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Knowledge of Human Papillomavirus and Human Immunodeficiency Virus, Preventive Service Uptake, and Barriers among University Students in Anambra State, Nigeria

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Abstract

Background: University students may be at increased risk of human papillomavirus (HPV) and human immunodeficiency virus (HIV) infection when sexual activity coincides with limited prevention knowledge and low uptake of preventive services. **Aim:** To assess HPV/HIV knowledge, preventive practices, service engagement, and perceived barriers among students at Nnamdi Azikiwe University, Anambra State, Nigeria. **Methods:** A cross-sectional online survey included 300 consenting students recruited through WhatsApp using convenience sampling between July and August 2026. The study defined a four-item core knowledge indicator that distinguished general awareness from consistent prevention-related knowledge. Multivariable logistic regression examined the association between complete core knowledge and previous HIV testing, adjusting for age, sex, relationship status, and year of study. **Results:** HPV awareness was high (84.7%). However, 60.3% knew HPV could cause

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cancer, 51.3% were aware of HPV vaccination, and 42.0% correctly answered all four core knowledge items. Only 113 participants (37.7%) reported previous HIV testing. Complete core knowledge was associated with higher adjusted odds of previous HIV testing (aOR 2.53, 95% CI 1.48 - 4.33). None reported HPV vaccination. Among female participants with valid cervical-screening responses (n = 182), none reported previous screening. Overall, 66.3% did not know whether cervical screening was accessible. **Conclusions:** Among students surveyed, high HPV awareness did not translate into adequate prevention knowledge or use of preventive services. Uncertainty about service access also remained. These findings highlight the need for accurate, stigma-sensitive education and clear pathways to confidential, affordable HIV testing, HPV vaccination, and age-appropriate cervical cancer prevention.

Keywords

Human Papillomavirus, Human Immunodeficiency Virus, University Students, Prevention, Anambra

1. Introduction

Persistent infection with oncogenic human papillomavirus (HPV) is the major cause of almost all cervical cancers and contributes to other anogenital and oropharyngeal malignancies [1]. The carcinogenic role of oncogenic viruses, including HPV, reflects persistent viral infection and molecular alterations that can support malignant transformation and may also provide targets for biomarker-based surveillance [2]. Cervical cancer is highly preventable through vaccination, screening, and treatment of precancerous lesions. The World Health Organization (WHO) elimination strategy established the 90-70-90 targets: 90% of girls fully vaccinated against HPV by age 15, 70% of women screened with a high-performance test by ages 35 and 45, and 90% of women with cervical disease received appropriate treatment by 2030 [1]. Therefore, effective prevention requires accurate HPV knowledge and accessible preventive services. Assessing knowledge gaps, preventive practices, and barriers among university students can inform targeted interventions that support these elimination goals.

HPV prevention is especially important in sub-Saharan Africa, where HPV infection coexists with a high burden of HIV [3]. Furthermore, HIV-related immunosuppression is associated with greater HPV persistence and progression, while women living with HIV experience a markedly higher cervical cancer risk than women without HIV [3]. In a global analysis, women living with HIV had approximately six times the risk of cervical cancer, with the largest HIV-attributable cervical cancer burden occurring in sub-Saharan Africa [3]. Maintaining accessible HIV prevention, testing, and treatment services is therefore important not only for HIV control but also for broader sexual and reproductive health.

Some studies in Nigeria evaluating cervical cancer screening have identified

cost, limited service availability, and poor knowledge as barriers to uptake. These findings highlight the need to address both information gaps and access to preventive care [4]. HPV and HIV share sexual transmission routes, while HIV-related immune dysfunction increases susceptibility to persistent HPV infection. Nigerian research has also documented a higher prevalence of high-risk HPV among women living with HIV [5]. However, findings from women attending screening or HIV clinics may not explain how university students understand and access prevention services. Assessing HPV/HIV knowledge, preventive practices, and perceived access barriers together can help identify priorities for university-based interventions.

Evidence from university populations suggests that awareness does not necessarily translate into prevention [6]-[9]. A 2025 systematic review and meta-analysis of 56 studies involving 184,351 university students estimated HPV awareness at 68.3% and vaccine awareness at 53.5%, yet only 10.4% had received at least one vaccine dose [6]. Also, studies conducted among tertiary students in Plateau State found that only 5% met the study definition of good HPV knowledge [7]. Other institution-based studies have reported low vaccine uptake despite varying levels of HPV knowledge and awareness [8]-[10]. Systematic reviews identify cost, inadequate information, stigma, and limited access to services as barriers to HPV vaccination. Provider recommendations, targeted communication, school-based delivery, and community engagement can improve uptake [11]-[13].

Cervical screening studies among female undergraduates have similarly shown that awareness of cervical cancer does not necessarily translate into knowledge of where, when, or why to screen [14]. Because these studies were conducted in specific institutions and populations, their findings cannot necessarily be assumed to reflect students in other university settings, including those in Anambra State. Institution-specific evidence is therefore important for understanding local patterns of knowledge, preventive practices, service accessibility, and barriers.

Against this background, there is a need to understand these relationships within the specific context of Nnamdi Azikiwe University in Anambra State, Nigeria. This study assessed HPV and HIV-HPV knowledge, preventive practices, information sources, and perceived barriers to service access among students at Nnamdi Azikiwe University. The findings can guide university-based interventions to improve HPV vaccination uptake and engagement with preventive services. We further examined whether consistent knowledge across four core HPV/HIV items was associated with previous HIV testing.

2. Methods

2.1. Study Design and Setting

We conducted a cross-sectional online survey among students of Nnamdi Azikiwe University, Nigeria, from July to August 2026. Nnamdi Azikiwe University is a federal university in southeastern Nigeria with students enrolled across multiple faculties and levels of study. The online approach was selected to permit broad

circulation of the questionnaire during the study period and to allow students to respond privately using their own devices.

2.2. Sample-Size Calculation

The sample size was calculated for estimating a proportion using $n = Z^2 p\,(1 - p)/d^2$.

A conservative p = 0.50 was used because there is no directly comparable estimate for the proposed primary awareness endpoint. At a 95% confidence level, $Z = 1.96$.

An absolute precision of d = 0.06 was selected as a feasible target for this survey.

$\mathbf{n} = (1.96^2 \times 0.50 \times 0.50)/(0.06^2) = 266.78$, rounded up to 267 completed observations.

Allowing approximately 10% non-response or unusable observations gives 267/0.90 = 296.67, rounded up to 297.

The recruitment target was rounded to 300 completed responses. This was a response target rather than a fixed number of individually invited students.

2.3. Participants and Recruitment

Eligible participants were currently enrolled students who accessed the electronic questionnaire during the study period and provided electronic informed consent. The survey link was circulated through WhatsApp platforms used by students. Recruitment therefore followed a non-probability convenience-sampling approach. Participation was voluntary; no personally identifying student number or name was requested, and only consenting respondents were included. The form restricted repeat submissions, and response collection closed when 300 completed submissions had been received. All 300 records contained consent and complete data for the knowledge indicator, HIV-testing outcome, and regression covariates; all were retained in the analysis. There were no respondent-level exclusions from the supplied 300-record dataset. Item-level non-response in optional questions was handled using the relevant available-response denominator. Because the link was shared through student platforms, the number who received or viewed it was not enumerated, and an invitation-based response rate could not be calculated.

2.4. Questionnaire and Variables

The structured Google Forms questionnaire, entitled "University Student Health Survey: HPV/HIV Co-Infection and Cervical Screening", is reproduced in Supplementary Material S1 with its response options. It covered sociodemographic characteristics; HPV/HIV knowledge; perceptions and attitudes; preventive practices, including previous HIV testing, HPV vaccination, cervical screening and condom-use frequency; and information sources, perceived service accessibility and barriers. Faculty/department was collected as free text. Multiple responses were permitted for information sources, testing barriers and reasons for non-screening. An optional open-ended question asked what would encourage partic-

ipation in vaccination or screening programmes; it was not included in the present quantitative analysis. The cervical-screening history item was labelled for female students but was optional; the subsequent reasons item was also optional and did not require a completed screening-history response in the supplied data. The questionnaire is presented as the study instrument, not as a validated scale; no published adaptation source or pretesting procedure is documented in the materials available for this report.

A study-defined complete-core-knowledge indicator required affirmative responses to four items: having heard of HPV (question 7); recognising HPV as a sexually transmitted infection (question 8); recognising that HPV can cause cervical cancer (question 9); and awareness that individuals living with HIV are at higher risk of persistent HPV infection and cervical cancer (question 10). Thus, "increased HIV-HPV risk" refers specifically to persistence and cervical cancer, not an unspecified acquisition risk. Each affirmative response contributed one point; "No" and "I don't know", where offered, contributed zero. Complete core knowledge required 4/4 points; scores of 0 - 3 were classified as incomplete. No responses were missing for these four items. Vaccine awareness was reported separately and was not included in this indicator. The scoring key is provided in Supplementary Material S1. The indicator distinguishes awareness from consistent affirmative responses across the four items and is not a validated psychometric scale.

2.5. Statistical Analysis

Data were checked for completeness, allowable response categories, and internal consistency before analysis. Cervical-screening analyses were restricted to female respondents; three male screening-history responses and five male reasons responses were excluded from those item-specific summaries, without excluding these participants from other analyses. Identical anonymous response profiles were not treated as proof of repeat participation; duplicate prevention relied on the form's repeat-submission restriction. Continuous variables were summarised using means, standard deviations, medians and ranges, as appropriate. Categorical variables were summarised using frequencies and percentages. Multiple-response percentages used the relevant respondent denominator and were not expected to sum to 100%. Crude odds ratios (ORs) were estimated for previous HIV testing. A multivariable binary logistic regression estimated the association between complete core knowledge and previous HIV testing, adjusting a priori for age, sex, relationship status, and year of study. These variables were included because they may influence both prevention knowledge and opportunities for HIV testing. Age was continuous; sex and relationship status were binary; year of study used categorical indicators with first year as reference. Relationship status compared "Single" with the questionnaire category "Married/In a relationship". Sexual activity and faculty/department were not included in the primary adjustment set. Adjusted odds ratios (aORs), 95% confidence intervals (CIs), and two-sided

p-values are reported. We defined statistical significance as $p < 0.05$. Analyses were performed in Python using statsmodels and SciPy.

2.6. Ethical Considerations

The study followed standard ethical guidelines, ensuring that all participants were fully informed about the study's purpose and that their anonymity and confidentiality were maintained. Participation was voluntary, and electronic informed consent was obtained before the survey. Ethical approval to conduct this research was obtained from the Anambra State Ministry of Health Ethics Committee with approval number ASMOHREC/2026/09,102,026/118.

3. Results

3.1. Participant Characteristics

The analysis included 300 consenting students aged 18 - 39 years (mean 23.2 ± 5.1). Females comprised 188 (62.7%) participants. Most respondents were single (283, 94.3%). Third-year students were the largest year group (96, 32.0%), followed by fifth year or above (78, 26.0%), fourth year (70, 23.3%), second year (34, 11.3%), and first year (22, 7.3%) (Table 1).

Table 1. Participant characteristics (N = 300).

Characteristic	Category	n (%)
Sex	Female	188 (62.7)
	Male	112 (37.3)
Year of study	Year 1	22 (7.3)
	Year 2	34 (11.3)
	Year 3	96 (32.0)
	Year 4	70 (23.3)
	Year 5 or above	78 (26.0)
Relationship status	Single	283 (94.3)
	Married/In a relationship	17 (5.7)

3.2. High Awareness but Incomplete Prevention-Relevant Knowledge

Overall, 254 (84.7%) participants had heard of HPV and 231 (77.0%) identified HPV as a sexually transmitted infection. Knowledge of prevention-relevant concepts was less widespread: 210 (70.0%) recognised increased risk associated with HIV-HPV co-infection, 181 (60.3%) knew that HPV can cause cancer and 154 (51.3%) were aware of HPV vaccination. Only 126 (42.0%) answered all four core HPV/HIV knowledge items correctly (Table 2). The pattern therefore showed a marked decline from general recognition of HPV to consistent knowledge across the concepts most directly relevant to prevention.

Table 2. HPV/HIV knowledge and preventive-service indicators.

Indicator	n/N (%)
Aware of HPV	254/300 (84.7%)
Identifies HPV as an STI	231/300 (77.0%)
Aware of increased persistent HPV infection/cervical cancer risk with HIV	210/300 (70.0%)
Knows HPV can cause cervical cancer	181/300 (60.3%)
Aware of HPV vaccine	154/300 (51.3%)
Complete core knowledge	126/300 (42.0%)
Ever tested for HIV	113/300 (37.7%)
HPV vaccinated	0/300 (0.0%)
Previous cervical screening, valid female responses	0/182 (0.0%)
Considers screening accessible	31/300 (10.3%)
Does not know whether screening is accessible	199/300 (66.3%)

STI, sexually transmitted infection. Complete core knowledge required affirmative responses to all four items (questions 7 - 10; Supplementary Material S1). The cervical-screening-history denominator excludes six female respondents with unanswered histories.

3.3. Preventive Engagement Lagged behind Awareness

Despite substantially higher HPV and HIV-HPV awareness, only 113 (37.7%) participants had ever tested for HIV, and none reported HPV vaccination. Of 188 female participants, 182 (96.8%) supplied a valid screening-history response; all answered "No". Six screening histories were unanswered. Screening accessibility was uncertain: 31/300 (10.3%) considered screening accessible, 70/300 (23.3%) considered it inaccessible, and 199/300 (66.3%) did not know. For condom use, 187/300 (62.3%) selected "Not sexually active", 46/300 (15.3%) selected "Never", 34/300 (11.3%) selected "Sometimes," and 33/300 (11.0%) selected "Always".

Reasons for non-screening were provided by 183 female participants. Among the 183 women supplying reasons, the most frequent selections were not being sexually active (100, 54.6%), having no symptoms (95, 51.9%), lack of information (61, 33.3%), cost (52, 28.4%), and fear of results (8, 4.4%). Multiple reasons were permitted.

3.4. Abundant Information Channels but Persistent Barriers

Social media/internet was the most frequently selected information source (213, 71.0%), followed by university lectures/courses (161, 53.7%), healthcare providers (117, 39.0%), school/university awareness programmes (102, 34.0%), public-health campaigns (88, 29.3%), friends/peers (86, 28.7%) and family members (79, 26.3%) (Table 3). The leading perceived testing barriers were STI-related stigma (176, 58.7%), lack of awareness (170, 56.7%), cost of tests (139, 46.3%), and long clinic

waiting times (76, 25.3%) (Table 3). Thus, substantial exposure to information co-existed with social, informational, financial, and service-delivery barriers.

Table 3. Information sources and perceived barriers (multiple responses permitted).

Domain	Response	n (%)
Information source	Social media/internet	213 (71.0%)
	University lectures/courses	161 (53.7%)
	Healthcare providers	117 (39.0%)
	School/university awareness programmes	102 (34.0%)
	Public-health campaigns	88 (29.3%)
	Friends/peers	86 (28.7%)
	Family members	79 (26.3%)
Perceived testing barrier	STI-related stigma	176 (58.7%)
	Lack of awareness	170 (56.7%)
	Cost of tests	139 (46.3%)
	Long waiting times	76 (25.3%)

3.5. Association between Complete Core Knowledge and Previous HIV Testing

Previous HIV testing was reported by 67/126 (53.2%) participants with complete core knowledge compared with 46/174 (26.4%) without complete core knowledge. The odds of previous testing were more than three times higher among participants with complete core knowledge (OR 3.16, 95% CI 1.94 - 5.14) (Table 4). After adjustment for age, sex, relationship status, and year of study, complete core knowledge remained independently associated with previous HIV testing (aOR 2.53, 95% CI 1.48 - 4.33; p = 0.001). Older age was also associated with previous testing (aOR 1.10 per additional year, 95% CI 1.03 - 1.16; p = 0.003). The estimate for being married/in a relationship was positive but imprecise (aOR 4.33, 95% CI 1.08 - 17.29), reflecting the small size of this subgroup (Table 4).

Table 4. Factors associated with previous HIV testing (N = 300).

Factor	HIV tested, n/N (%)	Adjusted OR (95% CI)	p-value
Age (years)	—	**1.10 (1.03 - 1.16)**	**0.003**
Sex			
Female	72/188 (38.3)	1.00	—
Male	41/112 (36.6)	0.70 (0.38 - 1.29)	0.252
Relationship status			
Single	99/283 (35.0)	1.00	—

Continued

Married/in a relationship	14/17 (82.4)	4.33 (1.08 - 17.29)	0.038
Year of study			
First year	11/22 (50.0)	1.00	—
Second year	6/34 (17.6)	0.38 (0.10 - 1.46)	0.158
Third year	20/96 (20.8)	0.43 (0.15 - 1.23)	0.116
Fourth year	37/70 (52.9)	1.76 (0.62 - 5.02)	0.287
Fifth year or above	39/78 (50.0)	0.78 (0.28 - 2.19)	0.638
Complete core HPV/HIV knowledge			
No	46/174 (26.4)	1.00	—
Yes	67/126 (53.2)	2.53 (1.48 - 4.33)	0.001

OR, odds ratio; CI, confidence interval. Adjusted odds ratios were estimated using a multivariable logistic regression model including age, sex, relationship status, year of study, and complete core HPV/HIV knowledge. For categorical variables, 1.00 indicates the comparison category. For age, the aOR represents the change in odds associated with each additional year of age.

4. Discussion

This study identified a gap between HPV awareness, prevention knowledge, and service engagement among students at Nnamdi Azikiwe University. Although the majority (84.7%) of study participants had heard of HPV, only 60.3% knew that HPV can cause cancer, 51.3% were aware of HPV vaccination, and 42.0% met the study definition of complete core HPV/HIV knowledge. Preventive engagement was lower, with 37.7% having ever tested for HIV, no respondents reporting HPV vaccination, and two-thirds did not know whether cervical-screening services were accessible. The findings therefore suggest that exposure to health information alone is insufficient when knowledge lacks depth or when service pathways remain unclear, costly or stigmatised.

The high level of general HPV awareness in this study exceeds the pooled estimate of 68.3% reported in a 2025 meta-analysis of 56 studies involving more than 184,000 university students [6]. It also contrasts with recent Nigerian evidence from the University of Ilorin, where only 5.6% and 6.6% of undergraduates met study-specific definitions of good knowledge of HPV infection and HPV vaccination, respectively [15]. Direct numerical comparison might not be impactful because instruments and scoring thresholds differ, but the broader pattern is consistent; however, recognising HPV does not necessarily imply detailed knowledge of transmission, oncogenic risk, vaccination or prevention pathways. A similar awareness-practice gap was observed in our previous study of 548 Nigerian university students on breast-cancer prevention, where awareness was nearly universal but detailed knowledge and use of early-detection practices remained substantially lower [16]. Together, these findings suggest that high headline awareness can coexist with important deficits in actionable cancer-prevention literacy.

The patterns found in this study are also visible internationally, although the size of the gap varies by setting. Among female health-science students in Ethiopia, 72.7% had good HPV-infection knowledge, but only 52.5% had good vaccine knowledge, with major gaps in knowledge of recommended age, dose, and schedule [17]. In China, studies among university students have similarly reported relatively high HPV awareness alongside lower vaccination or preventive behaviour; one 2024 study reported 77.9% vaccine awareness but only 40.0% positive vaccination-related behaviour [18], while another found that access difficulties involving vaccination centres, vaccine type, and information were associated with both intention and uptake [19]. These cross-country findings support a layered interpretation of prevention behaviour: knowledge is important, but perceived risk, trust, affordability, service availability and ease of access can determine whether knowledge is converted into action.

Nigeria's 2023 introduction of single-dose HPV vaccination for girls aged 9 - 14 years is an important structural advance [20]. However, the mean age of participants in this study was 23 years, meaning that many were already beyond the routine target cohort when national introduction began. Their zero reported vaccination should therefore not be interpreted as evidence of failure of the adolescent programme. Rather, it identifies a transitional population that may have missed routine adolescent delivery and now requires clear information about eligibility, availability and referral. This is especially relevant because the global university-student meta-analysis reported vaccine uptake of only 10.4% despite substantially higher awareness and willingness [6].

The cervical-screening findings also require age-sensitive interpretation. WHO population screening targets are centred on older age groups [1], and the young age distribution in this study means that zero previous screening does not imply that all female respondents were overdue. More informative is the finding that 66.3% of all respondents did not know whether screening was accessible and that 51.9% of women who provided a reason for non-screening selected "no symptoms". This may indicate that some students conceptualise screening as a response to symptoms rather than as preventive care. Research among Nigerian female undergraduates has similarly identified not knowing where screening services are available as a barrier to uptake [14].

Complete core HPV/HIV knowledge was independently associated with previous HIV testing. Participants with complete core knowledge had higher adjusted odds of previous HIV testing (aOR 2.53, 95% CI 1.48 - 4.33). This relationship is plausible because testing encounters can expose students to counselling and prevention information, while students with stronger prevention literacy may be more willing to seek testing. However, the cross-sectional design cannot establish directionality. The result should therefore be interpreted as evidence that knowledge and service engagement cluster together, rather than as proof that improving knowledge alone will cause higher testing uptake. This distinction is important in Nigeria, where HIV prevention and testing services remain dependent on func-

tioning health systems, sustained financing, and accessible delivery platforms [21].

The barrier profile helps explain why information exposure did not translate consistently into preventive behaviour. STI-related stigma (58.7%), lack of awareness (56.7%), cost (46.3%), and waiting time (25.3%) represent social, informational, financial, and organisational barriers operating simultaneously. This pattern is consistent with systematic reviews from sub-Saharan Africa that identify cost, inadequate information, service constraints, stigma, and access as recurrent determinants of HPV-vaccine uptake [11]-[13]. It also parallels our previous work among Nigerian university students on breast-cancer prevention, in which financial limitations and restricted access to healthcare facilities were prominent barriers despite high disease awareness [16]. The recurrence of these barriers across different preventive-health contexts suggests that awareness campaigns are unlikely to be sufficient unless they are linked to affordable and navigable services.

Universities are therefore not merely audiences for health education; they are potential implementation platforms. Social media/internet and university lectures were the two most frequently reported information channels in this study, indicating that universities already possess channels capable of reaching students. A stronger model would connect these channels directly to confidential HIV testing, clear HPV-vaccine eligibility and referral information, age-appropriate cervical-cancer prevention guidance, and low-friction referral pathways. Digital communication may extend reach, but the endpoint should be a concrete service action rather than awareness alone. This service-linked approach is also consistent with broader work on viral oncology, which emphasises that the value of prevention and surveillance technologies depends on equitable implementation and access to appropriate diagnostic pathways [2] [21].

Future studies should evaluate progression across the full prevention pathway rather than measuring awareness as the principal endpoint. Useful outcomes include accurate risk knowledge, knowledge of service location, intention to use services, completed referral, HIV-testing uptake, vaccine counselling, vaccination where eligible, and measures of acceptability, confidentiality, cost and waiting time. Longitudinal or intervention studies would help clarify whether improvements in knowledge lead to subsequent service use and which implementation strategies most effectively reduce the observed drop-off between awareness and action.

Strengths and Limitations

A strength of this study is that it examined HPV awareness, HIV-HPV knowledge, preventive behaviours, information sources, service accessibility and barriers within the same population, allowing the awareness-to-action gap to be characterised directly. The analysis also distinguished general awareness from a stricter all-items-correct knowledge indicator and examined its association with a behavioural outcome. Several limitations remain. Convenience recruitment through

WhatsApp may have selected students who were more digitally connected or health-aware and limits generalisability beyond the study university. Behaviours and barriers were self-reported and may be affected by recall and social-desirability bias. The complete-core-knowledge indicator was constructed for this analysis and has not been psychometrically validated. Residual confounding remains possible because sexual activity, health-science enrolment and previous healthcare contact may influence both knowledge and HIV testing. Although faculty/department and a condom-use item containing a "Not sexually active" option were collected, they were not included in the primary model; the latter did not specify a time window or provide a detailed sexual history.

5. Conclusion

Among students at this Nigerian university, the principal prevention challenge was not lack of exposure to HPV information. Rather, high awareness coexisted with incomplete prevention-relevant knowledge, uncertainty about service access, and low preventive-service engagement. Complete core HPV/HIV knowledge was independently associated with previous HIV testing, but the coexistence of stigma, cost, and service barriers indicates that education alone is unlikely to close the gap. University prevention strategies should connect accurate information to confidential, affordable, and navigable services, with explicit pathways for HIV testing, HPV-vaccine counselling, and age-appropriate cervical-cancer prevention.

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Author Contributions

Conceptualization, NFE, KCA, and MCU; methodology, NFE, MA, KCA, and MCU; software, MA; investigation, NFE, CRC, KCA, and MCU; data curation, NFE, MA; writing—original draft preparation, NFE and EIO; writing—review and editing, CEU, BAM, FK, AYN, OOA, MS, KCA, and MCU; visualization, MA; supervision, CRC, KCA, and MCU; project administration, NFE, KCA, and MCU.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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