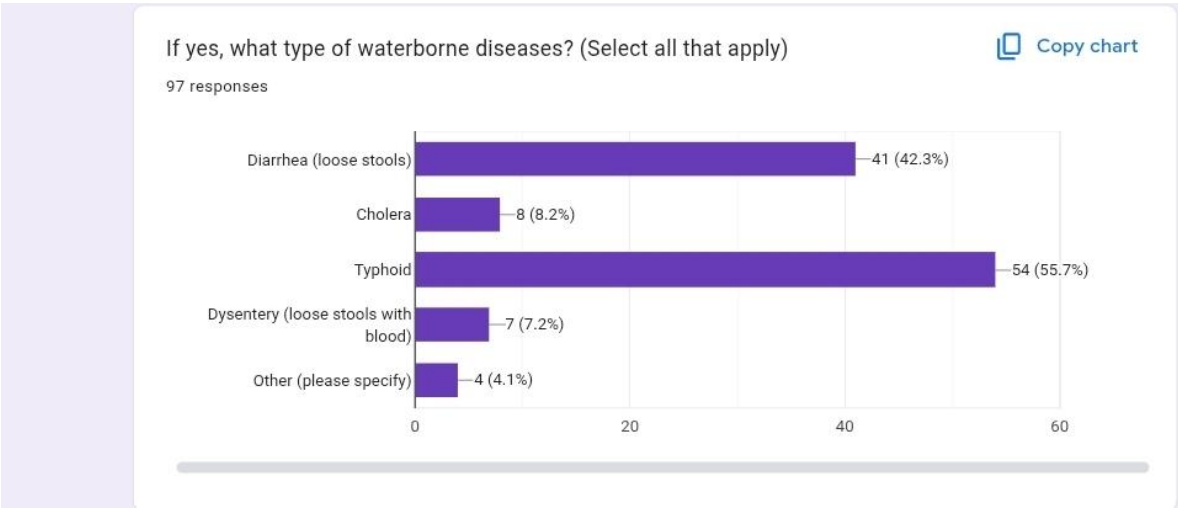

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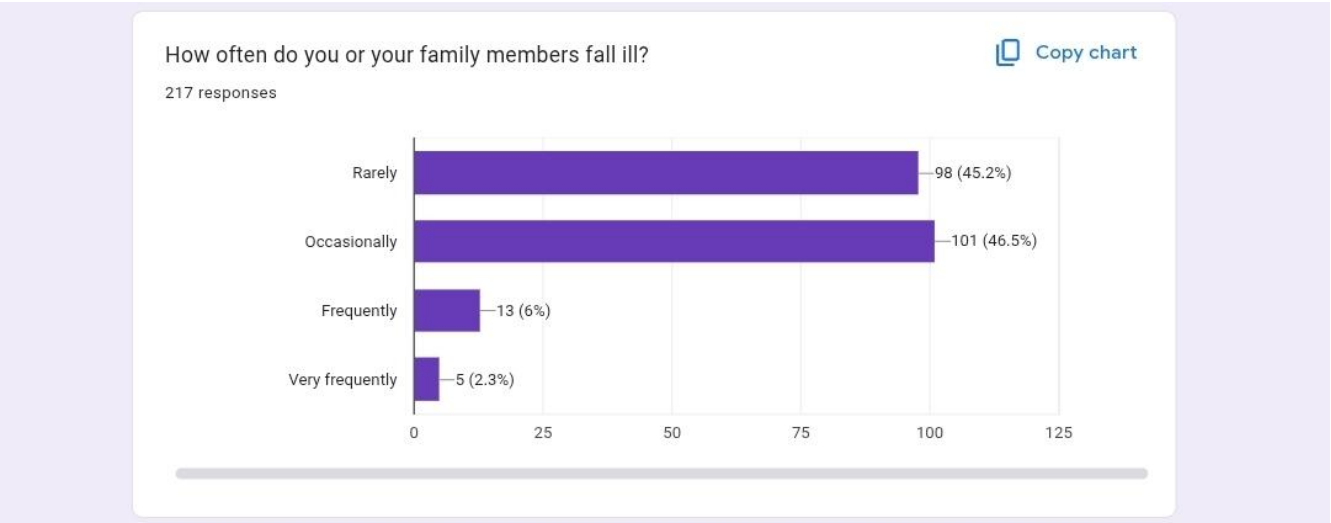

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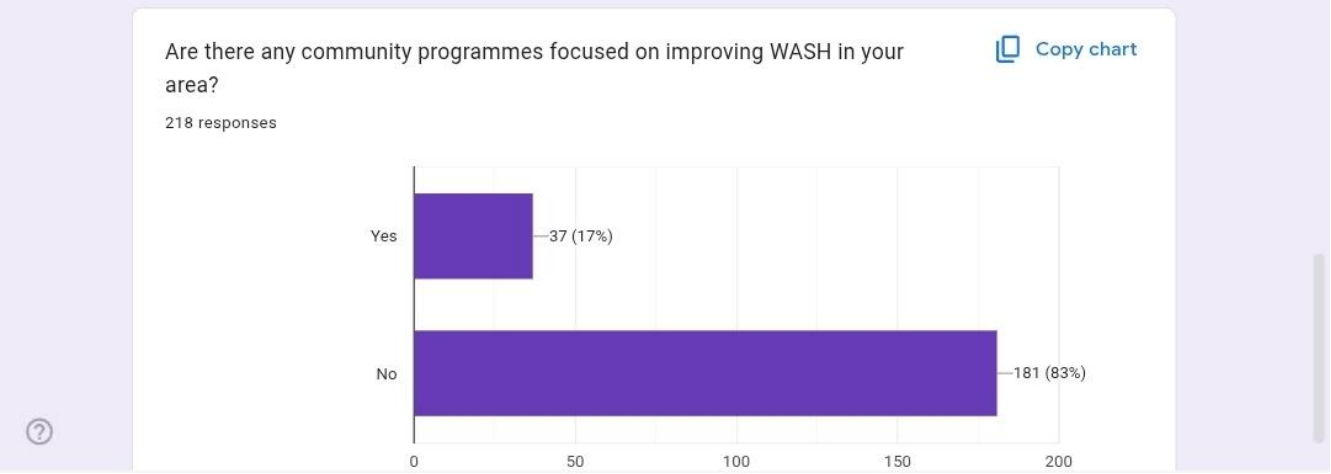
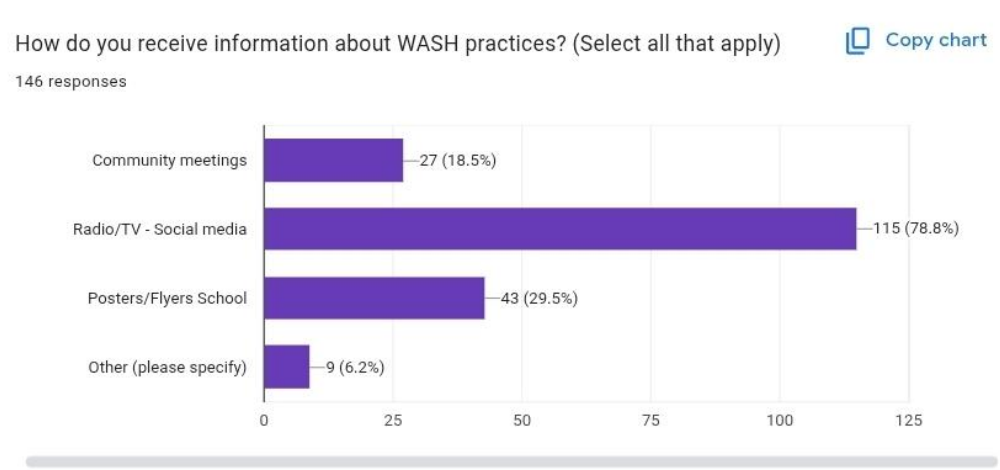


Appendix 1.24

Appendix 1.25

Appendix 1.26



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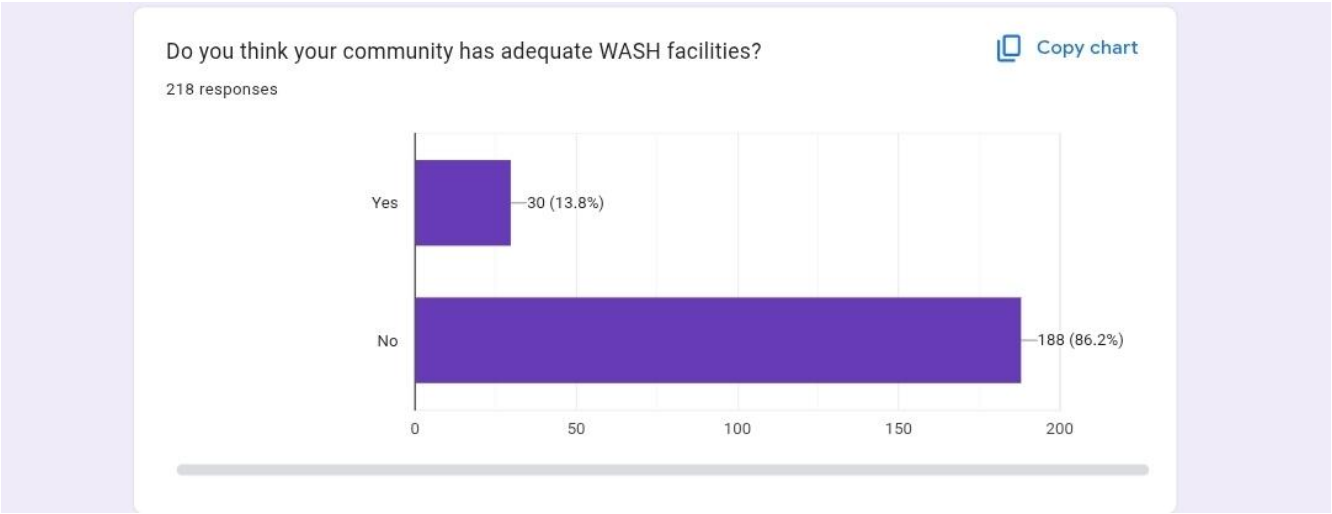

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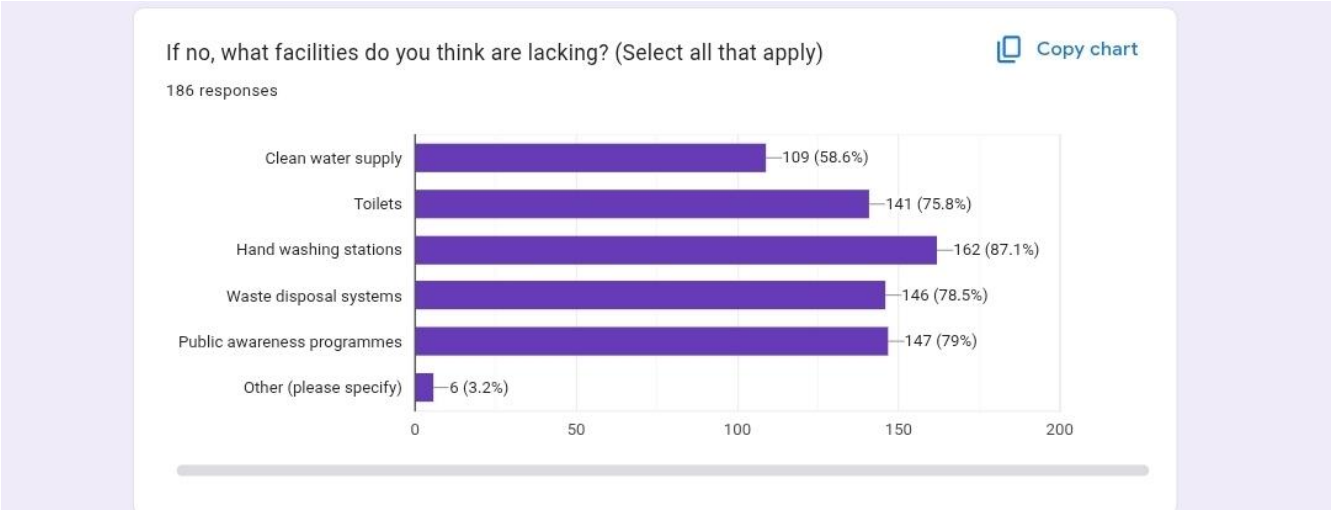

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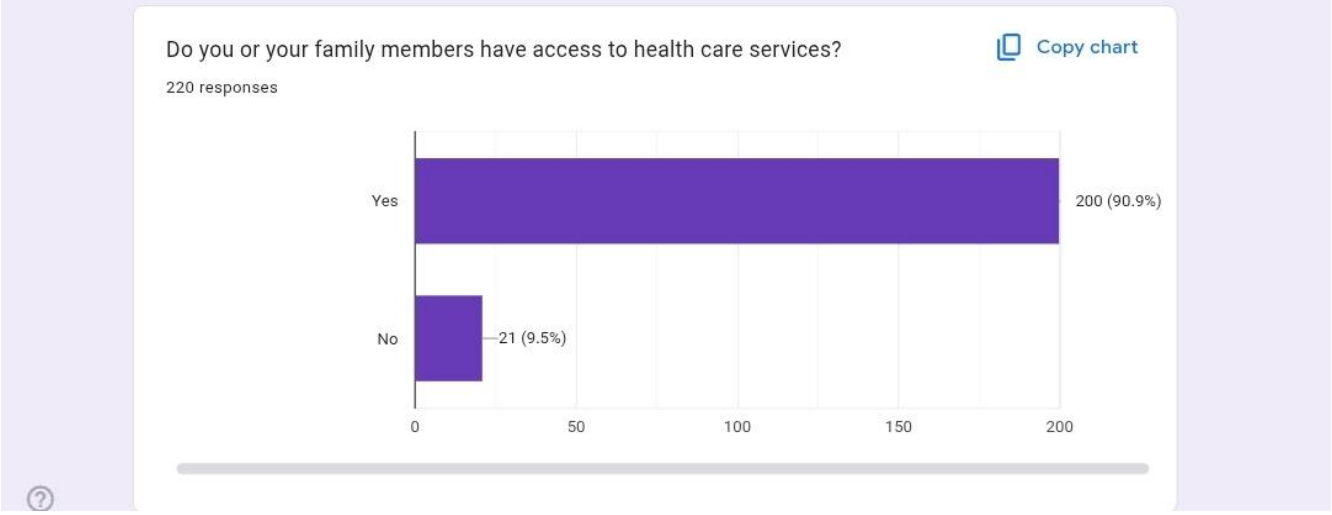

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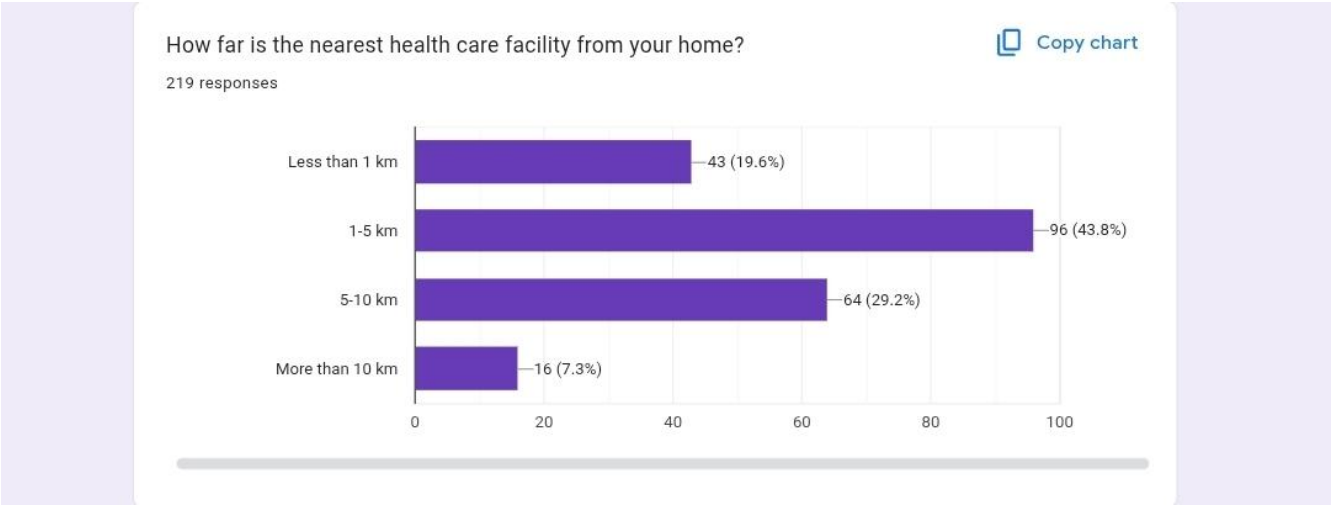

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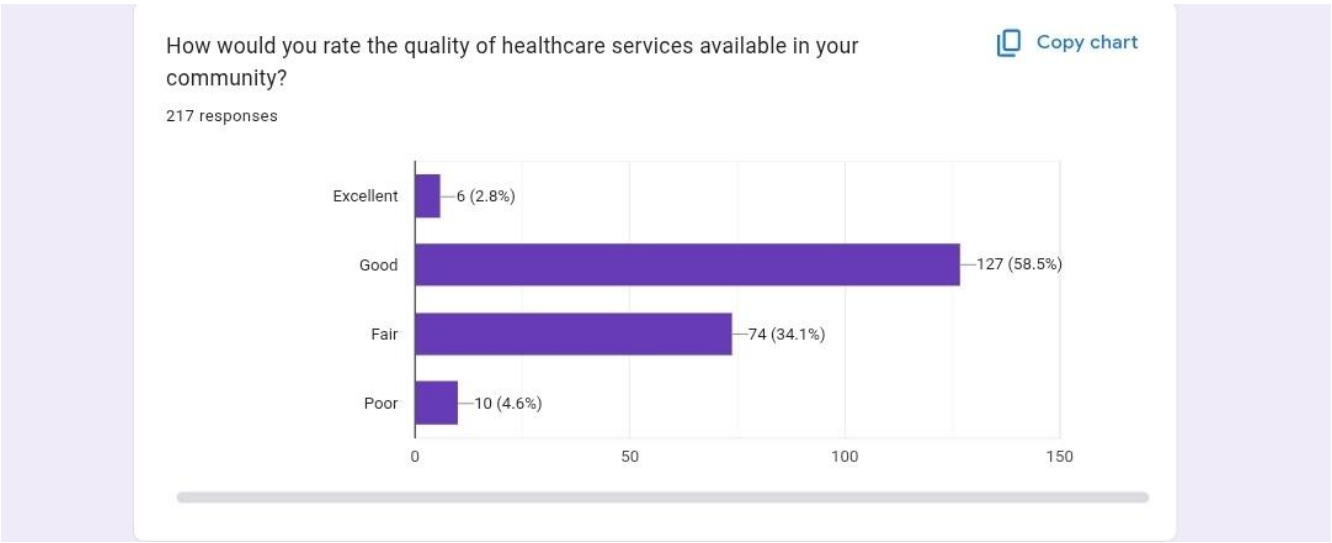

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