**Zamfara International Journal of Education (ZIJE)**
**The Official Journal of the Faculty of Education**
**Federal University Gusau, Zamfara State, Nigeria**
**Volume 6, Number 4, June, 2026**
**pISSN: (Hard Copy): 2814 – 1377; eISSN (Online): 2814 – 1369** www.foefugusau.com.ng
DOI: https://doi.org/10.64348/zije.2026477



# Assessment of Students' Knowledge and Practices of Microbial Water Contamination in Federal University of Education, Zaria

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## Abstract
*This study assessed undergraduate Biology students' knowledge and practices regarding microbial water contamination in the Federal University of Education, Zaria. The study adopted a descriptive survey design. The population comprised 323 undergraduate Biology students, all of whom were used due to manageable size (census sampling). Data were collected using a structured questionnaire titled Students' Knowledge and Practices of Microbial Water Contamination Questionnaire (SKPMWCQ). The instrument was validated through face, content, and construct validity, while reliability was established using Cronbach Alpha (Knowledge = 0.81; Practices = 0.78). Data were analyzed using mean and standard deviation to answer research questions and independent samples t-test to test hypotheses at 0.05 level of significance. Findings revealed that students possessed moderate knowledge (Grand Mean = 3.12) but demonstrated low-level safe water practices (Grand Mean = 2.41). No significant gender difference was found in knowledge ($p > 0.05$), while a significant difference was found in practices based on level of study ($p < 0.05$). The study concluded that knowledge does not necessarily translate into practice. It recommended that, Federal University of Education, Zaria management should ensure consistent provision of safe and treated water across hostels and lecture environments to reduce reliance on unsafe sources, among others.*

**Keywords:** Microbial contamination, water hygiene, students' knowledge, sanitation practices

## Introduction
Safe drinking water is universally recognized as a fundamental requirement for human survival, public health, and sustainable development. The World Health Organization emphasizes that access to safe water is critical for preventing diseases and improving quality of life. Common sources of drinking water include boreholes, wells, rivers, and sachet (packaged) water. Although these sources provide essential access, they are often vulnerable to microbial contamination due to poor regulation, environmental pollution, and inadequate treatment processes (Adewumi *et al.,* 2010 and Emenike ., Tenebe., Omole., Ngene ., Oniemayin & Maxwell 2021). However, despite global efforts, microbial contamination of water remains a major challenge, particularly in developing countries where infrastructure, sanitation, and regulatory systems are often inadequate (World Health Organization, 2022; UNICEF, 2023). Pathogenic microorganisms such as bacteria, viruses, and protozoa frequently contaminate water sources, leading to significant health risks. Microbial water contamination refers to the presence of disease-causing microorganisms in water, rendering it unsafe for human consumption. Common indicators used to assess contamination include total coliforms and *Escherichia coli*, which signal fecal pollution and potential presence of pathogens (Edokpayi., Rogawski., Kahler., Hill., Reynolds., Nyathi & Samie 2021 and Luo., Zhou., Zhou., Lai., Liu., Ao., Yao., Zhang & Lai 2021). These microorganisms enter water systems through pathways such as sewage discharge, agricultural runoff, open defecation, and improper waste management, especially in regions with weak environmental controls (WHO, 2022; UNESCO, 2023). Globally, unsafe water remains a leading cause of morbidity and mortality. According to the United Nations Children's Fund, millions of people are exposed to contaminated drinking water, resulting in diseases such as cholera, typhoid fever, and diarrheal infections (UNICEF, 2023). These health outcomes disproportionately affect populations in low- and middle-income countries, where access to improved water sources and sanitation facilities is limited (Prüss-Ustün et al., 2019; WHO, 2022). In Nigeria, the situation is particularly concerning due to rapid urbanization, population growth, and infrastructural deficits. Studies have consistently reported the presence of coliform bacteria and other pathogens in both surface and groundwater sources across various regions of the country (Odeyemi., Sani & Obadina,2022 and Chandler, Wong,.Zhihao Zhang., Walaa Eid, Julio

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DOI: https://doi.org/10.64348/zije.2026477


Plaza-Diaz., Pervez Kabir., Shen Wan., Jian-Jun Jia., Elisabeth Mercier., Ocean Thakali., Lakshmi Pisharody., Nada Hegazy., Sean., Stephenson., Wanting Fang., Tram., Nguyen., Nathan., Ramsay., Michael McKay., Ryland Corchis-Scott., Alex ., MacKenzie., Tyson., Graber., Patrick .,Aoust & Robert Delatolla, 2023). Sachet water, popularly known as "pure water," is widely consumed in Nigeria due to its affordability and accessibility. However, empirical studies have raised concerns about its microbiological safety, noting that some products fail to meet acceptable standards due to poor production and storage conditions (Olaoye & Onilude, 2020 and Ojekunle., Adekunle & Ogunfowokan 2021 and Oye., Abraham., Abraham & Martins, 2025).This underscores the complexity of ensuring water safety even in commercially processed supplies. Within academic environments such as universities, the assumption that educated individuals consistently practice safe water hygiene does not always hold. Research indicates that while students may possess theoretical knowledge of water contamination, this knowledge does not necessarily translate into appropriate practices (Onyango & Opiyo 2021 and Moyo., Ncube & Tshuma, 2022). Factors such as convenience, cost, accessibility of clean water, and behavioral attitudes often influence students' actions more than their knowledge.

Knowledge of microbial water contamination encompasses awareness of contamination sources, transmission pathways, and prevention strategies such as boiling, filtration, and proper storage. Higher education, particularly in science-related disciplines like Biology, is expected to enhance such knowledge (Nwadi., Attah., Ugwu., Nwakpadolu & Ezekoye 2023 and Abubakar., Abdullahi & Yusuf 2022). However, studies suggest that knowledge alone is insufficient to drive behavioral change, as individuals may neglect safe practices despite understanding the risks (Dreibelbis., Winch., Leontsini., Hulland., Ram., Unicomb., & Luby, 2018 and Martins., Ozawa Brasil Junior., Lyra., Castellano., Perez., Nonaka & Bonan,2021). Water hygiene practices involve actions taken to ensure water safety, including treatment methods, safe storage, and sanitation behaviors. These practices are influenced by multiple factors, including socio-economic conditions, environmental constraints, cultural beliefs, and institutional support systems (Pickering., Nul., Winch., Mangwadu ., Arnold ., Prendergast., Njenga ., Rahman., Ntozini., Benjamin-Chung., Stewart., & Clasen 2019 and Wolf ., Johnston ., Ambelu., Arnold ., Bai., Brauer., Brown ., Caruso ., Clasen ., Cumming & Prüss-Ustün 2023). In many developing contexts, limited access to treated water discourages consistent adherence to safe practices. Empirical evidence from various studies highlights a persistent gap between knowledge and practice among students and communities. For instance, research conducted in African universities revealed that although students demonstrated adequate knowledge of water contamination, many engaged in risky behaviors such as consuming untreated water and neglecting hygiene protocols (Ojo., Esan., Olowookere & Aluko, 2018 and Okonko., Adejoye & Ogunjobi, 2020 and Eze., Nwankwo & Nduka, 2022). This gap suggests that cognitive awareness alone does not guarantee behavioral compliance. Furthermore, environmental health education has been identified as a critical tool for bridging this gap. Scholars argue that integrating practical training, awareness campaigns, and institutional support can significantly improve water safety behaviors (Freeman *et al.*, 2020; Mosler, 2022). This approach emphasizes not only knowledge acquisition but also attitude change and skill development. The role of universities in promoting safe water practices is particularly important, as they serve as centers for knowledge dissemination and behavioral modeling. Institutions are expected to provide safe water infrastructure and foster health-conscious behaviors among students (Igudia and Agbonifoh, 2019 and UNESCO, 2023). Evidences gotten suggest that institutional challenges such as inadequate water supply and poor maintenance systems may hinder these efforts. In addition, demographic variables such as gender and level of study have been examined in relation to knowledge and practices of water hygiene. While some studies report no significant gender differences in knowledge, others suggest that experience and academic exposure may influence practices, with senior students demonstrating better hygiene behaviors (Adejumo ., Oladipo & Kareem, 2021 and Bello., Lawal & Ibrahim, 2022). Given these dynamics, there is a need for context-specific studies that examine both knowledge and practices within particular institutional settings. Understanding how students perceive and manage microbial water contamination can inform targeted interventions and policy decisions. Despite the growing body of literature, limited studies have specifically focused on undergraduate Biology students in teacher education institutions such as the Federal University of Education, Zaria. Considering their academic background, these students are expected to exhibit both high knowledge and appropriate practices regarding water safety. This study, therefore, assessed the knowledge and practices of undergraduate Biology students regarding microbial water contamination in the Federal University of Education, Zaria.

## Statement of the Problem

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Microbial contamination of drinking water remains a persistent public health concern in Nigeria, particularly in environments where water sources are inadequately treated or poorly managed. Despite increased global and national attention to water safety by agencies such as the World Health Organization and the United Nations Children's Fund, many communities—including educational institutions—continue to experience challenges related to unsafe water. University campuses, which rely on sources such as boreholes, wells, and packaged water, are not immune to contamination risks arising from environmental exposure, poor sanitation, and weak monitoring systems. Although undergraduate Biology students are expected to possess sound knowledge of microbial contamination due to their academic training, there is growing concern that such knowledge does not necessarily translate into safe water handling and consumption practices. Empirical evidence suggests that students often engage in risky behaviors such as drinking untreated water, improper storage, and neglect of hygiene practices, thereby increasing their vulnerability to waterborne diseases. This disconnects between knowledge and practice raises critical questions about the effectiveness of existing educational approaches in promoting behavioral change. The problem of this study, therefore, is to determine whether undergraduate Biology students in the Federal University of Education, Zaria possess adequate knowledge of microbial water contamination and whether they effectively apply this knowledge in their daily practices. Addressing this gap is essential for improving students' health outcomes and for informing interventions aimed at strengthening environmental health education within tertiary institutions.

**Objectives of the Study**

The specific objectives are to:

1. Determine the level of students' knowledge of microbial water contamination in FUE, Zaria.
2. Examine students' practices regarding water safety and hygiene in FUE, Zaria.
3. Determine the relationship between students' knowledge and their practices of water safety in FUE, Zaria.
4. Examine the difference in students' knowledge of microbial water contamination based on gender in FUE, Zaria.
5. Determine the difference in students' practices of water hygiene based on level of study in FUE, Zaria.

## Research Questions

The following research questions guided the study:

1. What is the level of students' knowledge of microbial water contamination in FUE, Zaria?
2. What are the students' practices regarding water safety and hygiene in FUE, Zaria?
3. What is the relationship between students' knowledge and their practices of water safety in FUE, Zaria?
4. Is there any difference in students' knowledge of microbial water contamination based on gender in FUE, Zaria?
5. Is there any difference in students' practices of water hygiene based on level of study in FUE, Zaria?

## Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

$H0_1$: There is no significant relationship between students' knowledge of microbial water contamination and their practices of water safety in FUE, Zaria.

$H0_2$: There is no significant difference in students' knowledge of microbial water contamination based on gender in FUE, Zaria.

$H0_3$: There is no significant difference in students' practices of water hygiene based on level of study in FUE, Zaria.

## Methodology

This study adopted a descriptive survey research design. The population comprised 323 students, from which a sample of 181 was selected using the sample size determination table of Krejcie and Morgan (1970). A simple random sampling technique was employed to ensure equal chance of selection and enhance representativeness. Data were collected using a self-structured questionnaire titled *Students' Knowledge and Practices of Microbial Water Contamination Questionnaire (SKPMWCQ)*, which consisted of demographic items and sections on knowledge and practices measured on a four-point Likert scale. The instrument was validated by two experts from the Department of Microbiology and also one expert from the department of Hydrobiology with maximum qualification of Ph,D, both are from Ahmadu Bello University ,Zaria. The reliability was established using Cronbach Alpha coefficients of 0.81 and 0.78 for knowledge and practices respectively. The questionnaires were administered directly to respondents and analyzed using the Statistical Package for the Social Sciences (SPSS). Mean and standard deviation were used to answer research questions, while Pearson Product Moment

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Correlation and independent samples t-test were used to test hypotheses at a 0.05 level of significance. Ethical considerations such as voluntary participation, confidentiality, and proper data usage were strictly observed.

## Presentation of Results

**Research Question One:** What is the level of students' knowledge of microbial water contamination in FUE, Zaria?

**Table 1: Mean and Standard Deviation of Knowledge**

| S/N | Items | Mean | SD | Decision |
|---|---|---|---|---|
| 1 | Microorganisms can contaminate drinking water | 3.42 | 0.64 | Agree |
| 2 | Untreated water can cause diseases | 3.25 | 0.73 | Agree |
| 3 | Boiling water kills microorganisms | 3.08 | 0.81 | Agree |
| 4 | Poor sanitation leads to contamination of water bodies | 3.02 | 0.79 | Agree |
| 5 | Sachet water may contain microbes | 2.86 | 0.87 | Agree |
| 6 | Waterborne diseases spread through contaminated water | 3.30 | 0.70 | Agree |
| 7 | Hand hygiene prevents contamination of microorganism of water for a long time | 3.18 | 0.75 | Agree |
| 8 | Storage affects water quality | 3.05 | 0.78 | Agree |
| 9 | Microbes are invisible but harmful | 3.22 | 0.71 | Agree |
| 10 | Filtration (water treatment) removes microorganisms | 2.90 | 0.83 | Agree |
| | **Grand Mean** | 3.13 | | Agree |

The findings revealed that undergraduate Biology students possessed a moderate level of knowledge regarding microbial water contamination (Grand Mean = 3.13). This indicates that most students are aware that microorganisms contaminate water and that untreated water can cause diseases such as cholera, typhoid fever, and diarrhea. (STOP)This finding is consistent with the expectations of Biology students, who are exposed to environmental microbiology and public health concepts during their stay in the university.

**Research Question Two:** What are the students' practices regarding water safety and hygiene in FUE, Zaria?

**Table 2: Mean and Standard Deviation of Practices**

| S/N | Items | Mean | SD | Decision |
|---|---|---|---|---|
| 1 | I boil water before drinking | 2.28 | 0.93 | Disagree |
| 2 | I store water in covered containers | 2.52 | 0.86 | Agree |
| 3 | I wash hands before handling water | 2.46 | 0.90 | Disagree |
| 4 | I drink untreated borehole water | 2.18 | 0.97 | Disagree |
| 5 | I clean storage containers regularly | 2.48 | 0.88 | Disagree |
| 6 | I avoid unsafe water sources | 2.44 | 0.91 | Disagree |
| 7 | I treat water before drinking | 2.36 | 0.92 | Disagree |
| 8 | I check water quality before use | 2.31 | 0.94 | Disagree |
| 9 | I use filtration methods | 2.40 | 0.90 | Disagree |
| 10 | I follow hygiene practices consistently | 2.47 | 0.89 | Disagree |
| | Grand Mean | 2.38 | | Disagree |

The study found that students exhibited low-level water safety practices (Grand Mean = 2.38). Many respondents reported inconsistent behaviours such as not always boiling water before drinking, irregular handwashing practices, and occasional consumption of untreated water.

**Research Question Three:** What is the relationship between knowledge and practices in FUE, Zaria?

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**Table 3: Pearson Product Moment Correlation (PPMC) of Knowledge and Practices**

| Variables | N | r | Sig. |
|---|---|---|---|
| **Knowledge vs Practices** | 181 | 0.42 | 0.000 |

The findings revealed a moderate positive and significant relationship between knowledge and practices ($r = 0.42$, $p < 0.05$). This indicates that students with higher knowledge levels are slightly more likely to engage in safer water practices.

**Hypotheses Testing**

**Hypothesis One:** There is no significant relationship between knowledge and practices in FUE, Zaria.

**Table 4: Pearson Product Moment Correlation (PPMC) Test of Relationship Between Knowledge and Practices**

| Variables | N | r | Sig. (p-value) | Decision |
|---|---|---|---|---|
| Knowledge vs Practices | 181 | 0.42 | 0.000 | Reject $H_0$ |

The result in Table 4 shows that the correlation between students' knowledge and practices of microbial water contamination is positive and moderate ($r = 0.42$) and statistically significant ($p = 0.000 < 0.05$). Therefore, the null hypothesis is rejected. This implies that there is a significant relationship between students' knowledge and their practices regarding microbial water contamination in the Federal University of Education, Zaria.

**Hypothesis Two:** No significant difference in knowledge based on gender in FUE, Zaria.

**Table 5: Independent Samples t-test on Students' Knowledge of Microbial Water Contamination Based on Gender**

| Gender | N | Mean | Std. Deviation | t | df | Sig. (2-tailed) | Decision |
|---|---|---|---|---|---|---|---|
| Male | 90 | 3.11 | 0.50 | | | | |
| | | | | -0.58 | 179 | 0.56 | Not significant |
| Female | 91 | 3.15 | 0.48 | | | | |

The independent samples t-test results show that there is no significant difference in the knowledge of microbial water contamination between male and female students ($t = -0.58$, $df = 179$, $p = 0.56$). Since the p-value is greater than 0.05, the null hypothesis is not rejected. This implies that gender does not significantly influence students' knowledge of microbial water contamination in the Federal University of Education, Zaria.

**Hypothesis Three:** No significant difference in practices based on level of study in FUE, Zaria.

**Table 6: Independent Samples t-test on Students' Practices of Microbial Water Contamination Based on Level of Study**

| Level | N | Mean | Std. Deviation | t | df | Sig. (2-tailed) | Decision |
|---|---|---|---|---|---|---|---|
| 100–200 Level | 88 | 2.29 | 0.58 | | | | |
| 300–400 Level | 93 | 2.47 | 0.54 | -2.45 | 179 | 0.015 | Significant |

The results presented in Table 4.8 show that there is a significant difference in students' practices of microbial water contamination based on level of study ($t = -2.45$, $df = 179$, $p = 0.015$). Since the p-value is less than 0.05, the null hypothesis is rejected. This implies that students in higher levels (300–400 level) demonstrate better water hygiene practices than those in lower levels (100–200 level) in the Federal University of Education, Zaria.

## Discussion of Findings

The findings revealed that undergraduate Biology students in FUE, Zaria possessed a moderate level of knowledge regarding microbial water contamination (Grand Mean = 3.13). However, the knowledge level was not exceptionally high, suggesting gaps in deep conceptual understanding. This finding aligns with Abubakar *et al*. (2022), who reported that although university students often demonstrate awareness of environmental health issues, their understanding of microbial processes is sometimes superficial and theoretical rather than applied. The study found that undergraduate Biology students exhibited low-level water safety practices in FUE, Zaria (Grand Mean = 2.38). This finding suggests a clear disconnect

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between knowledge and actual behaviour. It supports the position of Dreibelbis *et al.* (2018), who observed that awareness of water safety does not automatically translate into improved hygiene practices. Similarly, Mosler (2022) emphasized that environmental health behaviours are influenced more by habit formation, convenience, and environmental constraints than by knowledge alone. The implication is that even in academic environments, students may prioritize accessibility and convenience over safety when making water-related decisions. Another study by Ojo (2018) on handwashing practices among undergraduate students in a Nigerian university revealed poor compliance with standard hygiene and sanitation practices among students, despite awareness of the importance of personal hygiene. The study identified inadequate facilities and poor behavioral orientation as factors responsible for the low level of safe hygiene practices among undergraduates.

Similarly, Igudia and Agbonifoh (2019) investigated sanitation practices among undergraduate students at the University of Benin and found that many students demonstrated inadequate sanitation behaviours and poor environmental hygiene practices within their hostels and learning environment. The study concluded that poor sanitary habits among students could expose them to water-related health risks and environmental hazards. Another related study conducted by Nwadi *et al.* (2023) on hostel sanitation practices among students at the University of Nigeria, Nsukka found that poor sanitation and unhealthy environmental practices negatively affected students' health and wellbeing. The researchers observed that many students failed to adhere to appropriate hygiene and environmental safety practices within their residential environment. In the same vein, Oye *et al.* (2025) reported insufficient sanitation practices among undergraduates in a tertiary institution in Nigeria. The study found inadequate handwashing facilities, poor waste disposal systems, and low adherence to environmental sanitation practices among students. The researchers concluded that poor sanitation behaviour among undergraduates remained a major public health concern in tertiary institutions. These studies therefore support the present finding that undergraduate Biology students demonstrated low-level water safety practices, suggesting that inadequate sanitation culture, poor environmental awareness, infrastructural deficiencies, and weak compliance with safety measures remain prevalent among tertiary institution students in Nigeria. The findings also revealed a moderate positive and significant relationship between knowledge and practices in FUE, Zaria ($r = 0.42$, $p < 0.05$). This result is consistent with the findings of Moyo et al. (2022), who reported a positive relationship between environmental health knowledge and hygiene behaviour among university students. However, the moderate strength of the relationship confirms that knowledge alone is not a strong predictor of behaviour, reinforcing the need for behavioural and environmental interventions.
The hypothesis tested showed that there was no significant difference in knowledge based on gender in FUE, Zaria ($p = 0.56 > 0.05$). This finding aligns with Adejumo et al. (2021), who reported that gender does not significantly influence environmental health knowledge among tertiary institution students. It implies that academic instruction is equally accessible and effective across genders in transmitting theoretical knowledge. The study revealed a significant difference in practices based on level of study in FUE, Zaria ($p = 0.015 < 0.05$), with higher-level students demonstrating better water hygiene practices than lower-level students. This may be attributed to increased academic exposure, maturity, and awareness gained through advanced coursework and experience in higher levels. This finding is consistent with Bello et al. (2022), who reported that students in higher academic levels tend to adopt better environmental and hygiene practices due to increased exposure to health-related content and life experience.

## Conclusion

Based on the findings of this study, it can be concluded that undergraduate Biology students in the Federal University of Education, Zaria possess a moderate level of knowledge of microbial water contamination but demonstrate poor water hygiene practices in their daily lives. Although knowledge was found to have a positive relationship with practices, it was not strong enough to ensure consistent behavioural change. The study further concluded that gender does not significantly influence knowledge of microbial water contamination, while level of study significantly affects students' water hygiene practices. Overall, the study highlights a persistent knowledge–practice gap, indicating that awareness alone is insufficient to guarantee safe water-related behaviours among students.

## Recommendations

Based on the findings of the study, the following recommendations are made:

1. Biology curricula should include more practical demonstrations on water treatment, microbial testing, and hygiene practices to bridge the gap between theory and practice.

2. Federal University of Education, Zaria management should ensure consistent provision of safe and treated water across hostels and lecture environments to reduce reliance on unsafe sources.
3. Health promotion campaigns should be introduced to encourage consistent adoption of safe water practices among students, focusing on habit formation rather than awareness alone.
4. Regular seminars, workshops, and outreach programs on microbial water contamination should be organized to reinforce students' knowledge and promote behavioural compliance.
5. Advanced-level Biology students should be engaged as peer educators to mentor lower-level students on safe water practices, leveraging the influence of academic experience.

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