Safety First: Determinants Of Drinking Water Preferences Among Tertiary Students in a Ghanaian University

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Abstract

Access to safe drinking water in Africa is a serious public health concern, and it is relevant for attaining SDG 6.1. Among university students in Ghana, determinants of drinking water source preferences remain understudied despite their distinct residential, financial, and institutional contexts. Underpinned by Ajzen's Theory of Planned Behaviour, which links perceived behavioural control, attitude, and subjective norms to water choice, this study examined the determinants of drinking water source preference among students of the University of Education, Winneba, using a sample of 400 students selected via stratified sampling from halls of residence and off-campus hostels during the second semester of the 2022/2023 Academic Year. Data were collected using a structured questionnaire, and analysis employed descriptive statistics and multinomial logistic regression. Key findings indicate that sachet water was students' most preferred source (OR = 7.988; p = 0.005 for perceived healthiness), primarily due to perceived safety, even though piped water was most available. Reliability perceptions (OR = 0.099; p = 0.002 for pipe-borne water) and financial responsibility were also significant predictors. The study found no significant relationship between place of residence and drinking water preference. The study recommends that the University management and hostel owners install water storage infrastructure and filtration systems, conduct regular water quality testing, and subsidise the cost of safe water access for students. The findings represent the water situation as of the 2022 data collection period and should be read with that temporal context in mind.

Keywords: Drinking water preference, water sources, safety, tertiary students, Ghana.

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Introduction

Access to clean and safe drinking water remains a major public health concern worldwide, particularly in low- and middle-income countries (LMICs) (Ezeh et al., 2018; World Health Organisation [WHO], 2021). The sources from which people obtain their drinking water are therefore critical to achieving the United Nations' Sustainable Development Goal (SDG) 6, Target 6.1, which aims to ensure universal and equitable access to safe and affordable drinking water for all by 2030 (Rajapakse, Otoo, & Danso, 2023). Although having access to clean drinking water is a fundamental human right, an estimated 2.2 billion people globally do not have access to safely managed drinking water sources, which is usually located on premises, free from contamination, and available when needed (Lopes, 2023; WHO & United Nations International Children's Emergency Fund [UNICEF], 2021; WHO, 2019). In Sub-Saharan Africa, about 40% of the population lacks access to safe and clean water, and many rely on untreated water sources for consumption (WHO & UNICEF, 2021). The other concern in this part of the world is that, whereas availability and accessibility are improved, water sources are not varied (Howard et al., 2020).
The 2021 Population and Housing Census of Ghana reports that 87.7% of the population has access to diverse basic water services (pipe-borne, sachet water, borehole, rivers/streams, rainwater) (Ghana Statistical Service [GSS], 2022), but safety and quality are not guaranteed (WHO & UNICEF, 2021). Also, disparity exists between urban (pipe-borne, sachet water and boreholes) and rural (borehole, dug-out wells, streams and rainwater) areas, with access rates of 96.4% and 74.4%, respectively (Sanitation and Water for All, 2022; GSS, 2022).

Households in Ghana with diverse drinking water sources prefer sachet water (48.3%), followed by tap water (31.1%) and boreholes (20.6%) (Aidoo et al., 2019). In spite of the quality concerns raised about sachet water in Ghana, households' preference for it over tap water and boreholes has mainly been attributed to convenience, trust, and the purported safety nature of the sources over others, such as tap water and borehole (Ahiabor & Donkor, 2025; Moulds et al., 2022; Aidoo et al., 2019). Put differently, Osei-Tutu and Brenyah (2019) assert that sachet water is considered by most households as more reliable water because of inconsistent and erratic tap water supply. The main factors determining households' preferred drinking water sources are level of education, locality, socio-economic status, affordability, trust in the source, and safety perceptions (Biswas et al., 2020; Nyenje et al., 2019; Sultana et al., 2018; Zeleke & Kraemer, 2018). But in urban Ghana, household preference for drinking water sources was determined by price and accessibility (Semey et al., 2020). In other jurisdictions, time and convenience have largely been found to be contributors to drinking water preferences (Sohail et al., 2021).

Unfortunately, most of the information about preference for diverse water sources in Ghana is highly skewed towards households. The humongous amount of literature on household drinking water consumption neglects other demographics, especially students in boarding facilities, halls of residents, and hostels who spend a greater part of their lives outside their household dwellings (Appiah-Effah et al., 2021; Aryeetey et al., 2020; Nunoo, Koomson, & Orkoh, 2018; Abbam & Carsamer, 2017; Nketiah-Amponsah, Aidam, & Senadza, 2009; etc.). Particularly in developing countries, students with descriptions as indicated often face water access and quality challenges, which inevitably result in detrimental effects on their health and studies (Eshun, 2023). A comparative study of university students' drinking water preferences in Qatar by Mahmood et al. (2024) found that convenience, taste, and perceived safety were the primary variables driving students' preference for packaged water over tap water. Similar findings were made by Okeke and

Ezeama (2021) among university students in South-East Nigeria, and by Graydon et al. (2019) at the University of South Florida.

The focus on only two water sources in prior studies (Mahmood et al., 2024) limits the understanding of the preference for other water sources by tertiary students. Moreover, the limited use of multinomial logistic regression in existing studies means that simultaneous comparison across multiple water source types remains a gap in the literature. Additionally, the results lack a detailed understanding of the concept of place of residence (on-campus and off-campus) and its impact on water preference. Thus, it is crucial to consider that one's residential status might influence preference. Provision of water is commonly associated with on-campus residences as part of residential facility user fees. In contrast, those in off-campus hostels typically have to pay monthly or regularly for their water usage in their hostels.

This study aimed to assess the drinking water preferences among tertiary students residing both on and off campus at the University of Education, Winneba (UEW), Ghana. Specifically, it examined the range of water sources available to the students and the factors that influenced the choices they made, including affordability, accessibility, reliability, and perceived safety. Understanding these determinants not only deepens insight into students' behavioural patterns regarding water consumption but also supports efforts in promoting good health, academic performance, and sustainable water management. Improved access to safe drinking water enhances hydration and cognitive functioning (Bonda, 2025; Trinies et al., 2016; Chard et al., 2019). Therefore, this study provides an evidence-based foundation for interventions that ensure sustainable and equitable access to safe drinking water in tertiary institutions across Ghana and the subregion.

Conceptual Framework

The study is guided by a conceptual framework grounded in the Theory of Planned Behaviour (TPB) (Ajzen, 1991), which posits that behaviour is determined by behavioural intentions, which in turn are influenced by attitudes (e.g., perceived water quality and healthiness), subjective norms (e.g., social influence and trust in water sources), and perceived behavioural control (e.g., cost and payment responsibility). Applied to drinking water choice, the TPB provides the theoretical basis for understanding how perceptual, social, and economic factors shape students' water source preferences. Building on this foundation, the framework also incorporates determinants of water preference, demographic characteristics, drinking water sources, perceived water quality, water treatment practices, and health outcomes. Two major sets of independent variables are identified. The first set includes the determinants of water preference, namely affordability, accessibility, availability, and reliability. These factors represent external conditions that influence the choice of drinking water sources. The second set comprises demographic variables, such as age, gender, level of study, residence, and payment responsibility, which reflect the personal and social characteristics that condition students' choices and perceptions.

Students' drinking water sources (bottled, sachet, or pipe-borne) serve as the immediate outcome of the determinants of preference and demographic influences. This choice, in turn, shapes the perceived water quality, which is assessed through indicators such as smell, taste, healthiness, and

colour. In addition, students' engagement in water storage, water treatment, and water treatment processes further mediates the relationship between water quality and health outcomes, as these practices determine whether water remains safe for consumption.

The ultimate outcome in the framework is health, which reflects the extent to which students experience positive or negative health conditions because of their drinking water sources, the quality of the water they drink, and their water handling practices.

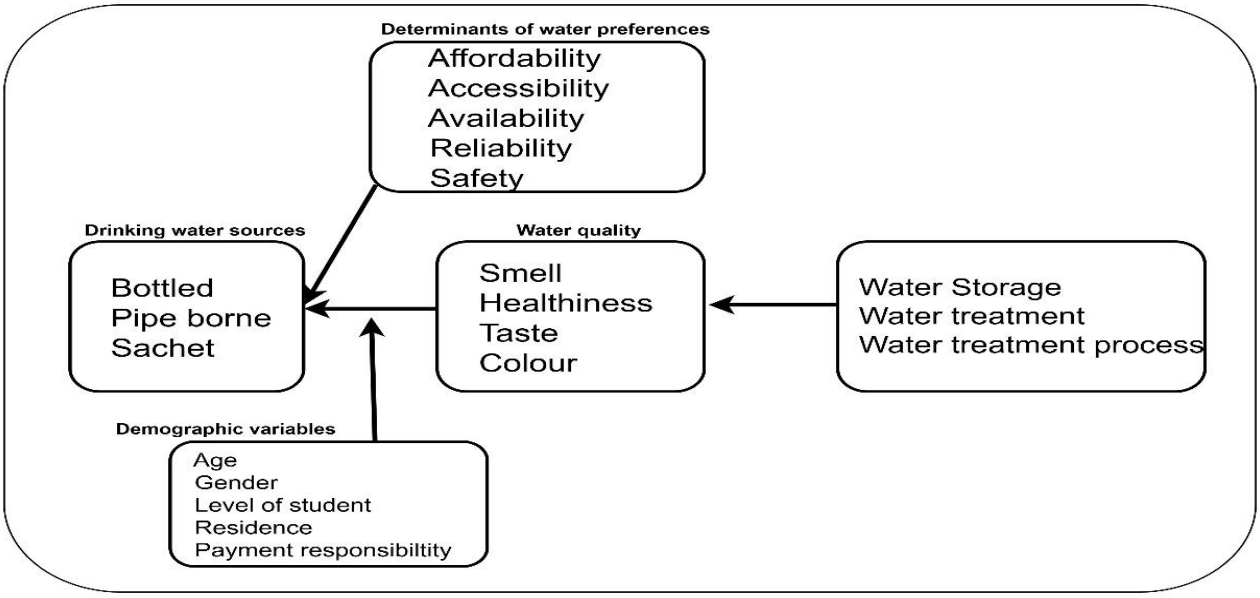

Figure 1: Conceptual framework of Determinants of Drinking Water Preference.
Source: Author's Construct (2025).

The framework illustrates how the determinants of water preference influence the selection of drinking water sources, while demographic characteristics directly impact both the sources chosen and the perception of water quality. The selected water source subsequently determines the perceived quality of water, which in turn shapes the need for treatment and storage practices. Water quality and water treatment processes have direct implications for students' health outcomes. Additionally, demographic factors indirectly influence health through their effects on water source selection and quality perceptions.

Methodology

Study setting

The study was conducted at the University of Education, Winneba (UEW), which is located within the Effutu Municipality of Ghana. The Municipality, which covers a land area of about 85 km2, is found between longitudes 0°33′11.87″W and 0°40′21.78″W, and latitudes 5°19′38.17″N, 5°26′30.45″N. Relatively, it is bordered at the west by Gomoa West, north by Gomoa East and not Akim West. The Municipality lies within the dry-equatorial climatic zone, where rainfall is generally low, with annual rainfall ranging from 400mm to 500mm. The area experiences a long dry season of five months with mean temperatures ranging from 22 °C to 28 °C. In spite of the

relative dryness, the Municipality is drained by two major rivers, Ayensu and Gyahadze, with the former and latter relatively entering the sea at Warabeba and Opram (Kyeremeh, Adu-Boahen, & Addai, 2023). Winneba is the administrative capital where the UEW is located.

Like many urban and peri-urban settlements across Ghana, the Effutu Municipality contends with persistent water supply challenges. These challenges are multifaceted, stemming primarily from rapid population growth within the Municipality, which is further compounded by the proliferation of educational institutions that have significantly increased demand for potable water. On the other hand, the Municipality is burdened by systemic water management inefficiencies, including inadequate water supply infrastructure, the encroachment upon and degradation of water bodies and designated Ramsar Sites, as well as indiscriminate solid waste disposal around water sources, contributing to widespread pollution. Additionally, the intrusion of saltwater into freshwater resources poses a growing threat to the viability of existing water supply systems. Collectively, these factors have contributed to the intermittent water supply and recurrent shortages across the Municipality (Effutu Municipal Assembly, n.d.). The University of Education, Winneba, was established in September 1992 as a University College under PNDC Law 322. Still, on 14th May 2004, it was upgraded to a full University through the University of Education Act, Act 672. Hitherto, the University had four campuses: the Winneba Campus (the seat of the Vice-Chancellor), Ajumako, Kumasi, and the Mampong campuses. After the passing of the University of Skills Training and Entrepreneurial Development Bill by Parliament in 2020, which gave legal backing to the proposed conversion of the Kumasi (and Mampong) campuses of the University, UEW was left with two campuses, the Winneba and Ajumako campuses.

This study was conducted in the Winneba Campus. In Winneba are the North, Central, and South campuses, with five (5) faculties and three (3) schools. There is also the School of Graduate Studies. About 36,044 students read various programmes at both undergraduate and post-graduate levels, comprising 33,050 undergraduate students and 2,994 post-graduate students (Planning Unit, UEW, 2023). The reason for choosing UEW-Winneba was its limited residential facilities, with very few admitted students housed in University Hall, Simpa Hall, Ghartey Hall, and Aggrey Hall. On-campus halls of residence usually have adequate water storage for students to reduce their water access stress. During critical water shortages, the University Management secures water from private sources at no immediate cost to students. However, over 70% of the remaining students are forced to rent in private hostels in the Winneba township and its environs, Kojo Beedu, Ateitu, Low Cost, Roman School, Sankor, Gyahadze (Fig. 1). In the private hostels where water storage tanks are lacking, students compete with about 107,798 residents (GSS, 2022) for potable water for various uses.

Study design

This study employed a descriptive cross-sectional survey design to assess the determinants of drinking water source preferences among university students. A descriptive survey design was deemed appropriate since it is known to facilitate the systematic collection of quantitative data from a relatively large and diverse sample (Mahmood et al., 2024) within a natural setting, while at the same time enabling the researcher to capture prevailing attitudes, behaviours, and choices at a single point in time (Creswell & Creswell, 2018; Levin, 2006). This approach is beneficial for public health and social science research where the primary aim is to describe population characteristics and identify associations between variables rather than establish causality (Babbie,

2020; Setia, 2016). By adopting this design, the study was able to generate a comprehensive description of students' drinking water preferences, the factors influencing their decisions, and their levels of satisfaction with the available water sources.

Whereas the study involved students of UEW, it was particularly interested in regular (full-time) undergraduate and post-graduate students who were either living on campus (halls of residence) or off-campus (private hostels), since residential status is known to significantly influence students' access and use of water (Otrubina, Heydari, & Stillwell, 2025). The sample size for this study was determined using Yamane's formula for finite populations (Yamane, 1967), which is expressed as:

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

where ***n*** is the required sample size; ***N*** is the population size, and ***e*** is the margin of error.

Using the student population of 36,044 and a margin of error of 5% at a 95% confidence level, the formula yielded an estimated sample size of 395 respondents. To account for potential non-response and ensure representativeness, the sample size was rounded up to 400 students as the study's respondents. This sample was then proportionally allocated across the two strata (on-campus and off-campus students) to reflect their actual distribution in the study population. Beyond this, an attempt was made to fairly distribute the total sample of 400 respondents across the academic levels to reflect the composition of the student population. Thus, each level, except Level 100s and post-graduate students, was allocated 25% of the 400 respondents. Due to the scarcity of data for Level 100 students and the smaller population of post-graduate students, they were allocated 20% and 5%, respectively. This proportional distribution ensured that each academic level was adequately represented in the study sample.

The study adopted a stratified random sampling procedure to ensure representativeness of the diverse student population. In this regard, two main strata were defined based on residential status: students residing on campus (halls of residence) and those living off campus (private hostels)**.** The proportion of respondents selected from each stratum was determined according to their actual distribution in the university population, with approximately 23% residing in halls and 77% in hostels (to include all post-graduate students who are primarily of non-residential status). Within each stratum, respondents were selected using a simple random sampling technique, thereby ensuring that every eligible student had an equal chance of being included. This stratified approach minimised sampling bias, enhanced precision in subgroup estimates, and allowed for valid comparisons between on-campus and off-campus students (Cochran, 1977; Creswell & Creswell, 2018).

Data were collected using a structured questionnaire consisting of 25 items, which included both closed-ended questions (Likert-scale and Yes/No) and a few open-ended questions for elaboration. The questionnaire was administered and distributed in person through face-to-face interactions with students both on campus and in off-campus hostels. Prior to full deployment, the instrument was pre-tested on a small group of students outside the study sample, and minor modifications were made to improve clarity. With water sources as the dependent variable, the study included seven independent variables (students' level, other occupation, satisfaction of students, water

quality (smell and healthiness), reliability, cost of water, and payment responsibility) in a model based on the literature review. Due to its sensitivity to outliers and robustness, a multinomial regression was undertaken to explore the influence of students on their drinking water preference. The independent variable (student attributes) was measured using student level, occupation, smell and healthiness, reliability, cost, payment, taste, colour and overall satisfaction. Consequently, the dependent variable (drinking water preference) had three levels: bottled water, pipe-borne water and sachet water. Using Jamovi version 2.4.8 and the Statistical Package for Social Sciences (SPSS, version 27), the output was presented as an odds ratio (OR) using a 95% Confidence Interval (CI).

Pretesting was conducted with five local residents (three males and two females) aged 18–30 years, an age range that corresponds with that of students at UEW. The exercise provided the researcher with the opportunity to assess the effectiveness of using KoboToolbox for online data collection, estimate the time required for each data collection session, and evaluate the clarity and relevance of the questions in eliciting the intended responses, as done in earlier studies by Odame et al., (2024) and Agyemang et al., (2023). Data was collected within four weeks during the Second Semester of the 2022/2023 academic year (approximately between July and August 2023). It is worth noting that the findings of this study represent the water access situation at UEW as of that period. Participation in the study was voluntary, and informed consent was obtained from all participants after the objective of the study had been clearly explained. Consent was sought verbally, with assurance that students could withdraw at any point from the study if they wished to. To safeguard confidentiality and anonymity, no personal identifiers such as names or student ID numbers were collected; instead, responses were coded numerically.

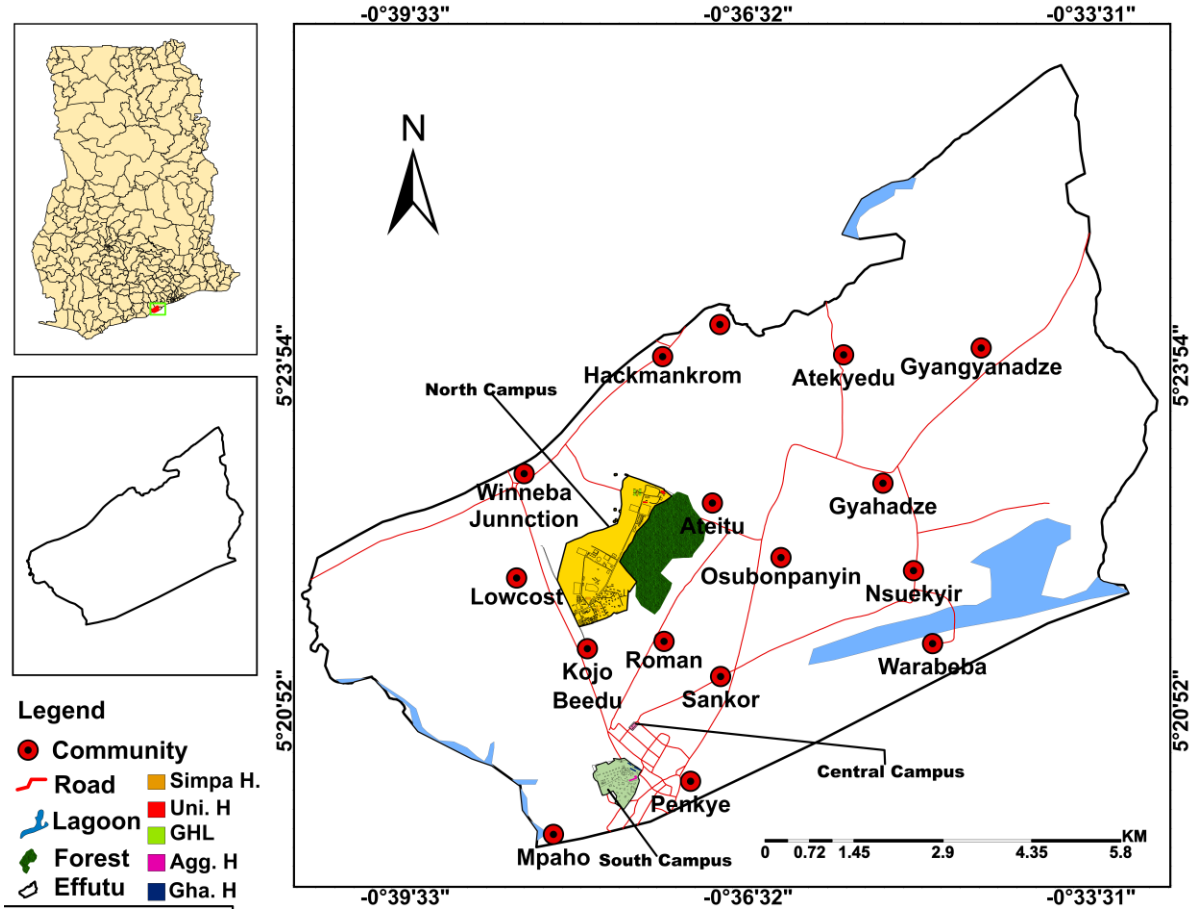

Figure 2: Map of Winneba showing UEW and halls of residents.
Source: Author's construct (2023)

Results

Demographic characteristics of respondents

The demographic characteristics of the students were summarised based on gender, age, educational levels, residence, and average monthly expenditure on all purchases (Table 1). The results revealed that 67% of the respondents were males. Most (29.8%) of the students were in Level 400 [final year] and levels 300s [third year] (23.5%). The dominant age cohort was students between 23 and 27 years old (37%), while those aged 33 years and above were the least represented (10.9%). It was further revealed that most respondents reside in hostels, with more than 76.5% of respondents, and a little above 23% living in campus halls.

Table 1: Demographic characteristics of respondents

Variable	Frequency	Percent
Gender		
Male	268	67.0
Female	132	33.0
Level		
L. 100	82	20.5
L. 200	92	23.0
L. 300	94	23.5
L. 400	119	29.8
Post-graduates	13	3.3
Age group		
18 – 22years	132	35.4
23 – 27years	151	37
28 – 32 years	77	16.7
Above 33 years	40	10.9
Residence		
Hall	94	23.5
Hostel	306	76.5
Average monthly expenditure		
Less than GH₵100	186	46.5
GH₵ 101 – 500	129	32.3
GH₵ 501 – 1000	35	8.8
Above GH₵ 1000	50	12.5
Total	400	100

Lastly, data on students' monthly income/stipend was sourced. It was found that close to half of the total respondents (46.5%), on average, spend less than Gh₵100 each month while on campus. Yet, on average, others spend between GH₵101 – GH₵500 (32.3%) and above GH₵1001 (12.5%) monthly. Furthermore, the study performed a multinomial logistic regression with the sources of water dependent and satisfaction with the source of water, water quality (smell), water quality (healthiness), payment responsibility, reliability and cost of water as the independent variables.

Determinants of students' preference for water sources

A multinomial logistic regression analysis was conducted to determine the determinants of students' drinking water sources. The predictor variables were based on academic levels of student (100, 200, 300, 400, and post-graduates); age cohort (18-22 years, 23-27 years, 28-32 years, and 33+ years); residence (on-campus hall, and off-campus hostel); other occupation (yes and no); satisfaction gained from water source (not satisfied, satisfied, and very satisfied), water quality (taste, smell, and healthiness) measured as acceptable, good and poor, reasons for choosing water source (reliability) was measured as (yes and no), average cost of water (less than GHS50, more than GHS100, and more than GHS50 but less than GHS100), and persons responsible for payment of water (guardian, and self).

The outcome variable was water sources (bottled water, pipe-borne water, sachet water, and other sources as a reference category). After subjecting the model to a forward entry stepwise, key predictors that emerged as significant included student level, occupation, satisfaction with

municipal water quality, perceptions of smell and healthiness, reasons for choosing a water source (reliability), cost of water, and payment responsibility. The regression model was statistically significant: ($\chi 2(66) = 373.914$, $p < .001$, Cox and Snell R2 =.607, Nagelkerke R2 =.703). The chi-square goodness-of-fit test showed significance ($\chi 2(525) = 635.593$, $p < .001$), indicating the observed frequencies significantly differed from the expected frequencies. However, the deviance chi-square test was not significant ($\chi 2(525) = 422.079$, $p = 1.000$), suggesting an adequate model fit according to the test statistic.

Table 2: Multinomial logistic regression of the determinants of students' preference for water sources.

	Drinking Water Sources					
	Bottled Water		Pipe Borne Water		Sachet Water	
Predictor variables	Odds ratio	Sig.	Odds ratio	Sig.	Odds ratio	Sig.
Level of Students						
Level 100	0.002	**0.019**	---	---	0.032	0.151
Level 200	15.210	0.197	---	---	30.911	**0.031**
Level 300	0.051	0.269	---	---	1.058	0.981
Level 400	0.004	**0.000**	---	---	0.044	**0.000**
Post-graduate	1	1	---	---	1	1
Other Occupation						
No	7.442	0.005	2.500	0.001	9.902	0.001
Yes	1	1	1	1	1	1
Water source satisfaction						
Not Satisfied	0.001	0.041	---	---	---	---
Satisfied	2.010	0.644	---	---	---	---
Very Satisfied	1	1	---	---	---	---
Water Quality (Smell)						
Acceptable	---	---	2.833	0.001	5.123	0.000
Good	---	---	1.765	0.001	3.435	0.000
Poor	---	---	1	1	1	1
Water Quality						
Acceptable	3.158	0.002	2.524	0.007	7.988	0.005
Good	2.209	0.001	1.410	0.010	3.218	0.009
Poor	1	1	1	1	1	1
Reliability						
No	0.765	0.007	0.099	0.002	0.810	0.001
Yes	1	1	1	1	1	1

Monthly/average Cost of water						
Less than GHS50	0.002	0.001	1.018	0.024	1.015	0.017
More than GHS100	7.357	0.989	4.280	0.991	3.444	0.990
More than 50 but less than GHS 100	1	1	1	1	1	1
Payment responsibility						
Guardian	0.038	0.011	0.003	0.006	0.002	0.003
Self	1	1	1	1	1	1

Reference category: Other water sources

Based on the multinomial logistic regression analysis presented in Table 2, the following predictor variables were found to be significant determinants of students' preference for different drinking water sources:

For bottled water:

Level 100 (p = 0.019) and Level 400 (p = 0.000) students had significantly different odds of preferring bottled water compared to post-graduate students. Students with no other occupation had 7.442 times higher odds (p = 0.005) of preferring bottled water compared to those with different occupations. Not satisfied students had 0.001 times lower odds (p = 0.041) of preferring bottled water compared to very satisfied students. Students who perceived water quality as acceptable or good had 3.158 (p=0.002) and 2.209 (p=0.001) times higher odds, respectively, of preferring bottled water compared to those who perceived it as poor. Students who perceived water as unreliable had 23.5% lower odds (OR = 0.765; p=0.007) of preferring bottled water compared to those who perceived it as reliable.

For pipe-borne water:

Students with no other occupation had 2.5 times higher odds (p=0.001) of preferring pipe-borne water compared to those with other occupations. Students who perceived water smell as acceptable or good had 2.833 (p=0.001) and 1.765 (p=0.001) times higher odds, respectively, of preferring pipe-borne water compared to those who perceived it as poor. Students who perceived water quality as acceptable or good had 2.524 (p=0.007) and 1.410 (p=0.010) times higher odds, respectively, of preferring pipe-borne water compared to those who perceived it as poor. Students who perceived water as unreliable had 90.1% lower odds (OR = 0.099; p=0.002) of preferring pipe-borne water compared to those who perceived it as reliable. Cost of water: Students who paid less than GHS 50 had 0.018 times lower odds (p=0.024) of preferring pipe-borne water compared to those who spent more than GHS 50 but less than GHS 100. Students whose guardians were responsible for payment had 0.003 times lower odds (p=0.006) of preferring pipe-borne water compared to those who were responsible themselves.

For sachet water:

Students who perceived water smell as acceptable or good had 5.123 (p=0.000) and 3.435 (p=0.000) times higher odds, respectively, of preferring sachet water compared to those who perceived it as poor. Students who perceived water quality as acceptable or good had 7.988 (p=0.005) and 3.218 (p=0.009) times higher odds, respectively, of preferring sachet water compared to those who perceived it as poor. Students who perceived water as unreliable had 19.0% lower odds (OR = 0.810; p=0.001) of preferring sachet water compared to those who perceived it as reliable. Students who paid less than GHS 50 had 0.015 times lower odds (p=0.017) of preferring sachet water compared to those who spent more than GHS 50 but less than GHS 100. Students whose guardians were responsible for payment had 0.002 times lower odds (p=0.003) of preferring sachet water compared to those who were responsible themselves.

The model was statistically significant, $\chi 2$ (26, $N = 400$) = 218, $p < .001$, indicating that the model predicted various factors that influence students' preference for drinking water sources. The model explained between 54% (Cox and Snell R-squared) and 63% (Nagelkerke R-squared) of the

variance in students' preference for drinking water sources. The model was also found to be fit ($\chi 2(501) = 469.389$, $p = .841$), suggesting an adequate model fit according to the test statistic. As shown in Table 2, only eight independent variables (student level, occupation, smell, healthiness, reliability, cost, payment, and overall satisfaction) significantly contributed to the model. Using respondents' academic level, respondents in level 100 (OR = 0.002, p = .0019) and level 400 (OR = 0.004, p = .0000) recorded a lower likelihood of preferring bottled water as their source of drinking water. With regards to sachet water, respondents in level 200 recorded a higher odds since they were 30.9 times more likely to prefer sachet water. However, level 400 undergraduate students, on the other hand, recorded a much lower chance of choosing this same water source as their preferred option (OR = 0.002, p = .0019). Using students' occupation, unemployed students recorded a lower likelihood of choosing bottled water (OR = 7.442, p = .005) and sachet water (OR = 9.902, p = .001).

With regards to students' overall perception about the quality of water, students who claimed not to be satisfied with the quality of water recorded a much lower chance (OR = 0.001, p = 0.041) of selecting bottled water as their preferred source of drinking water. Respondents' perception of the smell of water was examined. Respondents who ranked water smell as acceptable were more likely to choose pipe-borne water (OR = 2.833, p = .001) and sachet water (OR = 5.123, p = .000) as their preferred sources of drinking water. Similarly, those who rated the smell of water as good as recorded a higher likelihood of choosing pipe-borne water (OR = 1.765, p = .001) and sachet water (OR = 3.435, p = .000) as their preferred source of drinking water. Respondents' perception of water quality was also influenced by their rating of various water sources as acceptable, as they were more likely to choose all three water sources as their preferred option, albeit to varying degrees.

In order of ranking, pipe-borne water recorded the least likelihood (OR = 2.524, p = .0007), followed by bottled water (OR = 3.158, p = .002) and sachet water (OR = 7.988, p = .0005). Similarly, respondents who rated water quality as good were more likely to choose pipe-born water (OR = 1.410, p = .010), bottled water (OR = 2.209, p = .001), and sachet water (OR = 3.218, p = .009) as their preferred sources of drinking water. Respondents who did not consider the supply of various water sources as reliable recorded reduced odds across all three sources: bottled water (OR = 0.765, reflecting a 23.5% reduction in odds; p= .007), pipe-borne water (OR = 0.099, reflecting a 90.1% reduction in odds; p= .002) and sachet water (OR = 0.810, reflecting a 19.0% reduction in odds; p= .001). With regards to monthly expenditure on water, students who spent less than 50 Cedis ($3.65) recorded a lower likelihood of choosing bottled water as their preferred source but higher odds of choosing pipe-borne water (OR = 1.018, p = .0024) and sachet water (OR = 1.015, p = .017). Finally, respondents whose water costs are paid by their parents or guardians recorded lower odds of choosing bottled water (OR = 0.038, p = .0011), pipe-borne water (OR = 0.003, p = .006) and sachet water (OR = 0.002, p = .003).

Discussions

Drinking water sources play a critical role in attaining Sustainable Development Goal (SDG) 6.1 (Rajapakse, Otoo & Danso, 2023), and are a significant concern for policymakers in most developing countries due to their health concerns. Depending on several factors or determinants, accessing heterogeneous drinking water sources, particularly in low to middle-income countries, has raised significant public health concerns (Howard et al., 2020). Therefore, this study was

necessary to investigate the determinants of drinking water source preference among university students at the University of Education, Winneba (UEW), Ghana, for effective interventions for sustainable drinking water sources.

It was revealed that when it comes to bottled water preference, Level 100 and Level 400 students were more likely to choose bottled water compared to post-graduate students. This is due to variations in knowledge, awareness, and, more importantly, financial considerations among students at different academic levels. Furthermore, Graydon et al. (2019) confirmed that financial considerations play a significant role in bottled water choices, with students from lower academic levels often perceiving bottled water as a status symbol, despite potential budget constraints. While this was not surprising due to the reasons adduced, it was rather unexpected to have largely employed postgraduate students in the minority when compared with the undergraduate students. This scepticism is, however, explained. Thus, students without occupations were more inclined towards bottled water, due to the luxury of time or resources. According to Sohail et al. (2021) and Stoler et al. (2019), time availability influences water consumption habits, with those having freer time more likely to engage in perceived "healthier" or "premium" hydration options. Additionally, Kooy and Furlong (2020) found that marketing strategies often target younger students, potentially influencing the higher preference among Level 100 and 400 students.

Dissatisfaction with the campus water situation was linked to lower odds of preferring bottled water, indicating that students perceived bottled water only as an alternative when they were content with the campus water supply. A study by Etale et al. (2018) affirmed this finding as they revealed that dissatisfaction with local water quality often leads to increased consumption of alternative water sources, but not necessarily bottled water. This aligns with the observation that dissatisfaction with campus water was linked to lower odds of preferring bottled water. Positive perceptions of water quality and reliability are associated with higher odds of bottled water preference, potentially reflecting a preference for safer water sources. The preference for bottled water when students are content with campus water supply may be explained by findings from Díez et al. (2018), which suggest that perceived water quality influences bottled water consumption even when tap water is objectively safe.

Regarding the association between positive perceptions of water quality and reliability with higher odds of bottled water preference, Qian et al. (2019) noted that this counterintuitive relationship might stem from overall higher quality expectations among certain consumer groups. When it comes to pipe-borne water preference, students without occupations were more likely to choose this option, which is related to convenience and cost factors. The preference for pipe-borne water among students without other occupations is supported by research from Stoler et al. (2019), which highlights the role of convenience and cost-effectiveness in water source choices, particularly among time-rich but financially constrained populations like full-time students.

Positive perceptions of water smell, quality, and reliability are associated with higher odds of preferring pipe-borne water, indicating these factors are crucial in students' decision-making. Earlier studies by Aslan et al. (2020) also found that positive sensory perceptions of water, particularly regarding smell and taste, strongly influence consumer choices towards improved water sources, including pipe-borne and packaged water. This aligns with the observed higher odds of preferring both pipe-borne and sachet water among students with positive perceptions of water smell, quality, and reliability. The importance of these factors in decision-making is further

supported by Francis et al. (2020), who emphasise the role of organoleptic properties in shaping water consumption behaviours.

Interestingly, students who paid lower water costs or whose guardians are responsible for payment had lower odds of preferring pipe-borne water, potentially due to financial considerations and lack of direct responsibility for water expenses. Regarding the economic aspects, Stoler et al. (2021) recount similar thoughts as they note that a direct financial responsibility for water expenses significantly impacts water source choices. This supports the observation that students paying lower water costs or whose guardians are responsible for payment had lower odds of preferring pipe-borne or sachet water. The study suggests that a lack of direct financial accountability may lead to less conscious decision-making about water sources.

For sachet water preference, positive perceptions of water smell, quality, and reliability are strong predictors of higher odds of choosing sachet water. This highlights the importance of perceived water quality and consistency in influencing students' water source preferences. The preference for sachet water based on perceived quality and reliability is consistent with Semey et al.'s (2020) study. Their research in urban Ghana showed that sachet water is often perceived as a reliable and safe alternative to other water sources, particularly in areas with inconsistent piped water supply. Similar to pipe-borne water, lower water costs, and guardians being responsible for payment are associated with lower odds of preferring sachet water; hence, the influence of financial factors. The influence of financial factors on sachet water preference, mirroring the pattern seen with pipe-borne water, is supported by Kumpel et al.'s (2020) findings. According to the authors, economic considerations in choosing packaged water sources, with price sensitivity being a key factor, are especially important among student populations.

Conclusions

This study reveals that drinking water source preferences among students at the University of Education, Winneba (UEW), are shaped by a combination of economic, perceptual, and institutional factors. Sachet water emerged as the most preferred source, driven by positive perceptions of its safety, smell, and healthiness. Three clusters of determinants were statistically significant in the multinomial model: quality perceptions (smell and healthiness), economic factors (cost and payment responsibility), and academic-occupational characteristics.

Again, perceptions of water quality play a crucial role in water source preferences. Positive perceptions of water smell, quality, and reliability are associated with higher odds of preferring bottled, pipe-borne, and sachet water, emphasising the importance of sensory and quality factors in students' decision-making processes. Financial considerations significantly impact water source choices. Students who pay lower water costs or whose guardians are responsible for payment have lower odds of preferring pipe-borne or sachet water. This suggests that direct financial responsibility influences more conscious decision-making about water sources. Additionally, satisfaction with campus water supply affects bottled water preference. Interestingly, dissatisfaction with the campus water situation is linked to lower odds of preferring bottled water, indicating that students may view bottled water as an alternative when dissatisfied with the existing supply. Lastly, convenience and cost factors play a role in pipe-borne water preference, especially among students without other occupations. Collectively, these findings underscore the need for institutional policies that address both the infrastructure and affordability dimensions of safe water access in tertiary education settings in Ghana.

Recommendations

Given that reliability perceptions (OR = 0.099; p = .002) significantly reduced the odds of pipe-borne water preference, university management and private hostel owners should invest in specific infrastructure improvements, including the installation of storage tanks in hostels, water filtration systems at key distribution points, and regular water quality testing schedules. These targeted interventions would directly address the reliability and quality concerns identified in the regression model and reduce students' reliance on costly bottled water alternatives, which are financially draining for students. With a considerable number of students being financially constrained, the University management should explore avenues of subsidising water costs to students at reduced rates. Furthermore, 'structured water safety education programmes should be developed and formalised as part of student orientation and health promotion activities, covering water treatment methods, safe storage practices, and the health risks of unverified water sources, particularly in halls of residence and private hostels.

For the reason of sustainable drinking water, the University management in partnership with the Effutu Municipal Assembly should spearhead initiatives (awareness campaign) to promote sustainable water consumption practices, with critical emphasis on closing taps when not in use (esp. when brushing teeth), treating water (e.g. boiling) when suspected to be of lower quality (to still make it viable for drinking), and using reusable water bottles. These strategies will ensure the use of water only when needed, while at the same time using water for the right purpose (drinking), as well as cutting down on expenditure on bottled water consumption.

Implications for Future Studies

Future studies should extend coverage to multiple public and private universities, and future research should explore the cost-benefit dynamics of reducing bottled water consumption among university students. Expanding the research to include multiple universities in Ghana would also provide comparative insights into how institutional infrastructure, governance, and local water supply systems shape students' drinking water preferences and sustainable water use practices.

Limitations of the study

Despite the meticulousness of this study, it is not without limitations that need to be addressed for future studies. Firstly, although the University of Education, Winneba, a public University, has two major campuses at the time of the study at Winneba and Ajumako, the study was conducted only at the Winneba campus, which is the largest. In close connection to the above is the sample size of 400 students, which might not be a true reflection of the large number of students of the University, in particular, and those in Ghana as a whole. Indeed, the smaller sample size, similar to several other studies (Mahmood et al., 2024), presents a problem with generalising the findings. Furthermore, the data were collected in 2022/2023, representing conditions as of that period. Given that approximately four years have elapsed since data collection, factors such as changes in water infrastructure, municipal supply conditions, cost of water, and student demographics may have shifted. Future studies should verify whether the findings still reflect current realities, including any institutional or municipal water supply changes that may have occurred between 2022 and the present.

List of abbreviations

CI	–	Confidence Interval
GSS	–	Ghana Statistical Service
LMICs	–	Low- and Middle-Income Countries
OR	–	Odds Ratio
PNDC	–	Provisional National Defence Council
SDG	–	Sustainable Development Goal
SPSS	–	Statistical Package for Social Sciences
TPB	–	Theory of Planned Behaviour
UEW	–	University of Education, Winneba
UNICEF	–	United Nations International Children's Emergency Fund
WHO	–	World Health Organisation

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Authors' contributions
The conception, design of the study, data collection and analysis, drafting of the manuscript, and reviewing of the manuscript were all done by the author.

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