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Larval Habitat Mapping and Assessment of Knowledge, Attitudes, and Practices on *Aedes* Mosquito Control in a Nigerian University

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Abstract

Background: *Aedes aegypti* and *Aedes albopictus* are primary vectors of arboviral diseases posing a growing public health threat in sub-Saharan Africa. Nigeria has documented recurrent outbreaks, yet vector control remains malaria-focused, leaving *Aedes* surveillance underexplored. Also, since university environments may provide overlooked breeding hotspot, assessing students' knowledge and perception becomes vital in disease prevention.

Methodology: A cross-sectional mixed-methods study was conducted at Fountain University, Osogbo, Nigeria, between January and June 2026. Entomological surveys identified larval habitats using WHO-standard dipping and pipette procedures, with geospatial mapping via GPS and ArcGIS. Larvae were morphologically identified using Hopkin's keys. Concurrently, structured questionnaires assessed students' knowledge, attitudes, and practices (KAP) regarding *Aedes* bioecology and control. A sample size of 384 respondents was determined using Cochran's formula. Data were analyzed with SPSS, employing descriptive statistics and chi-square tests at a 95% confidence interval.

Results: Twenty-eight larval habitats were identified, predominantly around female hostels and school fields, with buckets/containers (28.6%) and discarded tyres (21.4%) as major breeding sites. Of 384 respondents, 73.2% had heard of *Aedes* mosquitoes, but only 34.1% could identify them. Misconceptions about biting times and breeding sites were common, while 70.3% had never reported mosquito breeding. Although 91.9% claimed proper waste disposal, inconsistent preventive practices persisted.

Conclusion: Institutional environments, such as universities, sustain *Aedes* breeding through ecological and behavioural factors. Integrating larval habitat mapping with KAP assessment

provides critical baseline data for campus-based vector management. Findings highlight the need for targeted educational interventions and community-led surveillance to strengthen Nigeria's arboviral disease preparedness.

Keywords: *Aedes* mosquito, mapping, vector control, Nigerian university, KAP

Background

Mosquito-borne arboviruses remain a major global health challenge, with *Aedes aegypti* and *Aedes albopictus* serving as the principal vectors of dengue, chikungunya, yellow fever, and Zika viruses (WHO, 2017). Globally, more than 390 million dengue infections occur annually, with approximately 96 million symptomatic cases (WHO, 2024). Arboviral diseases are now endemic in over 100 countries, placing 4 billion people at risk, a figure projected to reach 5 billion by 2050 (WHO, 2024). Africa, once considered marginally affected, has reported increasing outbreaks in the past decade, underscoring the expanding epidemiological footprint of *Aedes*-borne viruses (Adesola et al., 2022).

Transmission is facilitated by the anthropophilic feeding behaviour of *Aedes aegypti*, which preferentially feeds on humans and often takes multiple interrupted blood meals, thereby enhancing vectorial capacity (Johnson et al., 2023). Vertical transmission from female mosquitoes to offspring, alongside horizontal transmission between humans, sustains endemicity even in the absence of active outbreaks (Janjoter et al., 2024). The adaptability of *Aedes* eggs, which can survive desiccation for months, further complicates eradication efforts (Mundim-Pombo et al., 2021).

In Nigeria, arboviral diseases have been repeatedly documented. Yellow fever outbreaks have persisted for over six decades, with recent epidemics overwhelming health systems in southern states (Mukhtar & Ibrahim, 2022). Dengue virus genotypes II and V were confirmed in Nigeria as recently as 2019, highlighting ongoing transmission (Adesola et al., 2022). A systematic review revealed widespread insecticide resistance in *Aedes aegypti*, with pyrethroid resistance exceeding 75% and emerging resistance to carbamates and organophosphates (Mohammed et al., 2026). These findings raise serious concerns about the sustainability of chemical-based control strategies.

Local studies in Osun State have demonstrated the entrenchment of *Aedes aegypti*. Busari et al. (2025) reported that 27.8% of surveyed habitats tested positive for *Aedes* larvae, with *Aedes aegypti* accounting for 99.3% of adult flies identified. A previous study by Babalola et al., (2025) have reported environmental suitable of Lagos and Ogun State for *Aedes* breeding stating temperature and precipitation as major environmental drivers. Similarly, Adeleke et al., (2013) in Osogbo metropolis have reported the presence of suitable *Aedes* breeding habitat and suggestion changes in land charge use as possible measures for environmental prevention and control.

Despite recurrent arboviral outbreaks, Nigeria's vector control programs remain heavily skewed toward malaria, leaving *Aedes* mosquitoes under-monitored. The persistence of breeding habitats in urban and institutional settings, coupled with emerging insecticide resistance, threatens to exacerbate transmission. On university campuses, poor sanitation, open water storage, and inadequate waste management create ideal conditions for *Aedes* proliferation. Yet, there is a critical paucity of integrated research combining ecological surveillance with community-level knowledge, attitudes, and practices (KAP). This gap hinders the design of effective, sustainable interventions.

By characterizing and mapping larval habitats and assessing student KAP, the present study seeks to bridge ecological and social dimensions of vector control since university environment could serve as breeding hotspot for *Aedes* mosquito. The objectives directly address the identified problem, providing a comprehensive evidence-based approach for integrated vector management in academic settings, while serving as a model for similar interventions across Nigerian universities and globally.

Methods

Study Design

This study employs a cross-sectional descriptive design with a mixed-methods approach combining entomological surveys to characterize and map *Aedes mosquito* larval habitat. In addition, the assessment of the Knowledge, Attitude, and Practice (KAP) of the Fountain University, Osogbo, Osun State, Nigeria students using well-structured questionnaires on the bioecology, prevention and control of *Aedes* mosquito vector and *Aedes*-borne diseases.

Study Area

The research will be carried out at Fountain University in Osogbo, Osun State, Nigeria (N7.7667, E4.5500). Fountain University has a student population of about three thousand and is located in a tropical region typified by high humidity and seasonal rains, that may promote mosquito breeding. The campus is divided into zones, which include student hostels, lecture rooms, laboratories, offices, and administrative buildings. Many of which could possibly serve as *Aedes* breeding habitats, such as water containers, drains and others. The academic atmosphere is ideal for studying the relationship between community practices and the existence of mosquito breeding sites.

Entomological Larval Sampling

Larval sampling was conducted through a thorough prospection of the university, including student hostels, cafeterias, lecture rooms and others between January and June, 2026. All accessible water-holding containers, including buckets, drums, discarded tyres, gutters and ground pools, will be inspected for the presence of *Aedes* larvae and pupae using WHO-standard dipping and pipette procedures. This will be done between 0700-1100hrs. The collected larvae were put in clean

transparent containers, well labelled and covered with net of mesh size 0.05mm and transported to the Molecular Epidemiology and Vector Biology (MOVEB) (ISO 15189:2022) laboratory of the Department of Animal and Environmental Biology, Osun State University, Osogbo, Nigeria for further analysis.

Identification of larvae and Adult *Aedes mosquito*

The collected larvae were morphologically identified using keys by Hopkin (1952) to ensure they are *Aedes* mosquito larvae. This will assist in the proper determination of productive and prospective Aedes larval habitats.

Geospatial Data Collection

Each larval breeding site was georeferenced using Global Positioning System (GPS) Essential version 4.5.20 by the Swiss Army Knife of GPS Navigation on Android

Assessment of Knowledge, attitude and practice of students on *Aedes* mosquito bioecology, prevention and control

Well-structured questionnaire was developed using google form and administered to the university students across all level to assess their knowledge, attitude and perception regarding *Aedes mosquito* bioecology, prevention and control. The questionnaires are separated into four sections (Sections A-D). Section A included demographic data of the respondents with information such as age, gender, etc while Section B assessed respondents' knowledge on *Aedes* bioecology. Section C tested their perception on prevention and control while Section D evaluated their attitude and practice regarding the vector, disease prevention, control and public health impact. The questionnaire has been added as a supplementary file. Prior to being administered, the questionnaire were pre-tested to ensure its clarity and validity.

The sample size of 384 respondents was used after calculation using Cochran's proportions formula, which assumes a 50% prevalence (for maximum variability), a 95% confidence level, and a 5% margin of error.

Data Analysis

Data from questionnaires and entomological surveys will be entered and analyzed with SPSS. Descriptive statistics (frequency, mean, and percentage) will be used to summarize KAP responses and larval habitat characterization. Chi-square tests will be used to assess the relationship between KAP levels and demographic characteristics.
A p-value of less than 0.05 ($p < 0.05$) would be considered statistically significant at a confidence interval (CI) of 95%. The map was generated using ArcGIS version 10.5.

Result

Larval habitat abundance and characterization

A total of 28 locations were identified as *Aedes* breeding larval habitat around the university. These locations included the school field, the female hostels, basketball court, Information and Communication Technology (ICT) centre. The female hostel was predominant 8 (28.6), followed by the school field 4 (14.3) ($p < 0.05$)(Table 1). Within these locations, the larval habitat types encountered included drums, containers, discarded tyre, rock pool, gutter, tree holes and others. The bucket/containers 8 (28.6) were the majorly encountered followed by tyre 6 (21.4) while wheel barrow and drum had the lowest frequency of 1 (3.6) ($p < 0.05$) (Table 2). Furthermore, 10 (35.7) and 18 (64.3) productive and prospective larval habitat types were encountered respectively ($p > 0.05$).

Table 1: Locations with *Aedes* larval habitats in the study area

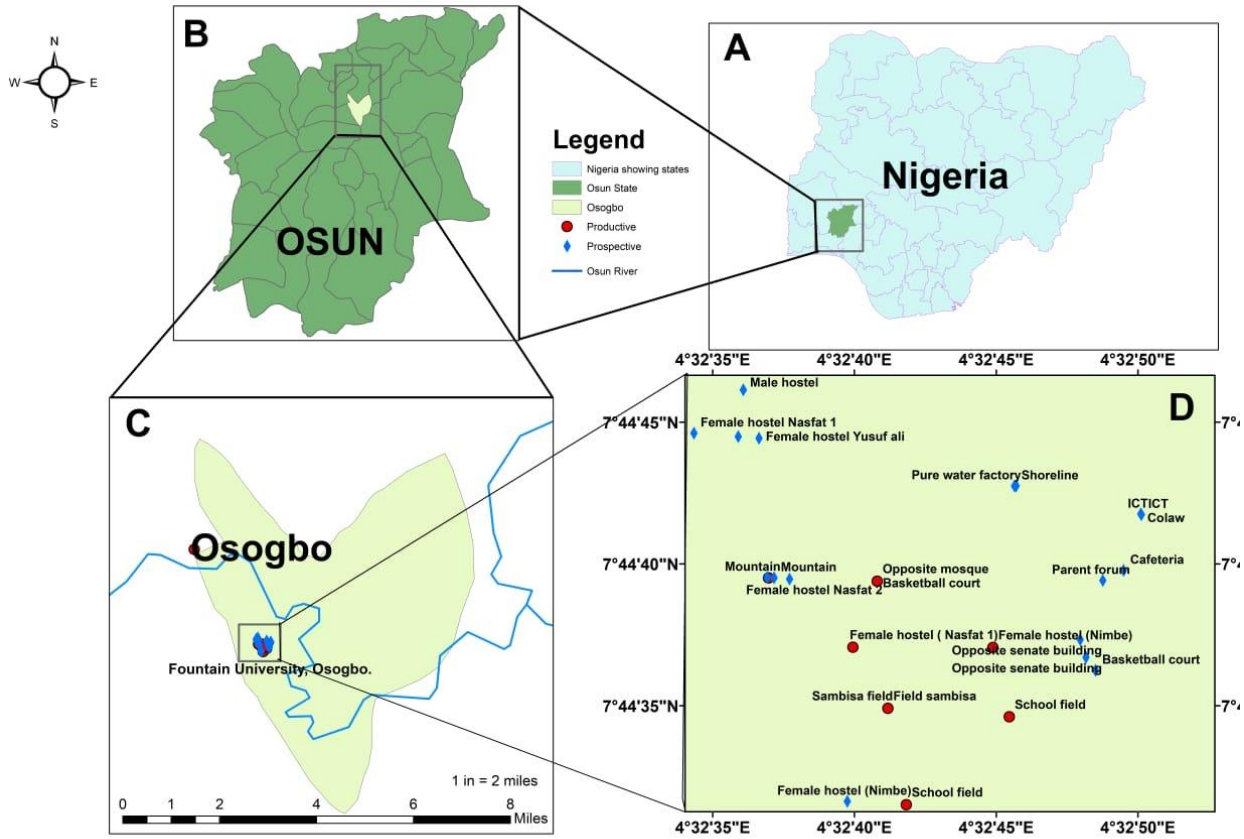
Location(s)	Number of breeding site (s)	Percentage (%)
School field	4	14.3
Female hostel	8	28.6
Mountain	3	10.7
Basketball court	2	7.1
Opposite mosque	1	3.6
Parent forum	1	3.6
Pure water factory	1	3.6
Opposite senate building	2	7.1
Male hostel	1	3.6
ICT	2	7.1
Shoreline	1	3.6
Colaw	1	3.6
Cafeteria	1	3.6
Total	28	100

Table 2: *Aedes* larval habitat types in the study area

Larval habitat type	Frequency	Percentage
Drum	1	3.6
Buckets/containers	8	28.6
Tyre	6	21.4
Gutter	3	10.7
Tree holes	2	7.1
Ground pool	4	14.3
Wheel barrow	1	3.6
Rock pools	3	10.7
Total	28	100

Mapping on *Aedes* larval habitat in the study area

The mapping of identified *Aedes* larval habitats within Fountain University, Osogbo, Nigeria is presented in Figure 1. A total of 28 larval habitats were identified in different locations within the study area. Productive and prospective larval habitats were identified around the female hostels, school field, Mountain area, ICT Centre, basketball court, shoreline, cafeteria, and other parts of the campus. Productive breeding sites were more concentrated around the female hostels and school field, while prospective habitats were distributed across several other locations. The map shows that *Aedes* larval habitats were unevenly distributed within the university, with clusters occurring mainly in areas characterized by human activities and the presence of artificial water-holding containers.



220

221 **Figure 1. Mapping of productive and prospective *Aedes* larval habitats in Fountain**
222 **University, Osogbo, Osun State, Nigeria.**

223

224 **Knowledge, attitude and practice on *Aedes* mosquito and *Aedes*-borne disease**

225 **Demographic data of the respondent**

226 A total of 384 respondents were involved in the study. 295 (76.8) of the respondents are female,
227 while 89 (23.2) are male ($p > 0.05$). The majority of the respondents are in the age range 18-22yrs,
228 349 (90.9), with the fewest in the 28- 32 years range, 4 (1.0). The number of respondents across
229 levels in 100, 200, 300, 400 and 500 are 247 (64.4), 41 (10.7), 27 (7.0), 58 (15.1) and 11 (2.8),
230 respectively (Table 3).

Table 3: Demographic data of respondents in the study area

Parameter		**Number (%)**
Gender	Male	89 (23.2)
	Female	295 (76.8)
Age	18-22	349 (90.9)
	23-27	26 (6.8)
	28-32	4 (1.0)
	Above 32	5 (1.3)
Level	100	247 (64.4)
	200	41 (10.7)
	300	27 (7.0)
	400	58 (15.1)
	500	11 (2.8)

Knowledge on bioecology of *Aedes* mosquito

Majority 281 (73.2) of the respondents have heard of *Aedes* mosquitoes ($p > 0.05$). Only 131(34.1) can identify the vector while 253 (65.9) cannot ($p > 0.05$). 117 (30.4) lack the knowledge of when mosquito bite, 64 (16.6) reported they bite both in the day and at night while 100 (26.0) reported they bite only in the day season ($p > 0.05$). 167 (43.4) reported *Aedes* mosquito breed in stagnant water while 1 (0.2) reported that they breed in clean water (Table 4).

Table 4: Knowledge on bioecology of *Aedes* mosquito in the study area

Question(s)	Response(s)	Number (%)
Have you heard of *Aedes* mosquito	Yes	281 (73.2)
	No	74 (19.2)
	Maybe	29 (7.6)
Can you identify *Aedes* mosquito	Yes	131 (34.1)
	No	253 (65.9)
When does mosquito bite	Day	100 (26.0)
	Night	103 (26.8)
	Both	64 (16.7)
	I don't know	117 (30.5)
What time of the year do they bite	Dry season	47 (12.2)
	Wet season	201 (52.3)
	I don't know	136 (35.4)
Where does *Aedes* mosquito breed	Bucket	12 (3.1)
	Discarded tyre	9 (2.3)
	Bucket/Discarded Tyre/Stagnant water	121 (32.0)

	Gutter	59 (15.3)
	Stagnant water	167 (43.4)
	I don't know	15 (3.9)

Knowledge, attitude and practice on public health implication

Majority 276 (71.9) of the respondents reported the bite of mosquitoes in their environment ($p > 0.05$). Similarly, majority 267 (69.5) acknowledged that *Aedes* mosquito pose public health threat, 102 (26.5) are unsure and 15 (3.9) do not see them as threat. Furthermore, 204 (53.1) opine that *Aedes* breeding is caused by the presence of stagnant water in the environment, 47 (12.2) by discarded containers, 11 (2.8) by discarded tyres, 76 (19.7) by gutter and 46 (11.9) do not have have an idea of risk factors for their breeding ($p > 0.05$). 114 (29.6) of respondents claim to have reported cases of mosquito breeding sites in the study area while 270 (70.3) have not reported (Table 5).

Table 5: Knowledge, attitude and practice on public health implication of *Aedes* mosquito in the study area.

Question(s)	Response (s)	Number (%)
Do mosquitoes bite in your environment	No	108 (28.1)
	Yes	276 (71.9)
Do *Aedes* mosquito pose a public health threat	Yes	267 (69.5)
	No	15 (3.9)
	Not sure	102 (26.5)
What causes the presence of *Aedes* breeding sites	Discarded tyre	11 (2.8)
	Gutter	76 (19.7)
	Discarded containers	47 (12.2)
	Stagnant water	204 (53.1)
	I don't know	46 (11.9)

Knowledge, attitude and practice on *Aedes* control and prevention in the study area

353 (91.9) of the respondents claim to dispose used containers properly ($p > 0.05$). Although the correlation between this and reported mosquito bite in the study area is not statistically significant, measure still need to be put in place to prevent bite which is a risk factor for *Aedes*-borne disease transmission. Majority 198 (51.5) believe *Aedes* bite can be controlled through the prevention of stagnant water while 37 (9.6) have no idea of how it could be controlled ($p > 0.05$). 229 (59.6) of respondents are reported to use mosquito repellents, nets and sprays while 73 (19.0) do not use any (Table 6).

Table 6: Knowledge, attitude and practice on *Aedes* control and prevention in the study area

Question(s)	Response(s)	Number (%)
How do you dispose used containers	Leave them outside	31 (8.1)
	Properly	353 (91.9)
How do you think *Aedes* can be prevented	Use of mosquito net	45 (11.7)
	Use of insecticides	104 (27.1)
	Removing stagnant water	198 (51.5)
	I don't know	37 (9.6)
Do you use mosquito repellents, net or spray	Yes	229 (59.6)
	No	73 (19.0)
	Occasionally	82 (21.4)
What do you after mosquito bite	Go to the hospital	215 (55.9)
	Use herb	26 (6.8)
	Visit a traditionalist	9 (2.3)
	Nothing	134 (35)

Discussion

Larval Habitat Characterization and Mapping

This study revealed that stagnant water, gutters, and discarded containers were the predominant breeding sites for *Aedes* mosquitoes within Fountain University. These findings are consistent with previous Nigerian studies, which have repeatedly identified anthropogenic habitats such as tires, buckets, and poorly managed drains as key larval reservoirs (Babalola *et al.*, 2025; Omoregie *et al.*, 2025). In Lagos State, geospatial modeling demonstrated that urban waste accumulation and indiscriminate water storage practices significantly increased larval density, particularly in peri-urban areas where sanitation infrastructure was weak (Babalola *et al.*, 2025). Similarly, in South-South Nigeria, Omoregie *et al.* (2025) reported that physicochemical parameters of water bodies, including chloride concentration and pH, influenced larval abundance, highlighting the ecological adaptability of *Aedes* species.

The implication of these findings is that institutional environments such as universities are not exempt from the ecological drivers of *Aedes* proliferation. The clustering of students, reliance on open water storage, and improper waste disposal create microhabitats that sustain larval development. This aligns with WHO's operational manual on larval source management, which emphasizes that institutional and community settings must be prioritized in integrated vector control programs (WHO, 2026). Thus, the mapping of larval habitats within Fountain University provides critical baseline data for campus-specific interventions, which could serve as a model for other Nigerian universities.

Knowledge, Attitudes, and Practices (KAP)

Despite 73.2% of respondents reporting awareness of *Aedes* mosquitoes, only 34.1% could correctly identify the vector, and misconceptions about biting times persisted. This mirrors findings from Delta State, Nigeria, where community members demonstrated high ITN usage but poor recognition of arboviral vectors, leading to ineffective preventive practices (Enwemiwe *et al.*, 2025). In Kenya, Kalva *et al.* (2025) demonstrated that school-based educational interventions significantly improved KAP scores over 12 months, underscoring the potential of structured awareness programs in academic institutions.

The observed knowledge gaps in Fountain University students are particularly concerning given the high risk of arboviral transmission in Osun State, where *Aedes aegypti* has been documented as the dominant species (Busari *et al.*, 2025). This is a population of educated people who are expected to be more knowledgeable and from whom knowledge is transmitted to the larger society. Without adequate knowledge, students may inadvertently sustain breeding habitats through poor sanitation practices. Furthermore, the finding that 70.3% of respondents had never reported mosquito breeding sites reflects a broader challenge in Nigeria, where underreporting of arboviral infections and vector presence remains widespread (Ali *et al.*, 2025; Nwofe *et al.*, 2026). This lack of proactive engagement hinders early detection and control, perpetuating localized transmission cycles.

Public Health Implications

The majority of respondents acknowledged *Aedes* mosquitoes as a public health threat, yet behavioral practices such as failure to report breeding sites and inconsistent use of repellents or nets undermine effective control. This is consistent with evidence from sub-Saharan Africa, where

community engagement remains the weakest link in vector control programs (Lepore *et al.*, 2025). In Nigeria, dengue virus seroprevalence studies have revealed high exposure rates despite limited clinical reporting, suggesting that silent transmission cycles are sustained by inadequate surveillance and poor community-level practices (Ali *et al.*, 2025; Nwofe *et al.*, 2026).

The implication for Fountain University is that student populations may serve as amplifiers of arboviral transmission, particularly given their mobility and social interactions. Universities therefore represent critical nodes for community-based surveillance and intervention, where student-led initiatives could enhance early detection and reporting of breeding sites. Embedding such practices within institutional health policies would strengthen Nigeria's broader vector control framework.

Control Strategies and Global Comparisons

The integrated approach adopted in this study by combining entomological surveillance with KAP assessment aligns with WHO's Global Strategic Preparedness, Readiness and Response Plan (GSPRP), which emphasizes community engagement, environmental management, and evidence-based interventions (WHO, 2024). However, scoping reviews across sub-Saharan Africa reveal that chemical interventions often yield only temporary impacts, while community-based source reduction lacks sufficient behavioral uptake (Lepore *et al.*, 2025). Your study therefore provides a novel contribution by demonstrating that institutional settings can serve as focal points for integrated surveillance and behavioral interventions, bridging ecological and social dimensions of vector control.

Comparatively, in Latin America, integrated community-based programs have successfully reduced *Aedes* indices by combining larval source reduction, health education, and biological

control agents such as *Bacillus thuringiensis var. israelensis* (Bti) (Gómez-Vargas & Zapata-Úsuga, 2022). Adapting such models to Nigerian universities could yield sustainable outcomes, particularly if embedded within student health committees and supported by local government health authorities.

Conclusion

This study reveals that institutional environments such as universities could be critical reservoirs for *Aedes* breeding, compounded by student knowledge gaps, limited reporting practices, and behavioural inconsistencies. Comparisons with other Nigerian and African studies confirm that climatic, anthropogenic, and behavioural factors converge to sustain *Aedes* populations. Therefore, integrated strategies combining ecological surveillance, educational interventions, and community-led source reduction are essential for sustainable control in university settings and beyond. Fountain University provides a paradigm for campus-based vector management, which could be replicated across Nigeria to strengthen national arboviral disease preparedness.

Declarations

Abbreviations

WHO – World Health Organization

KAP – Knowledge, Attitude and Practices

GPS – Global Positioning System

MOVEB – Molecular Epidemiology and Vector Biology

ICT – Information Communication Technology

GSPRP – Global Strategic Preparedness, Readiness and Response Plan

Bti – *Bacillus thuringiensis var israeliensis*

Ethics Approval and Consent to Participate

Ethical approval for this study was sought and obtained from the Institutional Review Board (IRB) of the Fountain University Center for Research, Innovation and Technology (FUCRIT), with reference number FUO/ERB/24/25/0035. The study was therefore carried out following the guidelines of the Fountain University Centre for Research, IRB and the declaration of Helsinki.

Informed consent was received from participant in the study. The consent was verbal after which the questionnaire was sent to them.

Availability of Data and Materials

All data generated and analyzed in this project are included in the article

Competing Interests

The authors declare no conflict of interest in the project

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Consent to Publish

Not applicable

Clinical Trial Number

Not applicable

Authors' Contributions

Conceptualization: L.O, A.M

Data curation: A.M, L.O

Data analysis: L.O, D.I

Supervision: K.O, M.O, A.O, A.M, K.A, A.A, M.A

Manuscript writing: L.O

Manuscript editing: L.O, A.S, A.A, S.A, M.A

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