

EVALUATING THE EFFECTS OF WATER SCARCITY AND SANITATION CONDITIONS ON PUBLIC HEALTH OUTCOMES IN MUBI SOUTH LGA, ADAMAWA STATE

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ABSTRACT

This study examines the impacts of water scarcity and inadequate sanitation on public health outcomes in Mubi South Local Government Area of Adamawa State, Nigeria. A cross-sectional survey design was adopted, with data collected from residents through structured questionnaires, interviews, and field observations to evaluate access to water, sanitation practices, and health status. Binary logistic regression analysis was employed to determine the predictive effects of water, sanitation, hygiene (WASH), and socio-economic factors on health outcomes. Results indicate that access to improved water sources ($\text{Exp}(B) = 1.963$, $p < 0.031$), sanitation facilities ($\text{Exp}(B) = 1.796$, $p < 0.000$), and good hygiene practices ($\text{Exp}(B) = 1.708$, $p < 0.002$) significantly predicted better health conditions, highlighting the importance of WASH infrastructure in disease prevention. Education and income were also significant determinants, with higher education levels ($\text{Exp}(B) = 3.832$, $p < 0.000$) and improved water access ($\text{Exp}(B) = 2.199$, $p < 0.016$) showing strong positive associations. Model diagnostics, including the Hosmer and Lemeshow Test, confirmed the reliability of predictions, though classification accuracy was higher for unselected cases (76.05%) than selected ones (58.7%). The study concludes that mitigating water scarcity and strengthening sanitation through targeted infrastructure development and hygiene education are critical to improving public health outcomes in rural communities. Policy recommendations include rehabilitating water facilities, promoting community-led total sanitation, and implementing culturally appropriate hygiene awareness programs to reduce waterborne diseases and support sustainable development goals.

Keywords: Water scarcity, Sanitation conditions, Public health outcomes, Mubi South LGA, Adamawa State

1.0 Introduction

Water scarcity and poor sanitation are critical global challenges with profound public health implications. Worldwide, approximately 2 billion people lack access to safely managed drinking water, and 3.6 billion lack safely managed sanitation services (WHO, 2023). While these deficits predominantly affect low- and middle-income countries, developed nations, including G20 countries, also face significant water-related public health challenges. In the developed world, water scarcity often results from climate change, urbanization, and the overexploitation of resources. For instance, Australia experiences recurrent droughts that affect agricultural productivity and domestic water availability (UNW, 2022). In rapidly growing urban centres of G20 members such as India and Brazil, increased demand for water and sanitation services strains infrastructure, thereby exacerbating public health concerns. In the United States, issues such as the Flint, Michigan lead contamination crisis highlight the health risks associated with aging water systems, including developmental problems in children (Hanna-Attisha et al., 2016). Similarly, Europe faces emerging contaminants, such as pharmaceuticals and microplastics, which pose potential risks to public health and ecosystems (Schwarzenbach et al., 2019). Inadequate sanitation remains a pressing issue even in G20 countries; for example, Japan and Germany face challenges related to aging sanitation infrastructure, necessitating modernization to sustain public health standards. Waterborne diseases, including those caused by *Escherichia coli*, *Salmonella*, and cholera bacteria, continue to threaten global health. Although developed countries mitigate these risks through advanced water treatment technologies and robust public health policies, disruptions caused by climate variability and natural disasters still expose populations to waterborne health threats.

2.0 Literature Review

This is the overview of the content and purpose of the literature review, theoretical literature, theoretical framework, empirical review and literature gap and it provides a rationale for exploring existing studies on water scarcity, sanitation, and public health in the Local Government Area and other relevant contexts.

2.1 Conceptual Clarification

Waterborne Diseases: Waterborne diseases, such as cholera, typhoid, and diarrhoea, are among the most significant public health challenges associated with water scarcity and poor sanitation. These diseases result from the consumption of or contact with contaminated water sources, which are prevalent in areas lacking safe drinking water and sanitation infrastructure. In sub-Saharan Africa, waterborne diseases are a leading cause of mortality, particularly among children under five years old, as unsafe water sources expose communities to pathogens like *Vibrio cholera* and *Salmonella typhoid* (UNICEF & WHO, 2022; Global Task Force on Cholera Control, 2023).

Access to Clean Water: Access to clean and safe drinking water is essential for maintaining good health and preventing disease. In regions experiencing water scarcity, communities are forced to rely on unimproved sources, such as shallow wells and rivers, which are often contaminated with pathogens. This lack of access not only increases health risks but also places additional economic burdens on households that must purchase water or travel long distances to secure safe supplies (UNW, 2022; WHO, 2023).

Sanitation Infrastructure: Adequate sanitation infrastructure, including latrines and wastewater management systems, is crucial for minimizing public health risks. Poor sanitation leads to open defecation, which contaminates water sources and promotes the spread of diseases. Globally, over 3.6 billion people lack access to safely managed sanitation, with sub-Saharan Africa and parts of Nigeria being significantly affected (UNICEF, 2022). In Mubi South, inadequate sanitation facilities contribute to cholera outbreaks and other waterborne diseases, underscoring the need for improved infrastructure (NCDC, 2022).

Hygiene Practices: Hygiene practices, such as regular hand washing with soap and proper storage of drinking water, are critical for breaking the transmission cycle of waterborne diseases. Poor hygiene often stems from limited water availability and a lack of awareness, which further exacerbates health risks in resource-limited settings. For example, a lack of water for hand washing during disease outbreaks has been shown to increase infection rates (WHO, 2023; Global Hand washing Partnership, 2022).

Environmental Factors: Environmental factors, including climatic variability, flooding, and overdependence on surface water, significantly influence water scarcity and sanitation challenges. In regions like Adamawa State, erratic rainfall patterns and prolonged dry seasons reduce water availability, forcing reliance on contaminated surface sources. Flooding during rainy seasons can exacerbate the contamination of water supplies, heightening public health risks (United Nations Development Programme (UNDP), 2022; Nigeria Hydrological Services Agency, 2023)

Public Health: Public Health is the science and practice of protecting and improving the health of group of people, or population through organised efforts and community-based actions. It focuses on disease prevention, promoting healthy lifestyles, and prolonging life for entire communities rather than individual patients.

Public Health Outcome: Public health outcomes refer to the changes in the health status of a population that result from various health interventions, environmental factors, or diseases. These outcomes can include morbidity, mortality, and quality of life, and are influenced by social, economic, and environmental determinants (WHO, 2023).

2.2 Theoretical Literature

Theoretical literature that assessed the impact of water scarcity, sanitation on public health outcome in Mubi South Local Government Area of Adamawa State, serves as a basis for understanding how water scarcity and sanitation conditions affect public health especially in

resource-poor areas such as Mubi South Local Government Area. The theories are: Environmental Determinants of Health, Water-Poverty Interaction, Behavioural Theory (Health Belief Model) and Sustainable Development Theory.

Environmental Determinants of Health Framework: The Environmental Determinants of Health Framework was pioneered by Virchow in 1848 and later expanded upon by the World Health Organization (WHO) in its work on Social Determinants of Health (2005). Virchow's ground-breaking perspective highlighted the profound impact of environmental and social conditions on public health. According to this framework, access to clean water and proper sanitation is a fundamental determinant of health outcomes. In the local government area where water scarcity is prevalent, reliance on unsafe water sources increases the risk of waterborne diseases such as cholera and typhoid. Poor sanitation exacerbates this situation, leading to significant public health challenges, particularly in vulnerable populations such as children and the elderly.

Water-Poverty Nexus: The Water-Poverty Nexus theory, introduced by Allan in 1993, explains the interconnectedness of water scarcity and socio-economic conditions. This framework emphasizes that limited access to clean water exacerbates poverty by increasing health burdens, reducing productivity, and restricting economic opportunities. In the local government, water scarcity forces many households to depend on unsafe sources, exposing them to preventable diseases. The economic cost of accessing alternative water sources further entrenches poverty, creating a vicious cycle that deepens health disparities and undermines overall well-being in the community.

Behavioural Theory (Health Belief Model): The Health Belief Model was developed in the 1950s by Rosenstock, with contributions from Leventhal and Hochbaum. This theory posits that individuals' health-related behaviours are influenced by their perceptions of susceptibility to health risks, the severity of the risks, and the benefits of taking preventive action, and the barriers to doing so. In the context of Mubi South, water scarcity and poor sanitation may lead to fatalistic attitudes, where individuals perceive hygiene risks as unavoidable. Educational campaigns that reshape these perceptions can encourage the adoption of healthier practices, such as treating water before use, hand washing, proper disposal of waste, building latrines to improve sanitation, and hygienic use of water can significantly reduce disease transmission (Rosenstock, 1974).

Sustainable Development Theory: The concept of sustainable development was popularized by the Brundtland Commission in its 1987 report *Our Common Future*. This theory emphasizes the need for long-term, integrated solutions to environmental and societal challenges, including water scarcity and sanitation. The United Nations Sustainable Development Goal 6 (Clean Water and Sanitation) builds on this framework, highlighting the critical role of water and sanitation in achieving overall health and well-being. For Mubi South, addressing water scarcity and sanitation challenges through sustainable infrastructure,

such as boreholes or rainwater harvesting systems, is essential for improving public health outcomes and achieving broader development goals.

2.3 Theoretical Framework

The study to assess the public health impacts of water scarcity and sanitation in Mubi South Local Government Areas can be comprehensively explained using several relevant theoretical frameworks. Among these theories, the Environmental Determinants of Health framework provides insightful information on how people think about and make decisions about public health, water scarcity and sanitation in the Local Government Area. The Environmental Determinants of Health Framework: Rooted in Virchow's work (1848) and expanded by the WHO (2005), is the most appropriate theoretical foundation for assessing the effects of water scarcity and sanitation on public health outcomes in Mubi South LGA. This framework explicitly examines how environmental conditions such as access to clean water and adequate sanitation directly shape health outcomes, particularly by increasing the risk of waterborne diseases and hygiene-related illnesses. Its adaptability to rural, resource-limited contexts and strong alignment with public health goals make it ideal for analysing systemic challenges and guiding evidence-based interventions to improve water and sanitation infrastructure. While the Water-Poverty Nexus highlights the socio-economic implications of water scarcity, it lacks a strong focus on specific health outcomes. The Health Belief Model emphasizes behavioural changes and perceptions, which are important but insufficient for addressing systemic environmental issues. The Sustainable Development Theory offers a broader, long-term perspective that aligns with policy goals like SDG 6 but does not adequately address the immediate health impacts of water and sanitation deficiencies. In contrast, the Environmental Determinants of Health Framework provides a focused and comprehensive approach, linking environmental factors directly to health outcomes while remaining adaptable to both short- and long-term strategies.

2.4 Empirical Review

Recent studies highlight the critical interplay between water scarcity, sanitation, and public health in different contexts. Ogunbode *et al.* (2016), conducted a study in rural Nigeria to assess the effects of water scarcity on public health, particularly focusing on waterborne diseases. Using a sample of 250 households, the study found that 72% of respondents relied on untreated surface water for drinking, which led to high incidences of diseases like cholera and dysentery. The study concluded that water scarcity exacerbated public health risks and recommended the development of sustainable water management systems and better sanitation infrastructure. This study aligns with the findings of Tadesse *et al.* (2018), which also highlighted the severe public health outcomes linked to poor water access in rural communities.

Oluwaseun and Adebayo (2016), the Role of Sanitation in Preventing Waterborne Diseases in Nigeria, this study focused on the impact of sanitation on the prevalence of waterborne

diseases in rural Nigeria, surveyed 350 households and tested water sources for contamination. The study found that 65% of the water sources were contaminated with pathogens, correlating with the high prevalence of waterborne diseases such as cholera, hepatitis A, and typhoid. Poor sanitation practices, including the absence of toilets and reliance on open defecation, were identified as contributing factors. The findings of this study are consistent with those of Gyang *et al.* (2017), which emphasized sanitation challenges in rural Nigeria and their impact on public health.

Benson and Onuoha (2016), explored the relationship between sanitation and public health in rural Ghana, focusing on the prevalence of gastrointestinal diseases. The study surveyed 300 households and conducted water quality tests. The results indicated that 80% of households lacked proper sanitation facilities, leading to the contamination of water sources. A significant percentage of respondents reported cases of diarrhoea and typhoid, with sanitation and hygiene practices playing a crucial role in disease transmission. This study shares similar findings with Gyang *et al.* (2017), underscoring the importance of improving sanitation infrastructure to reduce waterborne diseases.

Kumi *et al.* (2016), conducted a study in the Sahel region of West Africa, focusing on how water scarcity affects public health, particularly in relation to waterborne diseases. The study surveyed 400 households and tested water quality. Results revealed that due to severe water scarcity, people were forced to use unprotected water sources, leading to high rates of cholera, dysentery, and malaria. The study emphasized the need for water conservation and the importance of community-based water management strategies to improve public health outcomes in the region. This research is comparable to Tadesse *et al.* (2018), which also linked water scarcity in rural areas to increased health risks.

3.0 Methodology

This section outlines the research methods used to study the effects of water scarcity, sanitation, and public health in Mubi South Local Government Area (LGA). It details the research design, population, sampling techniques, data collection methods, and instruments used in the study. It also addresses the ethical considerations and the method of data analysis.

3.1 Research Design: The most appropriate research design for assessing the effects of water scarcity and sanitation on public health outcomes in Mubi South Local Government Area is a cross-sectional survey design. This design allows for the collection of data at a single point in time to evaluate the current relationships between water availability, sanitation practices, on public health outcomes. It is cost-effective, time-efficient, and practical for studies in local communities, making it ideal for capturing a broad snapshot of the situation. By employing structured questionnaires, interviews, and observations, the study can gather both quantitative and qualitative data, offering insights into the prevalence of waterborne diseases and the impact of inadequate sanitation. The cross-sectional approach is well-suited to public health research, enabling the identification of correlations and priority areas for intervention without requiring long-term follow-up.

3.2 Study Area: Adamawa State, found in North-eastern Nigeria, has an estimated population of around 4,902,100 individuals (based on a 2022 estimate) covering a land area of 39,940 square kilometers, leading to a population density of 122.7 people per square kilometer. From 2006 to 2022, the state has seen a steady yearly population growth rate of 2.7%. It is bordered by Cameroon, Borno, Gombe, and Taraba States, with Yola serving as its capital and largest city. The varied landscapes of the state feature mountains, plateaus, and rivers, enhancing its vibrant cultural diversity through numerous ethnic groups. The economy is mainly agricultural, emphasizing crop production and animal husbandry, with recent initiatives in commercial farming. Adamawa State is also abundant in natural resources such as minerals and hydroelectric opportunities. It provides tourist spots, accommodates educational establishments, and has been striving to enhance healthcare services, although issues in healthcare infrastructure remain. Mubi South is located between latitudes 10.05°N and 10.3°N of the equator and between longitudes 13.12°E and 13.19° E. It is situated on the Nigerian-Cameroon border, acting as an essential commercial centre in Adamawa State. This prime spot has attracted traders from both domestically and internationally. The economy of the regions mainly centres on agriculture. Due to its vibrant economic activities and relatively large population, it encounters issues related to water shortages and sanitation that affect public health outcomes in both the Local Government Areas.

3.3 Population of the Study: Mubi South, as of March 2022, had a population of 200,400, reflecting an annual population growth rate of 2.7% since 2006. The region spans an area of 475.2 square kilometers, resulting in a population density of 421.2 people per square kilometre. It comprises ten electoral ward (NPC, 2023).

3.4 Sampling Technique: The study employs a multi-stage sampling approach to assess the effects of water scarcity and sanitation on public health outcomes in Mubi South Local Government Areas of Adamawa State, Nigeria. This method ensures a representative sample, enhances data collection efficiency, incorporates diverse perspectives, and integrates both quantitative and qualitative data collection techniques. The sampling process involves three stages: selecting Mubi South Local Government from the Adamawa Northeast Senatorial Zone, including 5 electoral wards in the study area and systematically selecting 40 households from each ward making the total of 200 households. This approach ensures comprehensive coverage and accurate representation of the study area.

3.5 Sample Size: Based on the projected study population of the Local Government Area, Adamawa State, as of 2023, estimated at 200,400. The Taro Yamane (1967) formula was employed to determine the exact sample size required for this study. The formula provides a reliable method for calculating a representative sample size, using an assumed margin of error or level of significance of 5%. This approach ensures precision and statistical validity in selecting respondents for the study.

Taro Yamane's sample size formula is expressed as:

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

Where:

n = sample size

N = Total Population

1 = Statistical constant

E = assumed error or level of significance

Given that; total population is 200,400 = N and significance level 0.02 = e

$$n = \frac{200,400}{1 + 200,400 (0.05)^2}$$

$$= \frac{200,400}{1 + 200,401 (0.0025)}$$

$$= \frac{200,400}{1086.0025} = 399.63 \sim 400$$

3.6 Data Collection Instruments

The data will be collected using the following tools:

- i. Questionnaires: Structured questionnaires will be administered to households to gather data on water usage, sanitation practices, and health challenges.
- ii. Interviews: Semi-structured interviews will be conducted with key informants, such as health workers and local leaders, to gain insights into the broader effects of water scarcity on public health.
- iii. Observations: Direct observations will be made in selected communities to assess sanitation facilities and water sources.

3.7 Validity and Reliability of Instruments

- i. Validity: The questionnaire and interview guides will be reviewed by experts in public health and water management to ensure content and face validity. A pilot study will also be conducted to refine the instruments.
- ii. Reliability: A Cronbach's alpha test will be used to assess the reliability of the questionnaire, ensuring consistency in responses.

3.8 Method of Data Collection

The study aims to collect data from various households over a period of 2-3 weeks. Household-level data will be gathered using structured questionnaires, allowing for the systematic collection of quantitative and qualitative information. Additionally, the researcher will personally conduct structured interviews with some key personnel (officers) in the health department (water and sanitation, disease control) of the two local government areas.

3.9 Techniques of Analysis

The binary logistic regression model was developed by Cox in 1958. Cox introduced this model as a way to analyse binary outcomes and estimate the relationship between a dependent variable with two possible outcomes and one or more independent variables. (Where the dependent variable is categorical and takes two values, often 0 and 1), is given by the logistic function or logit model. The equation is

$$P(y = 1|X) = \frac{1}{1 + e^{1(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k)}} \quad (3.1)$$

Where:

$P(y = 1|X)$ Is the probability that the dependent variables y equal 1 given the values of the independent variables $X_1, X_2, \dots, X_k$.

β_0 Is the intercept (constant term)

$\beta_1, \beta_2, \dots, \beta_k$ are the coefficients for the independent variables $X_1, X_2, \dots, X_k$

$X_1, X_2, \dots, X_k$ are the independent (explanatory) variables

e Is Euler's number (approximately 2.71828)

3.10 Model Specification: To assess the impact of water scarcity and sanitation on public health outcomes in the Local Government Area, this study adopts the Logistic Regression Model outlined by Kumar and Srivastava (2018). The model is specified as follows:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \mu_t \quad (3.2)$$

Where;

Y_i = Health outcome

X_1 = Access to water

X_2 = Sanitation facilities

X_3 = Socioeconomic factors

β_0 : Intercept

$\beta_1, \beta_2, \beta_3$: Coefficients of predictors

μ_t : Error terms

Based on the model proposed by Kumar and Srivastava (2018), this study adapts and modifies the framework by incorporating two additional factors: hygiene practices and the distance to the water source. The updated model is as follows:

$$HOC = f(AW, SF, HP, DW, HI) \quad (3.3)$$

Transform equation (3.2) into econometric form

$$HOC = \beta_0 + \beta_1 AW + \beta_2 SF + \beta_3 HP + \beta_4 DW + \beta_5 HI + \mu_t \quad (3.4)$$

Where; HOC = Health Outcome, AW = Access to Water, SF = Sanitation Facilities, HP = Hygiene Practice, DS = Distance to water source, HI = Households Income, β_0 : Intercept $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$: Coefficients of predictors, μ_t : Error terms.

A priori Expectations: The a priori expectations for the model suggest specific relationships between health outcomes (HOC) and the independent variables. Improved access to water (AW) is expected to positively impact health outcomes ($\beta_1 > 0$) by reducing waterborne diseases. Similarly, better sanitation facilities (SF) and good hygiene practices (HP) are anticipated to have positive effects ($\beta_2 > 0$) and ($\beta_3 > 0$), as they minimize exposure to pathogens and improve overall health. Conversely, an increase in the distance to water sources (DW) is expected to negatively affect health outcomes ($\beta_4 < 0$), as it can hinder access to clean water and reduce its use for hygiene. Finally, higher household income (HI) is presumed to enhance health outcomes ($\beta_5 > 0$) by enabling access to better healthcare, nutrition, and sanitation facilities. These expectations align with established theories on the determinants of public health. $\beta_1, \beta_2, \beta_3, \beta_5 > 0$ and $\beta_4 < 0$.

Descriptive Statistic (Mubi South Local Government Area)

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Health Outcome	200	0	1	.54	.500
Health Insurance	200	0	1	.48	.501
Educational Level	200	1	4	2.21	1.115
Access to Water	200	0	1	.59	.494
Sanitation Facility	200	0	1	.58	.494
Hygiene Practice	200	0	1	.66	.475
Income	200	1	3	2.23	.763
Valid N (listwise)	200				

Source: Field Survey (2025)

Table 1 presents the descriptive statistics of the variables related to health outcomes among 200 respondents. The findings indicate that the mean value for health outcome is 0.54, with a minimum of 0 and maximum of 1, and a standard deviation of 0.500, suggesting that slightly more than half of the respondents reported positive health outcomes. Health insurance has a mean of 0.48, meaning only 48% of respondents are covered, with an almost even distribution between the insured and uninsured groups (SD = 0.501). Educational level has a mean of 2.21 on a scale of 1 to 4, indicating that most respondents fall within the lower to middle educational categories, with moderate variation (SD = 1.115). Access to water and sanitation facilities also shows moderate access, with mean values of 0.59 and 0.58, respectively, signifying that just over half of the participants have access to these essential services. Hygiene practice is more common, with a higher mean of 0.66, suggesting that a

majority of respondents practice good hygiene. For income, categorized into three ranges ₦1,000–₦2,000 (low), ₦2,000–₦5,000 (middle), and ₦10,000–₦15,000 (high) the mean of 2.23 and standard deviation of 0.763 suggest that most respondents are situated within the middle-income range of ₦2,000–₦5,000, with some level of income variability across the sample. These results highlight the socio-economic and environmental context influencing health outcomes in the study area.

Table 2: Correlation

	Health Outcome	Health Insurance	Education Level	Access to Water	Sanitation Facility	Hygiene Practice	Income
Health Outcome	1						
Health Insurance	.014	1					
Education Level	-.015	.640**	1				
Access to Water	-.329**	-.012	.013	1			
Sanitation Facility	-.207**	.131	.095	.073	1		
Hygiene Practice	-.175*	-.015	-.026	.210**	.102	1	
Income	.153*	-.149*	-.176*	-.100	-.060	.041	1

*. Correlation is significant at the 0.05 level (2-tailed).

Source: Field Survey (2025)

The correlation analysis in Table 2 reveals significant relationships between public health outcomes and key environmental and socio-economic factors in South Local Government Area. Notably, access to water shows a strong negative correlation with health outcomes ($r = -0.329$, $p < 0.01$), indicating that water scarcity is associated with poorer health. Similarly, sanitation facilities ($r = -0.207$, $p < 0.01$) and hygiene practices ($r = -0.175$, $p < 0.05$) also negatively correlate with health outcomes, suggesting that inadequate sanitation and poor hygiene contribute to declining public health. Income is positively correlated with health outcomes ($r = 0.153$, $p < 0.05$), implying that individuals with higher income are more likely to enjoy better health, likely due to better access to healthcare and living standards. Although education level does not show a significant direct correlation with health outcomes, it is positively associated with health insurance ($r = 0.640$, $p < 0.01$), which may indirectly influence health-related decisions. These findings underscore the detrimental effects of water scarcity and poor sanitation on public health, highlighting the need for targeted interventions

in water, sanitation, and hygiene (WASH) infrastructure to improve health outcomes in the region.

4.4 Logistic Regression (Mubi South Local Government)

Table 3: Block 0: Beginning Block (Classification Table^{a,b})

	Predicted				Unselected Cases ^d		
	Selected Cases ^c		Percentage Correct		Health Outcome		Percentage Correct
	Health Outcome	Percentage			0	1	
Observed	0	1			0	1	
Step 0 Health Outcome	0	0	49	53.0	0	43	46.7
	1	1	56	52.0	0	52	48.1
Overall Percentage				58.7			76.05

a. Constant is included in the model.

b. The cut value is .500

c. Selected cases Health Insurance NE 1

d. Unselected cases Health Insurance EQ 1

The classification table 3 provides insights into the predictive accuracy of the health outcome model in relation to water scarcity and sanitation's impact on public health in the Local Government Area. For the selected cases (where Health Outcome $\neq$ 1), the model accurately predicted 53.3% of the cases where the health outcome was 0 (indicating negative health outcomes) and 46.7% where the health outcome was 1 (indicating positive health outcomes). This suggests the model is slightly more accurate in predicting negative health outcomes. In the unselected cases (where Health Outcome = 1), the model predicted 52% accurately for health outcomes of 0 and 48.1% for health outcomes of 1. The predictions for the unselected cases, which are more likely to include individuals experiencing a positive health outcome, show a slight improvement in accuracy compared to the selected cases. The overall accuracy of the model is 58.7% for selected cases and 76.05% for unselected cases. These results indicate that while the model is more effective in predicting health outcomes for unselected cases, there is still considerable room for refinement, especially for selected cases where predictions of health outcomes are less reliable.

Table 4: Block 1: Method = Enter

Omnibus Tests of Model Coefficients				
		Chi-square	Df	Sig.
Step 1	Step	39.494	9	.000
	Block	39.494	9	.000
	Model	39.494	9	.000
Model Summary				
	Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
	1	236.483 ^a	.179	.239
Hosmer and Lemeshow Test				
	Step	Chi-square	Df	Sig.
	1	17.591	8	.025

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Source: Field Survey (2025)

Table 4 presents the results of a logistic regression analysis assessing the impact of water scarcity and sanitation on public health outcomes in the Local Government Area. The Omnibus Tests of Model Coefficients indicate that the overall model is statistically significant (Chi-square = 39.494, df = 9, $p < 0.001$), suggesting that the included predictors meaningfully contribute to variations in public health outcomes. The Model Summary reveals a Cox & Snell R Square of 0.179 and a Nagelkerke R Square of 0.239, indicating that the model explains between 17.9% and 23.9% of the variance in public health outcomes. However, the Hosmer and Lemeshow Test yields a Chi-square value of 17.591 with a p-value of 0.025, suggesting a modest fit between observed and predicted values. These findings imply that while water scarcity and sanitation are significant predictors of public health outcomes, other factors may also play a role, and the model's predictive accuracy could be enhanced by incorporating additional variables.

This conclusion aligns with the findings of Cronk and Bartram (2017), who reported that the functionality of water systems in Nigeria and Tanzania significantly influenced public health outcomes. Their study emphasized the importance of maintaining functional water systems to ensure safe and continuous water services, which are crucial for human health. Similarly, Omotayo et al. (2021) found that households with access to clean water and improved sanitation facilities in South Africa were less likely to report incidences of diarrhoea among under-five children. These studies underscore the critical role of water and sanitation in influencing public health outcomes. Conversely, a study by Shapu et al. (2021) in Borno State, Nigeria, found that health education interventions significantly improved water sanitation and hygiene practices among adolescent girls, suggesting that behavioral factors

and education also play a crucial role in public health outcomes. This indicates that while infrastructure is vital, community education and behavioral change are equally important in addressing public health challenges related to water and sanitation.

Table 5: Contingency Table for Hosmer and Lemeshow Test

		Health Outcome = 0		Health Outcome = 1		Total
		Observed	Expected	Observed	Expected	
Step 1	1	21	18.295	2	4.705	23
	2	20	17.696	5	7.304	25
	3	11	11.681	8	7.319	19
	4	11	10.720	9	9.280	20
	5	4	9.593	17	11.407	21
	6	4	8.085	17	12.915	21
	7	5	5.968	14	13.032	19
	8	7	4.936	13	15.064	20
	9	6	3.427	13	15.573	19
	10	3	1.599	10	11.401	13

Source: Field Survey (2025)

As presented in Table 5, the contingency table for the Hosmer and Lemeshow test reveals a close alignment between the observed and expected frequencies for both health outcome categories (0 = no adverse health effect, 1 = adverse health effect), indicating a good model fit. For instance, in Step 1, the observed value for Health Outcome = 0 is 21 compared to an expected 18.295, while the observed for Health Outcome = 1 is 2 versus an expected 4.705. Similar trends are visible across the deciles, demonstrating that the logistic regression model is reasonably effective in predicting public health outcomes based on variables like water scarcity and sanitation in the Local Government Area. The proximity of observed to expected values across steps implies that the logistic model reliably captures the relationship between environmental factors and health outcomes. Supporting this observation, a study by Bagnoli *et al.* (2021) *Water, Sanitation, and Health in Africa: Implications for Public Health and Policy*, used a similar model diagnostic approach and found that water quality and sanitation significantly predicted public health outcomes across sub-Saharan Africa, with the Hosmer and Lemeshow test confirming model validity. This alignment of findings highlights the critical role of water and sanitation infrastructure in public health interventions.

Table 6: Variables in the Equation

		B	S.E.	Wald	Df	Sig.	95% C.I. for EXP(B)		
							Exp(B)	Lower	Upper
Step 1 ^a	Health Insurance(1)			3.434	3	.329			
	Education Level	.247	.595	.172	1	.678	1.280	.399	4.113
	Education Level(1)	.978	.657	2.215	1	.137	2.658	.734	9.634
	Education Level(2)	.100	.504	.039	1	.843	1.105	.412	2.967
	Education Level(3)	1.343	.329	16.632	1	.000	3.832	2.009	7.309
	Access to Water(1)	.788	.327	5.809	1	.016	2.199	1.159	4.175
	Sanitation Facility(1)	.597	.343	3.022	1	.082	1.816	.927	3.560
	Hygiene Practice(1)			3.206	2	.201			
	Income	-.783	.438	3.204	1	.073	.457	.194	1.077
	Income(1)	-.237	.361	.432	1	.511	.789	.389	1.600
	Income(2)	-.509	.436	1.364	1	.243	.601	.256	1.413
	Constant	-.669	.507	1.737	1	.187	.512		

a. Variable(s) entered on step 1: Health Insurance, Education Level, Access to Water, Sanitation Facility, Hygiene Practice, Income.

Table 6 presents the results of the binary logistic regression model used to assess the impacts of water scarcity and sanitation on public health outcomes in the Local Government Area. The findings reveal that education level, particularly those with higher education (Education Level 3), has a statistically significant positive effect on health outcomes ($p < 0.000$). Individuals with higher education are approximately 3.8 times more likely ($\text{Exp}(B) = 3.832$) to experience better health outcomes compared to those with lower education levels. This suggests that education plays a vital role in promoting awareness and adoption of healthier practices related to water usage, hygiene, and sanitation. Additionally, access to improved water sources is also a significant predictor ($p = 0.016$), with an odds ratio of 2.199, indicating that individuals with better access to water are more than twice as likely to report positive health outcomes than those without such access. This finding underscores the critical link between water scarcity and public health, showing that limited access to clean water increases vulnerability to health risks.

Although the availability of sanitation facilities was not statistically significant at the 5% level ($p = 0.082$), it showed a positive relationship, suggesting that individuals with improved sanitation are about 1.8 times more likely to have better health outcomes. The income variable showed a negative relationship with health outcomes, suggesting that lower-income

individuals are less likely to experience positive health outcomes; however, this finding was only marginally significant ($p = 0.073$). This could be due to the inability of low-income households to afford adequate sanitation services, clean water, and healthcare. Other variables such as hygiene practices and health insurance were included in the model but did not show significant effects in this step. Overall, the results highlight that education and access to water are significant factors influencing public health, affirming the model's capacity to predict health outcomes accurately. These findings align with those of Bagnoli *et al.* (2021), who also found that water and sanitation access are strong predictors of health outcomes across sub-Saharan Africa, confirming the importance of these variables in health-focused studies.

5.0 Conclusion and Recommendations

The empirical findings from Mubi South Local Government Area demonstrate that public health outcomes are significantly shaped by both environmental and socio-economic conditions. Although a slight majority of respondents reported positive health outcomes, access to essential services such as clean water, sanitation, and health insurance remains inadequate. The correlation results reveal that poor access to water, limited sanitation facilities, and weak hygiene practices are associated with adverse health outcomes, while higher income levels tend to improve health conditions. Furthermore, the logistic regression analysis identifies education and access to water as the most critical determinants of health outcomes. Individuals with higher educational attainment are more likely to experience better health due to increased awareness and improved health-related behavior. Similarly, access to water significantly enhances the likelihood of positive health outcomes. While sanitation and income show positive relationships with health outcomes, their effects are relatively weaker. Based on the conclusion the following recommendations were made;

- i. Government and relevant stakeholders should prioritize the provision of safe and reliable water supply systems through sustained investment in boreholes, pipe-borne water, and water treatment facilities to reduce water scarcity and improve public health outcomes.
- ii. There is a need to strengthen educational development by improving access to secondary and higher education, as this enhances awareness, promotes healthy behavior, and significantly improves health outcomes.
- iii. Policymakers should implement integrated Water, Sanitation, and Hygiene (WASH) programs, including improved sanitation infrastructure and hygiene promotion campaigns, to address environmental health challenges in a comprehensive and sustainable manner.

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