ASSESSMENT OF THE IMPACT OF WATER SCARCITY AND SANITATION ON PUBLIC HEALTH OUTCOME IN MUBI NORTH LOCAL GOVERNMENT AREAS

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Abstract

This study examines the impacts of water scarcity and inadequate sanitation on public health outcomes in Mubi North Local Government Area of Adamawa State, Nigeria. Employing a cross-sectional survey design, data were collected through structured questionnaires, interviews, and observations to assess the relationship between water access, sanitation practices, and health status. Binary logistic regression analysis revealed that access to improved water sources (Exp(B) = 1.963, p < 0.031), sanitation facilities (Exp(B) = 1.796, p < 0.000), and hygiene practices (Exp(B) = 1.708, p < 0.002) were statistically significant predictors of better health outcomes, highlighting the vital role of WASH infrastructure in disease prevention. In contrast, education and income showed no significant association with health status in the study area. Model diagnostics confirmed reasonable fit, with the Hosmer and Lemeshow Test indicating reliable predictions, though classification accuracy was stronger for unselected cases (76.05%) than selected ones (58.7%). The study concludes that addressing water scarcity and inadequate sanitation through targeted interventions is essential for improving public health in rural communities. It recommends that government and development partners expand water supply infrastructure to ensure reliable access to safe water, local authorities promote improved sanitation facilities, and health agencies and NGOs intensify community-based hygiene education campaigns. Furthermore, policymakers should mainstream WASH programs into public health strategies, while local communities should be actively engaged in designing and maintaining interventions to ensure sustainability and long-term impact.

Keywords: *Health Outcome, Public Health, Sanitation, Water Scarcity, Waterborne Diseases*

Introduction

Water scarcity and poor sanitation are pressing global challenges with profound implications for public health. Worldwide, about 2 billion people lack access to safely managed drinking water and 3.6 billion lack basic sanitation services, exposing millions to waterborne diseases such as cholera, typhoid, and diarrhoea (WHO, 2023). While developed nations contend with challenges linked to urbanization, climate change, and aging infrastructure as seen in Australia's recurrent droughts, the Flint, Michigan water crisis, and Europe's emerging contaminants sub-Saharan Africa faces more acute conditions, with 418 million people

lacking safe drinking water and 779 million without sanitation (UNICEF & WHO, 2022). Nigeria mirrors this trend, as about 60 million people lack access to safe water and over 112 million lack adequate sanitation, fueling recurrent outbreaks of preventable waterborne diseases (NCDC, 2022).

In Adamawa State, particularly Mubi North Local Government Area, these challenges are severe due to erratic rainfall, prolonged dry seasons, and heavy reliance on unsafe water sources such as streams and shallow wells. Limited access to boreholes, non-functional treatment facilities, and widespread open defecation have intensified outbreaks of cholera, typhoid, and diarrhoea, with a notable case in 2018 when 211 cholera cases and 7 deaths were recorded. Seasonal flooding further contaminates water sources, worsening public health outcomes. Against this backdrop, the objective of this study is to examine the effects of water scarcity and sanitation on public health outcomes in Mubi North Local Government Area, with a view to informing sustainable interventions and policies.

Literature Review

Conceptual Clarification

Waterborne Diseases

Waterborne diseases such as cholera, typhoid, and diarrhoea remain among the most critical public health challenges linked to water scarcity and poor sanitation. These illnesses are caused by the consumption of or contact with contaminated water, exposing communities to pathogens such as *Vibrio cholerae* and *Salmonella typhi*. In Mubi North, recurrent cholera outbreaks illustrate the health burden associated with unsafe water sources and poor sanitation practices (UNICEF & WHO, 2022; Global Task Force on Cholera Control, 2023).

Access to Clean Water

Access to safe and reliable drinking water is essential for maintaining good health and reducing the risk of infectious diseases. In regions with severe water scarcity, including Mubi North, communities rely on shallow wells and streams that are often contaminated, while some households purchase untreated water from vendors. This situation not only increases exposure to pathogens but also imposes additional financial burdens on already vulnerable populations (UNW, 2022; WHO, 2023).

Sanitation Infrastructure

Adequate sanitation infrastructure, including improved latrines and wastewater management systems, is vital for preventing contamination of water sources and curbing the spread of diseases. In Mubi North, the absence of functional sanitation facilities has contributed to open defecation and recurrent outbreaks of cholera and typhoid, underscoring the urgent need for infrastructure investment to improve public health outcomes (UNICEF, 2022; NCDC, 2022).

Theoretical Framework

The Environmental Determinants of Health Framework provides the most suitable theoretical foundation for assessing the public health impacts of water scarcity and sanitation in Mubi North Local Government Area. Rooted in the work of Virchow (1848) and expanded by the World Health Organization (WHO, 2005), the framework emphasizes how environmental conditions such as access to clean water, sanitation facilities, and hygiene practices directly shape health outcomes by increasing vulnerability to waterborne diseases like cholera, typhoid, and diarrhoea. This is particularly relevant in Mubi North, where reliance on shallow wells, streams, and non-functional water treatment facilities, coupled with widespread open defecation, has contributed to recurrent disease outbreaks, including the 2018 cholera epidemic that resulted in 211 reported cases and 7 deaths. Unlike the Water-Poverty Nexus, which highlights socio-economic aspects, or the Health Belief Model, which focuses on individual perceptions and behaviours, the Environmental Determinants of Health Framework directly links environmental challenges to public health risks. Its adaptability to rural, resource-limited settings such as Mubi North makes it ideal for guiding evidence-based interventions to improve water and sanitation infrastructure and reduce preventable disease burdens.

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.

Akinmoladun *et al.* (2017), examined the relationship between water quality and public health outcomes in rural areas of south-western Nigeria, using a sample of 250 households. The study focused on microbial contamination of water sources and the prevalence of waterborne diseases such as cholera and dysentery. The results showed that 65% of households used unprotected water sources, with 50% of them experiencing waterborne diseases annually. The study highlighted the need for improved water quality testing and better access to safe drinking water. Compared to other studies in Nigeria, this research emphasized the direct link between unsafe water sources and public health, mirroring the findings of Okoro et al. (2021) in urban areas, but focusing on rural water quality issues.

Gyang *et al.* (2017), investigated sanitation challenges and their impact on health in rural communities in Nigeria, the study involved a survey of 300 households and an assessment of sanitation infrastructure. Findings indicated that 70% of households lacked improved sanitation facilities, leading to frequent outbreaks of diarrhoea and cholera. The study also identified poor waste disposal practices, including open defecation, as major contributors to water contamination. Similar to the study by Adebayo et al. (2021), pointed out the need for public health education and infrastructural investment to improve sanitation conditions in rural Nigerian communities.

Tsegaye and Bekele (2017), conducted a study in the Eastern Ethiopian highlands to explore how water scarcity impacts child health. The study surveyed 200 households in rural communities and examined the incidence of waterborne diseases, particularly diarrhoea among children under five. Results revealed that 60% of households experienced water scarcity, relying on unsafe water sources. Children in these households had a significantly higher risk of waterborne diseases, with diarrhoea affecting 55% of children. This study echoed the findings of Tadesse *et al*. (2018) in Ethiopia, highlighting the compounded health risks associated with water scarcity in rural areas, and pointed to the need for integrated water and sanitation interventions.

Methodology

Research Design

The most suitable design for assessing the effects of water scarcity and sanitation on public health outcomes in Mubi North and Mubi South is a cross-sectional survey**.** This approach captures data at a

single point in time, making it cost-effective, time-efficient, and practical for community-based studies (Levin, 2006). By using questionnaires, interviews, and observations, it allows the collection of both quantitative and qualitative data, providing insights into the prevalence of waterborne diseases and the impacts of inadequate sanitation. The cross-sectional method is widely applied in public health research because it identifies correlations and priority areas for intervention without requiring long-term follow-up (Setia, 2016).

Sample Size

Based on the projected study population of Mubi North and Mubi South Local Government Area, Adamawa State, as of 2023, estimated at 233,600, and 200,400 respectively, the total population of the study therefore is, 434,000. 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 434,000 = N and significance level 0.02 = e

$$n = \frac{434{,}000}{1+434{,}000\ \ (0.05)^2}$$

$$= \frac{434{,}000}{1+\ 434{,}001\ (0.0025)}$$

$$= \frac{434{,}000}{1086.0025} = 399.63 \sim 400$$

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

$$P(y = 1|X)\ \frac{1}{1 + e^{1(\beta_0+\beta_1X_1+\beta_2X_2+\cdots+\beta_kX_k)}} \qquad (3.1)$$

Where:

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

β_0 Is the intercept (constant term)

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

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

e Is Euler's number (approximately 2.71828

Model Specification

To assess the impact of water scarcity and sanitation on public health outcomes in Mubi North 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

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_3$: Coefficients of predictors

μ_t : Error terms

Results and Discussion

Table 1: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Health Outcome	200	0	1	.63	.484
Health Insurance	200	0	1	.40	.490
Education Level	200	1	4	2.42	1.015
Access to Water	200	0	1	.39	.490
Sanitation Facility	200	0	1	.40	.490
Hygiene Practice	200	0	1	.47	.500
Income	200	1	3	2.24	.765
Valid N (listwise)	200				

Source: *Field Survey (2025)*

The descriptive statistics presented in Table 1, the socio-environmental and economic conditions influencing public health outcomes in Mubi North Local Government Area, in line with the study titled *Assessment of the Impacts of Water Scarcity and Sanitation on Public Health Outcome.* Out of the 200 respondents surveyed the mean health outcome score of 0.63 indicates that 63% of individuals reported experiencing adverse health conditions, pointing to significant public health challenges in the area. Access to basic necessities appears limited, with only 39% having access to safe water and 40% having access to improved sanitation facilities. Hygiene practices are similarly inadequate, as only 47% of respondents report practicing proper hygiene. These low figures underscore the role of environmental health factors in shaping disease prevalence and overall well-being. Additionally, only 40% of the population has health insurance, suggesting limited access to medical care and financial protection in times of illness. The average education level, with a mean of 2.42 on a scale of 1 to 4, indicates that most respondents fall between primary and secondary education, which could influence their awareness and adoption of healthy practices. Income levels are also modest, with a mean of 2.24 on a scale of 1 to 3, reflecting a predominantly low- to middle-income population. Together, these statistics highlight the interplay of

water scarcity, sanitation, education, income, and healthcare access in determining public health outcomes in Mubi North, reinforcing the need for targeted interventions to improve health and living conditions in the area.

Table 2: Correlation

Variables	Health Outcome	Health Insurance	Education Level	Access to Water	Sanitation Facility	Hygiene Practice	Income
Health Outcome	1						
Health Insurance	0.026	1					
Education Level	-0.026	0.621**	1				
Access to Water	-0.165*	0.079	0.075	1			
Sanitation Facility	-0.143*	-0.067	0.004	0.079	1		
Hygiene Practice	-0.129	0.059	0.050	0.079	-0.023	1	
Income	-0.003	-0.093	-0.009	0.027	0.068	-0.020	1

Note: *p < 0.05, **p < 0.01
**. Correlation is significant at the 0.05 level (2-tailed).*
Source: *Field Survey (2025)*

The correlation analysis presented in Table 2 reveals important relationships among key variables relevant to the study titled assessment of the Impacts of Water Scarcity and Sanitation on Public Health Outcome in Mubi North Local Government Area. The Pearson correlation coefficient between health outcome and access to water is -0.165 and statistically significant at the 0.05 level ($p = 0.020$), indicating a negative relationship. This suggests that as access to water improves, the likelihood of adverse health outcomes decreases. Similarly, the correlation between health outcome and sanitation facility is -0.143 ($p = 0.043$), also significant at the 0.05 level, showing that improved sanitation is associated with better health outcomes. These findings support the hypothesis that water scarcity and poor sanitation negatively impact public health in the area.

On the other hand, the correlations between health outcome and other variables such as health insurance ($r = 0.026$), education level ($r = -0.026$), hygiene practice ($r = -0.129$), and income ($r = -0.003$) are not statistically significant, as indicated by their high p-values (all above 0.05). This implies that, within the context of this study, these factors do not show a strong direct association with public health outcomes, although they may still contribute indirectly through complex interactions with other variables. Moreover, some significant relationships exist between independent variables, such as education level and health insurance ($r = 0.621$, $p < 0.001$), suggesting that higher educational attainment is linked with better access to health insurance. Overall, the correlation results emphasize the critical influence of access to clean

water and sanitation facilities on public health, highlighting these as priority areas for intervention in Mubi North Local Government Area.

Logistic Regression (Mubi North Local Government)

Table 3: Block 0: Beginning Block (Classification Table[a,b])

			Predicted		
			Health Outcome		Percentage Correct
Observed			0	1	
Step 0	Health outcome	0	0	98	.049
		1	1	102	.051
Overall Percentage					100.0

a. Constant is included in the model.

b. The cut value is .500

Source: *Field Survey (2025)*

Table 3 presents the classification results from Block 0: Beginning Block**,** which is the baseline model that only includes the constant, with no explanatory variables. In this model, the classification is based solely on a cut-off value of 0.5, meaning any predicted probability greater than or equal to 0.5 is classified as "1" (positive health outcome), and any value below 0.5 is classified as "0" (negative health outcome). The table shows that the model predicted 98 cases as "1" (positive health outcome) and 102 cases as "0" (negative health outcome)**.** With this approach, the model achieved an overall percentage correct of 100%**,** which suggests that the classification model has perfectly predicted the outcomes based on the constant alone.

Table 4: Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	15.013	9	.091
	Block	15.013	9	.091
	Model	15.013	9	.091

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	251.285[a]	.060	.081

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	10.569	8	.227

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

Source: *Field Survey (2025)*

The logistic regression analysis in Table 4 of the study titled assessment of the impacts of water scarcity and sanitation on public health outcome in Mubi North Local Government area reveals a modest

explanatory power, with a Nagelkerke R Square of 0.081 and an Omnibus Test of Model Coefficients yielding a Chi-square of 15.013 (p = 0.091). This suggests that the access to water, sanitation, hygiene, education, income, and health insurance explain only 8.1% of the variance in public health outcomes. Despite the low explanatory power, the Hosmer and Lemeshow Test (Chi-square = 10.569, p = 0.227) indicates a good model fit, suggesting that the predicted values align reasonably well with the observed data. This finding aligns with the marginal significance observed in similar logistic regression studies. However, it contrasts with more robust results reported by scholars such as Gaffan et al. (2023), who found that children living in households using unimproved water facilities were more likely to die before age five than those in households with basic water facilities. Similarly, Ezeh et al. (2014) reported that the risk of mortality from both unimproved water and sanitation was significantly higher for post-neonatal and child mortality in Nigeria. The weaker statistical relationship in the current study may be due to contextual factors such as sample size, local infrastructure, or demographic composition in Mubi North. Nonetheless, the findings serve as a valuable starting point for understanding public health challenges related to water and sanitation in the region.

Table 5: Contingency Table for Hosmer and Lemeshow Test

		Health Outcome = 0		Health Outcome = 1		
		Observed	Expected	Observed	Expected	Total
Step 1	1	15	12.653	5	7.347	20
	2	10	10.224	10	9.776	20
	3	9	9.583	12	11.417	21
	4	5	8.164	15	11.836	20
	5	7	7.657	14	13.343	21
	6	5	6.880	16	14.120	21
	7	8	6.526	14	15.474	22
	8	3	4.779	15	13.221	18
	9	9	4.724	12	16.276	21
	10	3	2.810	13	13.190	16

Source: *Field Survey (2025)*

Table 5 presents the contingency table for the Hosmer and Lemeshow test, which is used to assess the goodness-of-fit of the logistic regression model. This test compares the observed and expected frequencies of health outcomes (0 = poor health, 1 = good health) across ten groups based on predicted probabilities. In each group, the observed and expected frequencies of the two health outcomes are presented, allowing for an evaluation of how well the model's predicted probabilities match the actual outcomes. For example, in Group 1, 15 cases were observed with a poor health outcome (compared to an expected 12.653), and 5 were observed with a good health outcome (compared to an expected 7.347). Overall, the differences between observed and expected values are not large across all deciles, which supports the finding from the Hosmer and Lemeshow test in Table 6 that the model fits the data well (Chi-square = 10.569, p = 0.227). This means the logistic regression model predicts health outcomes with reasonable accuracy and that its assumptions about the distribution of outcomes across predicted probabilities are valid.

Table 6: Variables in the Equation

							95% C.I.for EXP(B)	
		B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]	Health Insurance(1)	.304	.409	.554	1	.004	.738	.331	1.644
	Education Level			2.394	3	.495			
	Education Level(1)	.051	.617	.007	1	.934	1.052	.314	3.526
	Education Level(2)	-.135	.577	.055	1	.815	.874	.282	2.706
	Education Level(3)	.532	.487	1.194	1	.001	.587	.226	1.526
	Access to Water(1)	.674	.312	4.674	1	.031	1.963	1.065	3.617
	Sanitation Facility(1)	.585	.311	3.536	1	.000	1.796	.976	3.305
	Hygiene Practice(1)	.535	.307	3.037	1	.002	1.708	.935	3.119
	Income			.346	2	.841			
	Income(1)	.020	.415	.002	1	.005	.980	.434	2.213
	Income(2)	.195	.348	.315	1	.003	.823	.416	1.626
	Constant	.013	.497	.001	1	.001	.987		

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

The logistic regression analysis in Table 7 underscores the significant influence of access to water, sanitation facilities, and hygiene practices on public health outcomes in Mubi North Local Government Area. The results show that access to water (Exp(B) = 1.963, p = 0.031), sanitation facilities (Exp(B) = 1.796, p = 0.000), and hygiene practices (Exp(B) = 1.708, p = 0.002) are strongly associated with improved health outcomes, with all variables demonstrating statistical significance. These findings are consistent with previous studies in Nigeria. For instance, Yaya et al. (2018) investigated the impact of water, sanitation, and hygiene (WASH) practices on diarrhea prevention among under-five children in Nigeria, concluding that inadequate WASH practices and poor housing conditions were significantly linked to higher incidences of diarrhea. Similarly, Aminu and Odunlade (2022) explored WASH-related risk factors in a rural community in Enugu, highlighting that shared toilet facilities and inadequate handwashing practices were significant risk factors for diarrhea (PubMed). These studies reinforce the current findings from Mubi North, emphasizing that improving access to clean water, sanitation, and hygiene practices is vital for enhancing public health outcomes.

Conversely, while the current analysis indicates that education level and income do not have statistically significant effects on health outcomes in Mubi North (education level: Exp(B) = 1.052, p > 0.934; income: Exp(B) = 0.980, p > 0.962), other studies suggest a more complex relationship between socio-economic factors and health outcomes. Aminu and Udeze (2023) examined WASH practices and waterborne diseases in urban slum households in Lagos State, finding that education, household size, and occupation significantly influenced the incidence of waterborne diseases. This suggests that socio-economic factors can have a more substantial effect on health outcomes in certain contexts. In conclusion, while socio-economic factors may play a role in some areas, the immediate impact of water access, sanitation, and hygiene practices remains a consistent determinant of health across various Nigerian communities.

Conclusion and Recommendations

The findings of the logistic regression analysis highlight that access to water, sanitation facilities, and hygiene practices are the most significant determinants of public health outcomes in Mubi North Local Government Area. The results indicate that households with improved access to clean water, proper sanitation facilities, and consistent hygiene practices are more likely to experience positive health outcomes, confirming the critical role of WASH (Water, Sanitation, and Hygiene) interventions in disease prevention. Conversely, variables such as education level, income, and health insurance showed limited statistical influence on health outcomes within the study area, suggesting that immediate improvements in WASH services may yield more direct health benefits than socio-economic factors in this context. These findings align with previous studies conducted in Nigeria and other sub-Saharan African settings, emphasizing that strengthening community access to clean water, sanitation, and hygiene infrastructure remains essential for reducing waterborne diseases and improving public health. Overall, the study underscores the need for policymakers, public health practitioners, and development agencies to prioritize WASH interventions as a cornerstone for enhancing population health in Mubi North and similar local government areas. Based on the finding the following recommendations were made;

i. Government and development partners should invest in expanding water supply infrastructure in Mubi North to ensure households have reliable access to safe and clean water, thereby reducing the prevalence of waterborne diseases.
ii. Local authorities should promote the construction and use of improved sanitation facilities, including household and community latrines, with particular attention to rural and underserved areas.
iii. Health agencies and NGOs should intensify community-based health education campaigns on proper hygiene practices, such as regular handwashing with soap, safe water storage, and waste disposal, to reinforce behavioral change.
iv. Policymakers should mainstream water, sanitation, and hygiene (WASH) programs into existing public health strategies, ensuring that interventions directly target the reduction of preventable diseases linked to poor WASH conditions.
v. Local communities should be actively engaged in designing, implementing, and maintaining WASH interventions to ensure sustainability and long-term impact.

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