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Awareness and Knowledge of Antimicrobial Resistance among Dental Students in Nigeria: A Multi-Centre Cross-Sectional Study

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ABSTRACT

Background: Antimicrobial resistance (AMR) is a growing global public health threat, with inappropriate antibiotic prescribing in dentistry contributing to its acceleration. Understanding the knowledge and awareness of dental students is critical to inform educational interventions.

Objective: To assess the awareness, knowledge, and ability to identify antibiotics among dental students in six Nigerian universities and evaluate associated demographic and academic factors.

Methods: A cross-sectional study was conducted among dental students in clinical classes (years four to six) across six Nigerian universities: University of Nigeria, University of Port Harcourt, University of Maiduguri, Bayero University, University of Jos, and Obafemi Awolowo University. Pre-tested questionnaires were distributed electronically to each clinical class to assess demographics, awareness, and knowledge of AMR. Completed forms returned numbered 247. Statistical analyses included chi-square tests, logistic regression, one-way ANOVA, and Tukey HSD post hoc tests, with significance set at $p \leq 0.05$.

Results: Overall, 53.5% of students demonstrated poor knowledge of AMR. Knowledge improved with academic year (Year 4 vs. Year 6; OR = 2.449, 95% CI: 1.192–5.033; p = 0.015). No significant association was observed between gender and knowledge ($p > 0.05$). Significant inter-university differences were observed, with higher knowledge levels at University of Nigeria, Nsukka and Obafemi Awolowo University, Ile-Ife. Misidentification of antibiotics was common, with only 12.1% correctly identifying commonly used antibiotics.

Conclusion: AMR knowledge and awareness among Nigerian dental students are suboptimal and influenced by academic year and institution rather than gender. Curriculum harmonization, structured AMR modules, and enhanced clinical exposure are essential to address these gaps.

Key words: Antimicrobial resistance (AMR); Dental students; Antibiotic knowledge; Awareness.

INTRODUCTION

The discovery of penicillin in 1928 marked a transformative milestone in modern medicine, ushering in the antibiotic era and significantly reducing morbidity and mortality from infectious diseases. However, despite major therapeutic advances during the mid-20th century, the pace of novel antibiotic development has slowed dramatically.[1,2] At the same time, antimicrobial resistance (AMR) has accelerated, undermining the effectiveness of existing drugs and complicating the management of previously treatable infections.[1,3] AMR is now widely recognized as a global public health emergency, driven largely by inappropriate prescribing, misuse of antibiotics, and inadequate antimicrobial stewardship.[4] Its impact extends across medical and dental care, jeopardizing the safety of procedures such as organ transplantation, chemotherapy, maxillofacial surgery, implantology, and endodontic treatments, which often depend on effective antibiotic prophylaxis or therapy.[4,5]

Dentists are responsible for an estimated 5–10% of global antibiotic prescriptions, making the dental profession a significant contributor to outpatient antimicrobial consumption.[3] Recognizing this, the FDI World Dental Federation has emphasized the essential role of dental practitioners in reducing AMR through improved stewardship and adherence to evidence-based guidelines.[6] In clinical dentistry, antibiotics are commonly prescribed for odontogenic infections and, less appropriately, for non-odontogenic conditions.[7,8] Current professional guidelines recommend that local measures, such as incision and drainage of abscesses, caries removal, or debridement of necrotic tissue, should be the primary approach, with systemic antibiotics reserved for cases with systemic involvement or spreading infection.[7,13] Evidence also shows that systemic antibiotics provide no benefit for most routine endodontic conditions, including symptomatic irreversible pulpitis, pulp necrosis, or localized apical periodontitis.[10,11,12,14] Prophylactic antibiotic use remains justified only in well-defined high-risk patients, such as those with significant immunosuppression or specific systemic conditions.[15]

Inappropriate prescribing practices in dentistry—including unnecessary antibiotic initiation, incorrect dosage, or prolonged duration—continue to contribute to rising resistance rates.[16,17] To address this, the World Health Organization's Guide to Good Prescribing underscores the importance of structured training in rational prescribing, beginning at the undergraduate level.[18] In

Nigeria, dental students complete a compulsory one-year internship during which appropriate prescribing competencies should be reinforced.[19]

This study aimed to:
1. Assess the awareness and knowledge of dental students regarding AMR, its causes, and its consequences.
2. Compare awareness and knowledge across dental schools, identify gaps, and propose targeted recommendations.

METHODS

A descriptive cross-sectional, web-based survey was conducted among clinical dental students (Years 4–6) enrolled in six accredited Nigerian dental schools, each representing one of the six geopolitical zones of the country:

South-East: University of Nigeria, Nsukka
South-West: Obafemi Awolowo University, Ile- Ife
South-South: University of Port Harcourt
North-Central: University of Jos
North-East: University of Maiduguri
North-West: Bayero University, Kano

Ethical approval for the study was obtained from the Health Research Ethics Committee of the University of Nigeria, Nsukka. Participation was voluntary, and informed consent was obtained electronically from all respondents before survey completion. Included in the study were only dental students in clinical classes (years 4, 5, and 6). Excluded from the study were dental students in preclinical classes (years 1, 2, and 3).

Data were collected using a structured, self-administered online questionnaire developed based on previous studies on antimicrobial stewardship and dental prescribing practices.[20,21] The instrument underwent pre-testing among 20 clinical dental students from a non-participating institution to assess clarity, internal consistency, and face validity. Necessary modifications were made before final deployment.

The survey consisted of four sections:

Demographic characteristics (age, sex, year of study, institution)
Knowledge of antimicrobial resistance (AMR)
Awareness of AMR and its public health implications
Knowledge of appropriate antibiotic use in dentistry

The survey link was disseminated to students via institutional WhatsApp groups through their respective class representatives. To ensure data integrity, the platform was configured to restrict each participant to a single submission.

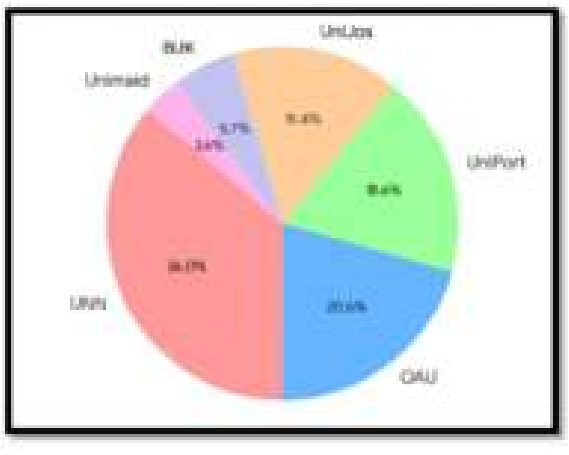
Data were analyzed using IBM SPSS Statistics version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequencies, percentages, means, and standard deviations) were used to summarize demographic characteristics and outcome variables. Inferential analyses included: chi-square tests to assess associations between categorical variables; binary logistic regression to identify predictors of good knowledge and awareness of AMR; one-way ANOVA to compare mean knowledge and awareness scores across institutions; and Tukey's HSD post hoc test to determine pairwise differences by sex, year of study, and dental school. The level of statistical significance was set at $p \leq 0.05$.

RESULTS

Data distribution among the six universities

The study successfully collected 252 responses from the 390 questionnaires distributed, achieving a 64.6% response rate. As shown in Figure 1, the University of Nigeria, Nsukka (UNN) provided the largest cohort with 36.0% (89) participants, followed by Obafemi Awolowo University (OAU) with 20.6% (51). Responses were also gathered from UniPort (18.6%, 46), UniJos (15.4%, 38), and BUK (5.7%, 14). A relatively low response rate was observed at Unimaid (3.6%, n = 9), which may limit the generalizability of findings specifically for that institution compared to the larger southern cohorts.

Figure 1: Data distribution among the six universities



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Predictors of awareness and knowledge of AMR

The most critical finding in Table 1 is that "Years of Study" is the only statistically significant predictor of AMR knowledge (p = 0.008). Interestingly, students in Year 4 were significantly more likely to demonstrate "Good Knowledge" compared to their seniors in Year 6, with an odds ratio (OR) of 2.45 (95% CI: 1.19–5.03). This suggests that foundational knowledge may be at its peak during the mid-clinical years or that recent curriculum changes have been particularly effective for this cohort. Despite the geographic and institutional diversity of the participants, there was no significant difference in knowledge levels based on the university attended (p = 0.178), indicating a relatively uniform standard of AMR education across the various dental schools surveyed in Nigeria.

The analysis, however, shows that sex does not play a role in AMR awareness (p = 0.623). Both male and female students exhibited similar proportions of "Good Knowledge," and the odds ratio for females (1.06) was near-neutral, confirming that gender is not a determinant of dental students' understanding of antimicrobial stewardship.

Table 1: Predictors of Awareness and Knowledge of AMR

Variables	Good Knowledge n (%)	p-value	Odds Ratio (95% CI)
Sex		0.623	
Female	55 (22.3)		1.06 (0.62–1.80)
Male	60 (24.3)		Reference
University		0.178	
BUK, Kano	5 (2.0)		0.55 (0.16–1.87)
OAU, Osun	25 (10.1)		1.44 (0.71–2.91)
UniJos, Plateau	18 (7.3)		1.11 (0.51–2.42)
Unimaid, Borno	1 (0.4)		0.23 (0.03–1.94)
UniPort, Rivers	27 (10.9)		1.62 (0.77–3.41)
UNN	39 (15.8)		Reference
Years of Study		0.008	
Year 4	34 (13.8)		2.45 (1.19–5.03)
Year 5	37 (15.0)		0.82 (0.46–1.47)
Year 6	44 (17.8)		Reference

Awareness (KAMI) vs. identification (KIDA) of antimicrobials

The data shown in Table 2 highlight a critical knowledge-action gap. While dental students' general awareness of antimicrobial resistance (AMR) is high and improves with seniority, their practical ability to identify specific antibiotics is significantly poor. Although Year 6 students possess high conceptual awareness, they recorded the lowest practical identification scores (3.2%), indicating that clinical experience is not translating into pharmacological proficiency. While gender does not affect awareness, males significantly outperformed females in drug identification (p = 0.022). Furthermore, students from high-awareness institutions like UNN still struggled heavily with practical identification.

Table 2: Awareness (KAMI) vs. Identification (KIDA) of Antimicrobials

Variables	KAMI Poor n(%)	KAMI Good n(%)	KAMI p-value	KIDA Poor n(%)	KIDA Good n(%)	KIDA p-value
Sex			0.984			0.022
Female	49 (19.8)	65 (26.3)		106 (42.9)	8 (3.2)	
Male	57 (23.0)	76 (30.8)		111 (44.9)	22 (8.9)	
University			0.001			0.034
BUK	8 (3.2)	6 (2.4)		12 (4.9)	2 (0.8)	
OAU	11 (4.5)	40 (16.2)		46 (18.6)	5 (2.0)	
UniJos	14 (5.7)	24 (9.7)		30 (12.1)	8 (3.2)	
Unimaid	2 (0.8)	6 (2.4)		5 (2.0)	3 (1.2)	
UniPort	29 (11.7)	17 (6.9)		39 (15.8)	7 (2.8)	
UNN	42 (17.0)	48 (19.4)		85 (34.4)	5 (2.0)	
Year of Study			<0.001			0.021
Year 4	34 (13.8)	18 (7.3)		40 (16.2)	12 (4.9)	
Year 5	29 (11.7)	65 (26.3)		84 (34.0)	10 (4.1)	
Year 6	43 (17.4)	58 (23.5)		97 (37.7)	8 (3.2)	

One-way ANOVA comparison (awareness vs. knowledge)

The one-way ANOVA in Table 3 demonstrates that there are statistically significant differences across the six universities for both awareness of AMR and knowledge of AMR. Both "Awareness" ($p = 0.003$) and "Knowledge of AMR" ($p = 0.004$) have p-values well below the standard 0.05 threshold. This indicates that where a student studies has a genuine impact on their understanding of antimicrobial resistance. Also, the F-values (3.538 and 3.678) are relatively similar, suggesting that the between-group variability is more than three times greater than the within-group variability for both metrics. Thus, the model shows that the institutional factor is a consistent predictor of performance, as both awareness and conceptual knowledge scores shift significantly depending on the group.

Table 3: One-Way ANOVA Comparison (Knowledge vs. Awareness)

Variable	Source of Variat ion	Sum of Squares	Df	Mean Square	F	Sig.
Knowledge of AMR	Between Groups	3.708	5	0.742	3.538	0.004
	Within Groups	50.506	241	0.210		
	Total	54.214	246			
Awareness (AMI)	Between Groups	0.424	5	0.085	3.678	0.003
	Within Groups	5.560	241	0.023		
	Total	5.984	246			

Tukey HSD post hoc

The post hoc analysis in Table 4 reveals that the most significant disparity in technical knowledge exists between UniPort and BUK, with UniPort students demonstrating significantly higher knowledge scores (p = 0.021). While UniPort performed well in knowledge, OAU emerged as the leader in general awareness (AMI). OAU students had significantly higher awareness scores compared to both UniPort (p = 0.006) and UNN (p = 0.043). Interestingly, the university with the highest awareness score (OAU) did not have the highest knowledge score (UniPort). This indicates that while some curricula may excel at imparting factual knowledge, others may be more effective at fostering general awareness of the AMR crisis.

Table 4: Tukey HSD Post Hoc Results

Comparison (I vs J)	Knowledge MD	Knowledge Sig.	Awareness MD	Awareness Sig.
BUK vs OAU	-0.295	0.272	—	—
BUK vs UniJos	-0.340	0.170	—	—
BUK vs Unimaid	0.039	1.000	—	—
BUK vs UniPort	-0.444*	0.021	—	—
BUK vs UNN	-0.211	0.597	—	—
OAU vs UniPort	-0.149	0.599	+0.110*	0.006
OAU vs UNN	0.084	0.901	+0.078*	0.043
UniJos vs UniPort	-0.105	0.903	—	—
Unimaid vs UniPort	-0.483	0.069	—	—
UniPort vs UNN	0.233	0.059	—	—
***Significant at p < 0.05. (MD = Mean I - Mean J)**				

DISCUSSION

The global escalation of antimicrobial resistance (AMR) represents one of the most significant threats to modern medicine. This necessitates a robust educational foundation for the next generation of dental practitioners.[4,22] This study achieved a diverse 64.6% response rate across six Nigerian universities. It provides a critical window into the "awareness and knowledge gap" currently existing within Nigerian dental education.

Findings: A primary finding is the striking disparity between conceptual awareness (KAMI) and practical identification (KIDA) of antimicrobials. This "seniority paradox" aligns with global trends. Bajalan et al.[3] noted in a cross-continental survey that while dental students often acknowledge AMR as a global crisis, their confidence and accuracy in specific prescribing tasks remain inconsistent.

Institutional and gender variations reported (Table 2) mirror findings in other contexts. Shaik and Meher[23] reported variations in antibiotic knowledge among dental students across different academic years in South India. Cope et al.[24] documented antibiotic prescribing patterns in UK general dental practices that highlight the need for improved stewardship education. Akande-Sholabi and Ajamu[25] also identified that institutional focus on antimicrobial stewardship programs (ASP) directly correlates with student knowledge levels rather than sex.

Interestingly, while sex played no role in general awareness (p = 0.623), it was a significant predictor of practical identification (p = 0.022). Male students (8.9%) outperformed females (3.2%). This specific practical disparity is less commonly reported in global literature, where gender usually shows no significant correlation with AMR knowledge.[26] This finding suggests a need for further investigation into learning styles or differences in "subjective awareness measures" as proposed by Wierzchoń et al.[20]

The findings also reveal that Year 4 students were 2.45 times more likely to demonstrate "Good Knowledge" than their Year 6 counterparts (p = 0.008) (Table 2). This decline in specific knowledge as students progress has been observed in other contexts. For instance, Ahmad et al.[27] noted that while pharmacy students in Trinidad and Tobago maintained positive attitudes, factual retention often fluctuated based on recent academic focus. Similar patterns of awareness and misuse have been documented among university students.[28,29]

Implications: The "awareness-knowledge gap" identified here suggests that Nigerian dental schools' curricula, much like those in other developing regions,[30,31] may be successfully teaching the theory of resistance (the "why") but failing in the application of pharmacology (the "how"). This echoes the warnings of Thompson et al.,[6] emphasizing that the dental team plays an essential but under-utilized role in reducing AMR. In regions such as Saudi Arabia, similar gaps have led to inappropriate dental antibiotic prescriptions.[30] If students cannot accurately identify the agents involved in stewardship, theoretical awareness remains an abstract concept. This aligns with the WHO's "Guide to Good Prescribing"[18] and the "Tailoring Antimicrobial Resistance Programs (TAP)," which show that focused, practical education can significantly reduce inappropriate use.[32]

Key implications include:

Curricular Integration: An urgent need for standardized AMR and stewardship training in core dental curricula.

National Guidelines: Development of uniform AMS training standards by regulatory bodies.

Active Learning: Adoption of case-based learning and simulations to prepare students for real-world prescribing.

Post-Graduate Support: Mandated continuing professional development (CPD) programs to reinforce stewardship knowledge for graduates.

Trade-Offs (Limitations): First, as a cross-sectional survey, causality cannot be inferred, and knowledge levels may fluctuate over time. Second, reliance on self-administered questionnaires may introduce response bias. Third, the antibiotic identification component was limited to common medications; broader prescribing scenarios were not assessed. Finally, the study did not explore specific pedagogical factors, such as hours of pharmacology teaching or instructor qualifications, that might underlie institutional differences.

Take-Home (Conclusion): This study reveals significant deficiencies in AMR awareness and antibiotic identification among Nigerian dental students. These gaps are strongly associated with academic progression and institutional factors rather than gender. Misconceptions pose substantial risks for inappropriate prescribing. Failure to implement reforms may have severe consequences; AMR is projected to cause up to 10 million deaths globally by 2050 if left unaddressed.[32] Strengthening competencies among dental students is an essential step toward safeguarding public health.

Expectations for Future Research: Future research should include qualitative assessments, such as curricular audits and focus group discussions, to identify root causes of knowledge gaps. Intervention studies testing the impact of structured AMS modules and stewardship training in dental education would be highly valuable to bridge the "theory-practice" divide.

Recommendations

To mitigate these challenges, a coordinated approach is essential:

1. Reform curricula to integrate structured AMS modules across all clinical years.
2. Secure government and institutional investment in teaching resources, simulation-based training, and faculty development.
3. Foster student-led stewardship initiatives to reinforce peer learning.
4. Ensure consistency in clinical messaging through CPD for educators and practitioners.

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