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Urban Public Water Supply and Environmental Health Implications for Sustainable Development Goal 6 in Enugu, Nigeria

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Abstract

Access to safe and reliable water remains a major challenge in many rapidly urbanising cities in Nigeria, with significant implications for environmental health and the attainment of Sustainable Development Goal 6 (SDG 6). This study examined urban public water supply in Enugu, Nigeria, focusing on its adequacy, reliability, and environmental health implications, as well as the institutional, infrastructural, and socioeconomic factors influencing equitable and sustainable access to safe water. A descriptive survey research design was adopted, combining questionnaire administration to urban residents with interviews and field observations. The sample size of 400 respondents was determined from a population of 1,029,400 people using Taro Yamane formula. Quantitative data were analysed using frequency, mean and linear regression, while qualitative data were thematically analysed. Findings indicate that public water supply services in Enugu urban are largely inadequate and unreliable, with most indicators failing to align with SDG 6 standards. Inadequate water supply was found to significantly exacerbate environmental health risks, including increased incidence of waterborne diseases, poor hygiene practices, and unsafe household water storage, particularly in low-income and informal settlements. Institutional weaknesses, insufficient infrastructure investment, poor maintenance, and household income disparities further constrain equitable and sustainable access to safe water. The study concludes that persistent gaps between water policy objectives and service delivery undermine progress toward SDG 6 in Enugu urban. It recommends strengthened institutional coordination, increased investment in water infrastructure, improved maintenance regimes, and targeted pro-poor water policies to enhance environmental health outcomes and ensure sustainable urban water access.

Keywords: Digital Entrepreneurship; Youth Empowerment; Employment Creation; Post-Training Support; Digital Skills

1. Introduction

The availability of water underpins ecological stability and human survival, particularly in rapidly urbanizing environments. Water improves the health of humans, supports the environment, and contributes to economic growth. Water is critical to improving public health, sanitation, and sustainable management of the environment. The lack of a safe, reliable source of clean drinking water for many urban areas in Nigeria, including Enugu urban, is an issue that leads to a variety of adverse consequences for environmental health. The United Nations recognises that water is vital to human development and sustainability, and has established Sustainable Development Goals (SDG 6) to ensure the availability and sustainable management of water, sanitation and hygiene (WASH) for all people worldwide by 2030 (Ghulam *et al.,* 2023). Data from Enugu urban and other cities in urban Nigeria demonstrate that the availability of safe and affordable drinking water remains a significant challenge due to systemic, infrastructure and environmental problems.

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In Enugu urban, access to clean and reliable water sources remains sporadic and insufficient, compelling a large section of the population to rely on alternative and often unsafe water sources such as shallow wells, untreated boreholes, streams, and commercial water vendors. This irregular access is often a reflection of decaying infrastructure, poor maintenance of public water systems, and institutional inefficiencies. Asomba and Ofodu (2024) noted that the urban water supply system in Enugu is characterized by frequent pipeline failures, insufficient treatment capacity, and poor network coverage, resulting in low per capita water delivery. These deficiencies directly contradict the goals outlined under Sustainable Development Goal 6, which emphasize the need for sustainable water infrastructure and inclusive service delivery. The World Health Organization (2020) noted that inadequate water supply, particularly in densely populated urban areas, often leads to increased incidences of waterborne diseases, such as cholera, typhoid, and dysentery, due to the reliance on contaminated sources and improper storage methods at the household level.

Furthermore, the health implications of this water crisis are far-reaching. A study by Chiaha and Ewuim (2024) revealed that more than 70 percent of households in Enugu urban lack access to water that meet the minimum standards of safety and quality. The environmental health of residents is compromised not only by contaminated water but also by the poor sanitary conditions that arise from water scarcity. The inability to maintain proper hygiene such as handwashing, toilet flushing, and cleaning of cooking utensils fosters a breeding ground for disease transmission, especially in semi-urban and low-income neighborhoods. These challenges reflect the failure to meet not just the infrastructure component of Sustainable Development Goal 6, but also the hygiene and sanitation targets which are integral to ensuring safe living environments.

Globally, water insecurity in urban contexts has been linked to poor institutional governance, inadequate investment in infrastructure, and climate-related stressors (Adeoti *et al.,* 2023). In Nigeria, institutional fragmentation is a significant barrier to realizing Sustainable Development Goal 6. Multiple layers of authority, federal, state, and local government agencies share overlapping responsibilities for water management, leading to disjointed efforts, accountability gaps, and ineffective service delivery. This is particularly evident in Enugu, where coordination among water authorities has remained weak, resulting in delayed policy implementation and underfunded infrastructure projects.. In addition to institutional challenges, socioeconomic inequalities in Enugu urban also play a pivotal role in limiting access to clean water. Residents in informal settlements and low-income areas are disproportionately affected by water scarcity, often paying more for unsafe water than their counterparts in affluent neighborhoods. This inequity contravenes the core ethos of Sustainable Development Goal 6, which promotes universal access and aims to reduce disparities within and among communities. This intersectional burden has been well-documented by World Bank (2021), which argues that achieving Sustainable Development Goal 6 requires not only technical solutions but also socio-behavioural interventions that recognize the gender dimensions of water access.

Environmental consequences of inadequate water supply further exacerbate health risks in Enugu urban. In many cases, residents are forced to store water in open or semi-covered containers, creating breeding grounds for mosquitoes and other vectors. This contributes not only to waterborne diseases but also to vector-borne illnesses such as malaria and dengue fever. According to Ume and Nnaji (2020), the link between inadequate water infrastructure and poor environmental health outcomes in Enugu urban is evident in the high frequency of preventable diseases and the strain on public health facilities. These findings underscore the importance of integrating environmental health indicators into water management policies to achieve a more holistic implementation of Sustainable Development Goal 6. The inadequacy of water supply in Enugu urban presents a multidimensional challenge that affects environmental health, public hygiene, social equity, and institutional governance. These challenges mirror broader national and global trends in urban water insecurity, yet the consequences in Enugu are particularly severe due to the interplay of poor infrastructure, institutional inefficiencies, and socioeconomic vulnerabilities.

Addressing these issues requires a deliberate and context-specific approach aligned with Sustainable Development Goal 6, which emphasizes not only infrastructural improvements but also inclusive governance, environmental protection, and social equity. By situating this study within the framework of Sustainable Development Goal 6, the research aims to contribute to a deeper understanding of how inadequate water supply affects environmental health and to explore strategies for sustainable urban water management in Enugu urban and similar Nigerian cities.

1.1. Statement of the Problem

Despite the recognition of water as a fundamental requirement for human health, environmental sustainability, and socioeconomic development, access to safe, reliable, and affordable drinking water remains a persistent challenge in many urban areas of Nigeria. Enugu urban exemplifies this challenge, where public water supply systems are characterized by erratic service delivery, deteriorating infrastructure, limited treatment capacity, and inadequate network coverage. As a result, a substantial proportion of residents depend on alternative water sources such as shallow

wells, untreated boreholes, surface water, and commercial vendors, many of which do not meet minimum safety and quality standards.

This situation poses serious environmental health concerns. The reliance on contaminated or poorly managed water sources increases residents' exposure to waterborne and vector-borne diseases, while water scarcity undermines basic hygiene practices such as handwashing, sanitation, and safe food preparation. Poor water availability also encourages unsafe water storage practices, further compounding environmental health risks. These conditions disproportionately affect low-income and informal settlements within Enugu urban, thereby exacerbating social and health inequalities.

Although Sustainable Development Goal 6 (SDG 6) emphasizes universal access to safe water, sanitation, and hygiene through sustainable and inclusive water management, progress toward achieving this goal in Enugu urban has been limited. Institutional inefficiencies, weak governance structures, inadequate funding, and poor stakeholder coordination continue to hinder effective water service delivery. Moreover, limited community participation in water governance and planning has reduced the responsiveness and sustainability of existing interventions.

While several studies have examined water supply challenges in urban Nigeria, there remains a gap in specific research that explicitly links inadequate water supply to environmental health outcomes within the framework of SDG 6 in Enugu urban. This lack of integrated understanding constrains evidence-based policy formulation and targeted interventions. Therefore, the problem addressed in this study is the persistent inadequacy of water supply in Enugu urban and its implications for environmental health, equity, and sustainable development, despite national and global commitments to achieving Sustainable Development Goal 6.

Objectives of the Study

The specific objectives are to:

- Assess the alignment of the adequacy and reliability of water supply sources in Enugu urban to the standards and targets of Sustainable Development Goal 6.
- Examine the environmental health implications of inadequate water supply in Enugu urban, with particular focus on waterborne diseases, hygiene practices, and household water storage conditions.
- Evaluate how the institutional, infrastructural, and socioeconomic factors influence equitable and sustainable access to safe water in Enugu urban.

Research Questions

The following research questions are posed to guide the study.

- To what extent do the adequacy and reliability of water supply sources in Enugu urban align with the standards and targets of Sustainable Development Goal 6?
- What are the environmental health implications of inadequate water supply in Enugu urban, with particular focus on waterborne diseases, hygiene practices, and household water storage conditions?
- How do institutional, infrastructural, and socioeconomic factors influence equitable and sustainable access to safe water in Enugu urban?

Statement of Hypotheses

The following hypotheses were tested in the course of this research

- There is a significant alignment between the adequacy and reliability of water supply sources in Enugu urban and the standards and targets of Sustainable Development Goal 6.
- Inadequate water supply has a significant impact on environmental health in Enugu urban, particularly with respect to waterborne diseases, hygiene practices, and household water storage conditions.
- Institutional, infrastructural, and socioeconomic factors significantly influence equitable and sustainable access to safe water in Enugu urban.

2. Review of the Related Literature

2.1. Conceptual Review

2.1.1. Water Supply

Water supply refers to the process of providing water in adequate quantity and quality for various human uses, including drinking, sanitation, domestic, industrial, and agricultural purposes. In the context of urban areas, it involves the abstraction, treatment, distribution, and regulation of water to meet the needs of a growing population (Okafor, Dim and Ezeabasili, 2023). Water supply is not merely the physical availability of water, but also encompasses the reliability, safety, and accessibility of that water to end users in a sustainable and equitable manner. Effective water supply systems are essential for public health, economic productivity, and environmental sustainability, particularly in developing countries like Nigeria, where infrastructure deficits and governance issues often undermine service delivery (Asomba and Ofodu, 2024).

2.1.2. Adequacy and Reliability of Water Supply Sources

The adequacy and reliability of water supply sources are critical determinants of public health, environmental sustainability, and overall quality of life in urban areas. Adequacy refers to the sufficiency of water quantity and quality to meet daily domestic needs, while reliability concerns the consistency and predictability of water availability over time (Adeoti *et al.,* 2023). Inadequacy of water supply according to WHO (2020) refers to the situation where households or communities lack sufficient access to clean, safe, and reliable water for daily use, including drinking, cooking, hygiene, and sanitation. It encompasses both quantitative inadequacy (insufficient volume) and qualitative inadequacy (unsafe or contaminated water). In urban contexts, this may result from failing infrastructure, limited water sources, or poor governance. In many rapidly growing urban centers such as Enugu urban, water supply systems are often constrained by aging infrastructure, limited treatment capacity, and weak distribution networks, resulting in intermittent supply and unequal access. These challenges force households to depend on alternative and often unsafe water sources, undermining hygiene practices and increasing exposure to water-related diseases. Ensuring adequate and reliable water supply is therefore essential for achieving sustainable urban development and meeting the targets of Sustainable Development Goal 6.

2.1.3. Environmental Health

Environmental health refers to the branch of public health that deals with all the physical, chemical, and biological factors external to a person, and all related factors impacting behaviours. It encompasses the assessment and control of environmental factors that can potentially affect health; including water quality, waste management, air pollution, and vector control (USEPA, 2021).

Environmental health plays a crucial role in preventing disease and promoting well-being by addressing environmental risk factors that can affect populations. Poor environmental conditions such as contaminated water sources, exposure to hazardous chemicals or unsanitary waste disposal can lead to a range of health problems, including respiratory diseases, gastrointestinal infections, neurological disorders, and even certain types of cancer. Vulnerable populations, such as children, the elderly, and those living in low-income or densely populated areas, are especially at risk due to limited access to clean environments and healthcare services (Joshua et al., 2023). Environmental health emphasizes the critical role of regulating and monitoring air and water quality. Air pollution, stemming from industrial activities and fossil fuel combustion, poses significant health risks, particularly from particulate matter, nitrogen dioxide, and ozone. Access to clean drinking water is equally vital for preventing waterborne diseases. Effective water treatment and sanitation are therefore essential public health components **(**Milstein and Stark, 2025).

2.1.4. Water Supply Infrastructure

Water supply infrastructure refers to the physical systems and facilities used to extract, treat, store, and distribute water to end users. These include dams, reservoirs, treatment plants, transmission pipelines, distribution networks, pumping stations, storage tanks, and service connections (Ajayi and Olagunju, 2022). An effective water supply infrastructure ensures that water is delivered in sufficient quantity and acceptable quality to meet the demands of households, institutions, and industries. Water infrastructure challenges are often compounded by rapid urbanization, population growth, and limited investments in infrastructure renewal. Without regular maintenance and expansion of water networks, the system becomes increasingly unable to meet demand, especially in peri-urban and low-income settlements. According to UN-Habitat (2023), the lack of resilient water infrastructure in African cities is one of the main barriers to achieving Sustainable Development Goal 6, which emphasizes sustainable water management and equitable

access. Thus, the quality, reach, and reliability of water supply infrastructure are fundamental to improving water access and reducing the environmental health risks associated with water scarcity and contamination.

2.1.5. Access to Safe Water

Access to safe water refers to the ability of individuals or communities to obtain water that is safe for drinking and other domestic uses, free from pathogens and harmful contaminants. The World Health Organization (2020) defines water as water that meets national or international quality standards and is safe for consumption without risk of waterborne disease. Access is not merely about availability but also involves affordability, reliability, and proximity. Long distances to water sources and high costs from commercial vendors place additional burdens on low-income households. These inequities contradict the principles of SDG 6, which aims to ensure universal and equitable access to safe and affordable drinking water for all by 2030.

2.1.6. Sustainable Development Goal 6 (SDG 6)

Sustainable Development Goal 6 (SDG 6) is one of the 17 global goals adopted by United Nations Member States in 2015 as part of the 2030 Agenda for Sustainable Development. SDG 6 aims to "ensure availability and sustainable management of water and sanitation for all" by the year 2030. It recognizes water as a fundamental human right and a critical component of health, environmental sustainability, and economic development (UN-Water, 2020).

The goal comprises several targets, including:

- **6.1:** Achieving universal and equitable access to safe and affordable drinking water.
- **6.2:** Providing access to adequate and equitable sanitation and hygiene.
- **6.3:** Improving water quality by reducing pollution, eliminating dumping, and minimizing the release of hazardous chemicals.
- **6.4:** Increasing water-use efficiency and ensuring sustainable withdrawals.
- **6.5:** Implementing integrated water resources management at all levels.
- **6.6:** Protecting and restoring water-related ecosystems (UN, 2023).

Sustainable Development Goal 6 (SDG 6) provides a globally recognized framework for evaluating and improving water and sanitation systems. The failure to achieve SDG 6 affects the attainment of other goals, such as SDG 3 (Good Health and Well-being), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action).

2.2. Theoretical Framework

This study is grounded on Pressure-State-Response (PSR) Theory developed by the Organisation for Economic Co-operation and Development (OECD) in the early 1990s. Pressure-State-Response (PSR) Theory provides a comprehensive theoretical basis for analyzing environmental health issues, including water supply challenges in urban settings. It is a widely used environmental management model that explains the dynamic relationship between human activities, environmental conditions, and societal responses. The framework categorizes environmental issues into three interrelated components:

- **Pressure**: These are the human activities and natural forces that exert stress on the environment. In this study, pressures include population growth, poor water administration, infrastructural decay, and pollution of water sources due to improper sanitation and waste disposal.
- **State**: This refers to the condition of the environment as a result of these pressures. For instance, the current state in Enugu urban includes irregular water availability, contamination of water sources, and degraded water infrastructure all contributing to compromise water quality and public health risks.
- **Response**: These are the actions taken by individuals, governments, or institutions to prevent, reduce, or manage environmental degradation. In this context, responses include policy reforms, investment in water infrastructure, community participation in water management, and alignment with Sustainable Development Goal 6.

The Pressure-State-Response (PSR) framework is relevant to this study as it provides a structured approach for examining how human-induced pressures affect water supply systems, alter environmental conditions, and influence health outcomes in urban areas. In Enugu urban, pressures such as rapid population growth, aging infrastructure, poor maintenance, and institutional fragmentation have led to unreliable access to safe water and increased reliance on unsafe sources, thereby heightening the risk of waterborne and vector-borne diseases. These impacts are more severe in low-income communities. The framework also reveals that policy and community responses remain inadequate due to weak enforcement, limited funding, and low stakeholder participation. Applying the PSR model enables a systematic

evaluation of these challenges and supports the identification of inclusive and sustainable strategies for achieving Sustainable Development Goal 6 in Enugu urban.

3. Materials and Methods

This study employed a descriptive survey design to examine the adequacy and reliability of urban water supply and associated environmental health outcomes in Enugu urban, Nigeria. The study area comprises Enugu East, Enugu North, and Enugu South Local Government Areas in Enugu State South-Eastern Nigeria. The study population included urban households and key informants such as officials of the Enugu State Water Corporation, environmental health officers, and community leaders. Based on a projected population of 1,029,400 (National Bureau of Statistics, 2022), a sample size of 400 respondents was determined at a 5% margin of error using the Taro Yamane method and proportionally allocated across the three local government areas. A two-stage sampling procedure was applied; involving stratification by local government area followed by purposive selection of respondents with direct experience of water supply and environmental health conditions. Data were collected using structured questionnaires, key informant interviews, and field observations. The questionnaire comprised Likert-scale items addressing water source characteristics, adequacy, reliability, cost, and self-reported environmental health outcomes. Semi-structured interviews provided institutional and governance perspectives, while observational assessments focused on water infrastructure conditions, sanitation facilities, and environmental health risks. Instrument validity was established through expert review in public administration and environmental health, and a pilot test conducted outside the study area yielded a Cronbach's alpha coefficient of 0.78, indicating satisfactory internal consistency. A total of three hundred and forty-two (342) copies of the questionnaire were properly completed and were used for the analysis. Quantitative data were analysed using both descriptive and inferential statistical techniques. Descriptive statistics such as frequencies and mean scores were used to analyze quantitative data, while inferential statistics including linear and multiple regression analysis were used to test the formulated hypotheses at a 0.05 level of significance. Qualitative data were analysed thematically to support interpretation of the quantitative findings.

4. Results

The results of data collected are presented and analysed according to the research questions using frequency and mean scores, any item with a mean of 3.00 or above was agreed while any item with a mean score below 3.00 was disagreed. The hypotheses were also tested using Linear and Multiple Regression analysis.

4.1. Research Question One

To what extent do the adequacy and reliability of water supply sources in Enugu urban align with the standards and targets of Sustainable Development Goal 6?

Table 1 Mean score on extent the adequacy and reliability of water supply sources in Enugu urban align with the standards and targets of Sustainable Development Goal 6

S/N	Questionnaire Items	SA \(5)	A (4)	U (3)	D (2)	SD (1)	Total	Mean	Decision
1	Public water supply services in Enugu urban are reliable enough to reduce dependence on alternative water sources such as wells or vendors	60 300	72 288	54 162	86 172	70 70	342 1386	2.41	Disagree
2	Water from the main source used by households is consistently available when needed	58 290	69 276	51 153	88 176	76 76	342 971	2.84	Disagree
3	Information on water supply schedules, interruptions, or maintenance is communicated clearly and in a timely manner by water authorities	45 225	63 252	49 147	92 184	93 93	342 901	2.63	Disagree
4	The quality of water supplied to households meet acceptable standards	62 310	70 3280	44 132	90 180	76 76	342 978	2.86	Disagree

	for safe domestic use without additional treatment								
5	Interruptions in water supply in Enugu urban occur frequently	140 700	112 448	30 90	40 80	20 20	342 1338	3.91	Agree
6	The cost of obtaining water in Enugu urban is affordable and consistent with the principle of equitable access promoted under SDG 6	55 275	68 272	50 150	95 190	74 74	342 961	2.81	Disagree
7	The water supply system in Enugu urban aligns with the SDG 6 target of ensuring safe, reliable, and sustainable access to water for all.	52 260	61 244	48 144	98 196	83 83	342 927	2.71	Disagree
Total average mean		2.41+2.84+2.63+2.86+3.91+2.81+2.71					20.17 7	2.88	Disagree

Source: Field Work, 2025

The results presented in Table 1 show that the adequacy and reliability of water supply sources in Enugu urban largely do not align with the standards and targets of Sustainable Development Goal 6 (SDG 6). Six of the seven indicators recorded mean scores below the acceptance benchmark of 3.00, indicating respondents' general disagreement that public water supply is reliable, consistently available, safe for domestic use, affordable, or equitably accessible. In addition, respondents perceived communication from water authorities regarding supply schedules and interruptions as inadequate, further reflecting institutional weaknesses in water service delivery.

However, respondents strongly agreed that interruptions in water supply occur frequently, as reflected by the high mean score for this item. The average mean score of 2.88 confirms that water supply services in Enugu urban remain inadequate and unreliable when assessed against SDG 6 targets. These findings suggest persistent gaps between policy aspirations and actual service provision, underscoring the need for improved infrastructure, better governance, and more equitable water management strategies to advance sustainable urban water access in Enugu urban.

4.2. Test of Hypothesis One

There is a significant alignment between the adequacy and reliability of water supply sources in Enugu urban and the standards and targets of Sustainable Development Goal 6.

Table 2 Summary of Linear Regression Analysis for Hypothesis One

Variable	**Unstandardized Coefficients**		**Standardized Coefficients**	**T-value**	**P-value**
	B	Std. Error	Beta		
(Constant)	2.984	0.211	-	14.14	0.000
Adequacy and reliability of water supply sources	0.084	0.061	0.072	1.38	0.168.

Model Summary: R = 0.072, R^2 = 0.005, Adjusted R^2 = 0.002, F(1, 340) = 1.90, p = 0.168

Table 2 presents the results of the linear regression analysis conducted to test Hypothesis One. The findings show that the adequacy and reliability of water supply sources do not significantly predict alignment with the standards and targets of Sustainable Development Goal 6. The standardized beta coefficient (β = 0.072) indicates a very weak positive relationship between the variables. The t-value of 1.38 and corresponding p-value of 0.168 ($p > 0.05$) indicate that the relationship is not statistically significant. The model summary further reveals a very low coefficient of determination ($R^2 = 0.005$), suggesting that only 0.5% of the variation in alignment with SDG 6 targets is explained by the adequacy and reliability of water supply sources. The F-statistic ($F = 1.90$, $p = 0.168$) confirms that the regression model is not a good fit.

Based on these results, the null hypothesis is accepted, while the alternative hypothesis is rejected. This implies that there is no significant alignment between the adequacy and reliability of water supply sources in Enugu urban and the standards and targets of Sustainable Development Goal 6. This finding corroborates the descriptive results from research question one, which revealed widespread inadequacy, unreliability, and frequent interruptions in urban water supply.

4.3. Research Question Two

What are the environmental health implications of inadequate water supply in Enugu urban, with particular focus on waterborne diseases, hygiene practices, and household water storage conditions?

Table 3 Mean Score on the environmental health implications of inadequate water supply in Enugu urban

S/N	Questionnaire Items	SA (5)	A (4)	U (3)	D (2)	SD (1)	Total	Mean	Dec
1	Inadequate water supply in Enugu urban increases the incidence of waterborne diseases such as cholera, typhoid, and diarrhea	126 630	91 364	26 78	53 106	46 46	342 1224	3.58	Agree
2	Poor access to water makes it difficult to maintain proper sanitation and hygiene practices in many household	74 370	169 670	18 54	37 74	44 44	342 1218	3.56	Agree
3	Inadequate water supply in Enugu Urban contributes to the spread of waterborne diseases in low-income areas	61 305	154 616	36 108	42 84	49 49	342 1162	3.40	Agree
4	Lack of adequate water supply leads to increased open defecation in some parts of the city	79 395	107 428	28 84	56 112	72 72	342 1091	3.19	Agree
5	People in slums and ghetto areas suffer from dysentery due to drinking unsafe water	166 830	76 304	11 33	55 110	34 34	342 1311	3.83	Agree
6	Families in low income areas regularly experience water-related health issues (such as diarrhea or typhoid) due to poor water access	181 905	67 268	14 42	60 120	18 18	342 1353	3.96	Agree
7	Environmental health of residents in Enugu urban is adversely affected by inadequate and unreliable water supply	206 1030	91 364	9 27	21 42	15 15	342 1478	4.32	Agree
Total average mean		3.58+3.56+3.40+3.19+3.83+3.96+4.32					25.84 7	3.69	Agree

Source: Field Data, 2025

The statistical analysis in Table 3 indicates that inadequate water supply in Enugu urban has significant adverse environmental health implications. All seven questionnaire items recorded mean scores above the benchmark of 3.00, signifying respondents' general agreement that poor and unreliable water supply contributes to increased incidence of waterborne diseases, undermines hygiene and sanitation practices, and exposes residents—particularly those in low-income and slum areas—to serious health risks such as diarrhea, typhoid, and dysentery.

The overall average mean score of 3.69 further confirms that inadequate water supply negatively affects the environmental health of residents in Enugu urban. Respondents strongly acknowledged that poor access to water exacerbates unsafe water consumption, poor household sanitation, and unhealthy living conditions, thereby increasing vulnerability to preventable diseases. These findings underscore the close link between water supply inadequacy and environmental health outcomes and highlight the urgent need for improved, reliable, and equitable water provision as a critical strategy for reducing disease burden and promoting public health in Enugu urban.

4.4. Test of Hypothesis Two

Inadequate water supply has a significant impact on environmental health in Enugu urban, particularly with respect to waterborne diseases, hygiene practices, and household water storage conditions.

Table 4 Summary of Linear Regression Analysis for Hypothesis Two

Variable	Unstandardized Coefficients		Standardized Coefficients	T-value	P-value
	B	Std. Error	Beta		
(Constant)	1.287	0.196	-	6.57	0.000
Inadequate water	0.648	0.059	0.728	10.98	0.000
Model Summary: R = 0.728, R^2 = 0.530, Adjusted R^2 = 0.526,F(1, 340) = 122.6, p = 0.000					

The linear regression analysis indicates a statistically significant relationship between inadequate water supply and environmental health outcomes in Enugu urban. Inadequate water supply is a strong positive predictor of adverse environmental health conditions ($\beta = 0.728$, $p < 0.001$). The model explains approximately 53% of the variance in environmental health outcomes, including the prevalence of waterborne diseases, compromised hygiene practices, and unsafe household water storage conditions.

The high explanatory power of the model ($R^2 = 0.530$) suggests that deficiencies in water availability and reliability play a substantial role in shaping environmental health risks in the study area. The F-statistic further confirms the overall significance of the regression model ($F = 122.6$, $p < 0.001$). Given that the regression coefficient is statistically significant at the 5% level, the alternate hypothesis two is accepted. The findings provide empirical evidence that inadequate water supply significantly affects environmental health in Enugu urban, consistent with the standards and public health concerns emphasized under Sustainable Development Goal 6

4.5. Research Question Three

How do institutional, infrastructural, and socioeconomic factors influence equitable and sustainable access to safe water in Enugu urban?

Table 5 Mean score on how institutional, infrastructural, and socioeconomic factors influence equitable and sustainable access to safe water in Enugu urban

S/N	Questionnaire Items	SA (5)	A (4)	U (3)	D (2)	SD (1)	Total	Mean	Dec
1	Weak coordination among water management institutions in Enugu urban negatively affects equitable access to safe water	212 1060	79 316	16 48	23 46	12 12	342 1482	4.33	Agree
2	Inadequate investment in water infrastructure such as pipelines, treatment plants, and storage facilities limits the sustainability of water supply in Enugu urban	173 865	103 412	22 66	31 62	13 13	342 412	4.15	Agree
3	Poor maintenance of existing water infrastructure contributes to frequent breakdowns and unequal water distribution across neighborhoods	206 1030	85 340	26 78	15 30	10 10	342 1488	4.35	Agree
4	Household income level influences the ability of residents to access safe and reliable water sources in Enugu urban	184 920	73 29	22 66	34 68	29 29	342 1375	4.02	Agree
5	Government policies and regulatory frameworks are ineffectively implemented to ensure	211 1055	88 352	12 36	20 40	11 11	342 1494	4.37	Agree

	equitable and sustainable access to safe water in Enugu urban.								
6	Residents in low-income or informal settlements experience greater challenges in accessing safe water compared to those in high-income areas	197 985	85 340	22 66	26 52	12 12	342 1455	4.26	Agree
7	The cost of water from private sources as a result of inadequacy of public sources affects households' ability to maintain consistent access to safe water	194 970	97 388	7 21	38 76	6 6	342 1461	4.27	Agree
Total average mean		4.33 + 4.15 + 4.35 + 4.02 + 4.37 + 4.26 + 4.27					29.75 7	4.25	Agree

Source: Field Work, 2025

The analysis of data presented in Table 5 indicates a strong consensus among respondents that institutional, infrastructural, and socioeconomic factors significantly influence equitable and sustainable access to safe water in Enugu urban. All seven items recorded mean scores well above the acceptance benchmark of 3.00, with values ranging from 4.02 to 4.37, reflecting broad agreement that weaknesses in governance structures, inadequate infrastructure investment, and poor maintenance of water facilities contribute to persistent inequalities in water access across the city. In particular, high mean scores for institutional coordination failures and ineffective policy implementation highlight systemic governance challenges affecting urban water service delivery. The respondents underscore the socioeconomic dimensions of water inequality in Enugu urban by strongly agreed that household income levels, high dependence on private water vendors, and the marginalization of low-income and informal settlements exacerbate disparities in access to safe and reliable water.

The overall average mean score of 4.25 confirms that these combined factors pose major constraints to achieving equitable and sustainable urban water management in line with SDG 6. The results suggest that addressing water access challenges in Enugu urban requires integrated reforms that strengthen institutional capacity, expand and maintain infrastructure, and reduce the financial burden of water access on vulnerable households.

4.6. Test of Hypothesis Three

Institutional, infrastructural, and socioeconomic factors significantly influence equitable and sustainable access to safe water in Enugu urban.

Table 6 Summary of Multiple Regression Analysis for Hypothesis Three

Variable	Unstandardized Coefficients		Standardized Coefficients	T-value	P-value
	B	Std. Error	Beta		
(Constant)	1.214	0.196	-	6.19	0.000
Institutional factors	-0.483	0.061	0.412	7.92	0.000
Infrastructural factors	0.526	0.058	0.447	9.07	0.000
Socioeconomic factors	-0.391	0.064	-0.338	6.11	0.000

Model Summary: $R = 0.743$; $R^2 = 0.552$; Adjusted $R^2 = 0.546$; $F(3, 338) = 138.62$; $p = 0.000$

The regression results indicate that institutional, infrastructural, and socioeconomic factors exert a statistically significant influence on equitable and sustainable access to safe water in Enugu urban. All predictor variables recorded positive standardized coefficients and p-values less than 0.05, demonstrating that weaknesses in governance and coordination, inadequate and poorly maintained infrastructure, and household socioeconomic constraints significantly shape patterns of water access across the city.

The model explains approximately 55.2% of the variation in equitable and sustainable access to safe water, underscoring the combined importance of these structural factors. Infrastructural factors exerted the strongest influence, followed by institutional and socioeconomic factors, reinforcing the descriptive findings that deficiencies in

investment, maintenance, policy implementation, and income-related inequalities are central barriers to achieving SDG 6 in Enugu urban. Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted.

5. Discussion of Results

This study critically assessed the adequacy and reliability of urban water supply in Enugu urban, its environmental health implications, and the institutional, infrastructural, and socioeconomic factors shaping equitable and sustainable access to safe water in the context of Sustainable Development Goal 6 (SDG 6).

The result of the first hypothesis revealed that there is no significant alignment between the adequacy and reliability of water supply sources in Enugu urban and the standards and targets of Sustainable Development Goal 6. The descriptive analysis in research question one indicated that the adequacy and reliability of water supply sources in Enugu urban largely fall short of SDG 6 standards. Most respondents disagreed that public water supply is reliable, consistently available, safe for domestic use, or affordable, while strongly affirming the frequent occurrence of supply interruptions. This suggests a substantial gap between policy commitments and on-ground realities of water provision. Similar patterns of unreliable and intermittent urban water supply have been documented in other Nigerian and sub-Saharan African cities, where aging infrastructure, poor maintenance, and weak institutional capacity undermine sustainable service delivery (Adeniji et al., 2022; UNICEF, 2023). The rejection of alignment with SDG 6 highlights the need for systemic reforms to improve reliability, water quality, and continuity of supply.

The result of the regression analysis in second hypothesis revealed that inadequate water supply has a significant impact on environmental health in Enugu urban, particularly with respect to waterborne diseases, hygiene practices, and household water storage conditions. The descriptive analysis in second research question shows that respondents strongly associated water shortages with increased incidence of waterborne diseases, poor hygiene practices, unsafe household water storage, and heightened vulnerability among low-income communities. These findings are consistent with earlier studies linking intermittent water supply to increased disease transmission due to reliance on unsafe alternative sources and prolonged household water storage (WHO, 2022; Ezeh et al., 2023). The strong statistical relationship between inadequate water supply and environmental health outcomes confirms that water insecurity remains a critical public health concern in urban Nigeria.

The result of the statistical analysis in third hypothesis discovered that institutional, infrastructural, and socioeconomic factors significantly influence equitable and sustainable access to safe water in Enugu urban. The descriptive analysis revealed that weak institutional coordination, ineffective policy implementation, inadequate infrastructure investment, poor maintenance practices, and income-related disparities were identified as key constraints. Infrastructural deficiencies exerted the strongest influence, underscoring the centrality of physical systems in determining service coverage and reliability. These results align with urban water governance literature, which emphasizes that sustainable water access depends not only on infrastructure expansion but also on effective institutions, inclusive policies, and affordability mechanisms for vulnerable populations (OECD, 2021; UN-Habitat, 2023).

6. Conclusion and Policy Recommendations

This study assessed urban water supply in Enugu in relation to Sustainable Development Goal 6, with emphasis on adequacy, reliability, environmental health impacts, and equity of access. The findings revealed that public water supply in Enugu urban is largely inadequate and unreliable, characterized by frequent interruptions, limited availability, weak institutional communication, and concerns over water quality. Consequently, many households depend on alternative and often unsafe water sources, indicating a clear misalignment with SDG 6 targets. Inadequate water supply was found to have significant environmental health implications, including increased exposure to waterborne diseases, compromised hygiene practices, unsafe household water storage, and heightened vulnerability among low-income and informal settlements. Institutional weaknesses, poor infrastructure investment and maintenance, ineffective policy implementation, and socioeconomic inequalities further constrain equitable and sustainable access to safe water.

In conclusion, this study therefore reinforces the need for coordinated urban water management strategies that prioritize equity, sustainability, and public health protection. Enugu urban will remains off-track in achieving SDG 6 without substantial systemic reforms.

Based on the findings of the study, the following policy recommendations are proposed:

- Public water management structures should be streamlined to enhance coordination among relevant agencies at state and local levels. Clear institutional mandates, improved inter-agency collaboration, and stronger regulatory oversight are essential to improve service delivery in Enugu urban water sector.
- Government should prioritize sustained investment in water supply infrastructure, including treatment plants, distribution networks, storage facilities, and metering systems. Public-private partnerships can be leveraged to mobilize additional financial and technical resources for infrastructure expansion and rehabilitation. Routine maintenance and timely rehabilitation of existing water infrastructure should be institutionalized to reduce frequent breakdowns and supply interruptions.
- Regular water quality testing should be conducted, and results communicated transparently to the public. Water authorities should also improve communication on supply schedules, service disruptions, and maintenance activities to build public trust and enable households to plan appropriately.
- Targeted interventions, such as subsidized tariffs, pro-poor connection policies, and community-based water schemes, should be implemented to improve access for marginalized and low-income communities. These measures are critical for reducing water-related inequalities and advancing social inclusion.
- Urban water supply planning should be closely integrated with sanitation, hygiene promotion, and public health initiatives. This integrated approach will help reduce the prevalence of waterborne diseases and improve overall environmental health outcomes.
- Existing water policies and strategies should be aligned more closely with SDG 6 targets, with clear implementation frameworks, measurable indicators, and regular monitoring and evaluation. Periodic assessments will help track progress and inform evidence-based policy adjustments.

Compliance with ethical standards

This study involved survey and interview data collected from adult participants. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. Anonymity and confidentiality were assured; no personally identifiable information was collected, and all responses were used strictly for academic purposes. The study did not involve vulnerable populations, clinical interventions, or experimental procedures.

Disclosure of Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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