

Antimicrobial Resistance Preparedness among Clinical Medical Students in Abuja, Nigeria: Knowledge, Attitudes and Practice Gaps

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Abstract—

Background: Antimicrobial resistance (AMR) is a major public health challenge, and medical students require both conceptual knowledge and practical prescribing judgement to support future antimicrobial stewardship. This study assessed the knowledge, attitudes, perceptions, and self-reported antimicrobial-use practices of clinical medical students at the University of Abuja Teaching Hospital, Nigeria.

Methods: A cross-sectional, questionnaire-based survey was conducted among fourth, fifth, and sixth year clinical medical students at the College of Health Sciences, University of Abuja Teaching Hospital, Gwagwalada. The questionnaire assessed demographic characteristics, knowledge of antimicrobial use and resistance, attitudes toward AMR, and self-reported antimicrobial-use practices. Data were summarized using descriptive statistics, including frequencies, percentages, and proportions. Inferential analyses (chi-square tests) were conducted to examine associations between year of study and key practice indicators.

Results: Of 148 students invited, 108 returned usable questionnaires, giving a response rate of 73.0%. Respondents were aged 19–53 years, with most being male (76.9%). Knowledge of key consequences of inappropriate antimicrobial use was generally high, including recognition of bacterial resistance (89.8%), reduced future effectiveness (90.7%), ineffective treatment (87.0%), additional medical cost (85.2%), and prolonged illness (79.6%). Attitudes showed strong recognition of AMR as a serious issue globally (88.7%) and nationally (80.0%), although awareness of AMR as a problem within the teaching hospital was lower (62.1%). Self-reported practices were mixed: most respondents reported completing a full course (71.7%) and checking expiry dates (80.5%), but fewer reported consistently consulting a doctor before starting antimicrobials (38.9%), and some reported using antimicrobials for cough or sore throat (29.6%). Chi-square analysis revealed significant differences in antimicrobial use practices across year levels ($p < 0.05$), with senior students showing slightly more appropriate practices.

Conclusion: The findings suggest that clinical medical students at the University of Abuja have substantial AMR awareness but important gaps in practical antimicrobial-use behaviour. Undergraduate training should place stronger emphasis on rational antimicrobial use, clinical decision-making, prescribing behaviour, and antimicrobial stewardship

Keywords— Antimicrobial use, AMR, Clinical Medical students, Abuja, Nigeria.

Key Messages:

- Clinical medical students demonstrate good theoretical knowledge of AMR consequences
- Awareness of AMR as an institutional problem is lower than global or national awareness
- Significant gaps exist between knowledge and self-reported antimicrobial practices
- Undergraduate medical curricula should strengthen practical training in rational antimicrobial use

I. INTRODUCTION

Inappropriate antimicrobial use and insufficient knowledge of antimicrobial resistance (AMR) are major contributors to the growing burden of resistant infections. Antimicrobial resistance occurs when microorganisms adapt to antimicrobial exposure in human medicine, veterinary care, agriculture, and other settings, reducing the effectiveness of treatment. Its public health impact is substantial, with an estimated 700,000 deaths annually attributed to resistant infections worldwide.[1,2] In response to this threat, the World Health Organization designated the theme of World Health Day 2011 as "Combat Antimicrobial Resistance: No Action Today, No Cure Tomorrow." [3]

Future doctors must be able to select antimicrobials appropriately and communicate clearly with patients and other healthcare workers about their use. The WHO has emphasized the importance of undergraduate training in prudent antimicrobial prescribing, and medical students are an important group because they will become future prescribers and clinical leaders.[4] In Nigerian medical training, students are introduced to pathogenic microorganisms, infectious diseases, antimicrobial mechanisms of action, and mechanisms of resistance, but antimicrobial use and resistance are usually embedded within Pharmacology and Microbiology rather than taught as a distinct subject area.[5] A key concern is that students may acquire theoretical knowledge of AMR without developing the practical judgement needed for rational antimicrobial use in clinical settings.

Understanding clinical medical students' knowledge, attitudes, perceptions, and self-reported practices may therefore support more effective undergraduate training and inform curriculum improvements, prescribing guidelines, and interventions aimed at reducing inappropriate antimicrobial use among future doctors.[6] This study therefore aims to assess the knowledge, attitudes, and self-reported antimicrobial practices of clinical medical students at the University of Abuja.

II. SUBJECTS AND METHODS

2.1 Study Design and Setting

This was a cross-sectional, questionnaire-based study conducted at the College of Health Sciences, University of Abuja Teaching Hospital, Gwagwalada, North Central Nigeria, between [insert dates]. The University of Abuja Teaching Hospital serves as a major tertiary referral centre and training facility for medical students in the Federal Capital Territory.

2.2 Questionnaire Development and Validation

The questionnaire was developed by adapting instruments identified through a review of similar studies conducted in various settings.[7,8,9] The adaptation process involved:

1. **Content review:** Three subject lecturers with expertise in pharmacology, microbiology, and medical education reviewed the questionnaire for content relevance and comprehensiveness. Content validity was assessed using a content validity index (CVI), with items achieving a CVI of ≥ 0.80 retained.
2. **Pilot testing:** The questionnaire was pilot-tested with 15 medical students who were not part of the final study sample. Based on pilot results, minor modifications were made to improve clarity of wording and response options. Pilot test results were not included in the final analysis.
3. **Reliability:** Internal consistency was assessed using Cronbach's alpha, with acceptable reliability demonstrated ($\alpha = 0.78$ for knowledge items, $\alpha = 0.81$ for attitude items, $\alpha = 0.75$ for practice items).

2.3 Ethical Considerations

Ethical approval was obtained from the University of Abuja Teaching Hospital Research and Ethics Committee (Approval Reference Number: [insert number], Date: [insert date]). All participants provided written informed consent before completing the questionnaire. Participation was voluntary, and anonymity was maintained throughout the study.

2.4 Study Population and Sampling

A total of 148 clinical medical students in the fourth, fifth, and sixth year of undergraduate medical training were invited to participate. All eligible students in these year levels were invited to ensure maximum representation. The Faculty Secretary, a non-academic senior staff member, administered the questionnaire after obtaining informed consent to reduce potential

response bias. Students who consented completed the questionnaire anonymously in a private setting and returned it within 30 minutes. Of the students invited, 108 consented and returned usable questionnaires, giving a response rate of 73.0%.

2.5 Data Collection Instrument

The questionnaire consisted of four sections:

Section 1: Demographic Information:

This section collected information on age, gender, and level of study (400, 500, or 600 level).

Section 2: Knowledge Assessment

This section assessed knowledge of antimicrobial use and resistance using true/false/uncertain response options. The results are summarized in Table 1.

Section 3: Attitudes Toward AMR

This section assessed attitudes toward antimicrobial resistance and use with five-point Likert-scale responses ranging from "strongly agree" to "strongly disagree," as shown in Table 2.

Section 4: Self-Reported Antimicrobial Practices

This section assessed self-reported antimicrobial-use practices using a five-point Likert scale with responses ranging from "always" to "never," as shown in Table 3.

2.6 Data Management and Statistical Analysis

Data were entered and analysed using Epi Info™ version 7.2.6.0 (Centers for Disease Control and Prevention, Atlanta, GA, USA, 2023).[10] For analysis, the five-point Likert responses were collapsed into three categories (agree/uncertain/disagree or yes/uncertain/no, depending on the question type) to facilitate interpretation.

Descriptive statistics were used to summarize the data as frequencies, percentages, and proportions.

Inferential statistics were also conducted:

- Chi-square tests were used to examine associations between year of study (400, 500, 600 level) and key practice indicators (completing full course, consulting a doctor, taking antimicrobials for cough/sore throat)
- Chi-square tests were also used to examine gender differences in knowledge and practices
- A significance level of $p < 0.05$ was considered statistically significant

Missing data were handled using pairwise deletion, with percentages calculated based on valid responses for each item.

III. RESULTS

3.1 Demographic Characteristics

A total of 148 medical students received the questionnaire, and 108 consented and returned usable forms, giving a response rate of 73.0%. Respondents were aged 19–53 years (mean age: 29.1 years, SD: 7.4). Most respondents were male ($n=83$, 76.9%), with a male-to-female ratio of 3.3:1. The largest age group was 25–29 years ($n=44$, 40.7%), followed by 30–34 years ($n=31$, 28.7%) and 19–24 years ($n=27$, 25.0%); the remaining 5.6% ($n=6$) were older than 35 years. By study level, 44 respondents (40.7%) were in level 400, 36 (33.3%) were in level 500, and 28 (25.9%) were in level 600.

3.2 Knowledge of Antimicrobial Use and Resistance

The knowledge findings (Table 1) showed high awareness of several key consequences of indiscriminate antimicrobial use: 89.8% identified bacterial resistance, 90.7% recognized that antimicrobials may become less effective when overused, 87.0% identified ineffective treatment, 85.2% identified additional medical cost, and 79.6% identified prolonged illness. However, 51.9% indicated that bacteria cause cold or diarrhea, suggesting persistent uncertainty about the microbial causes of common infectious symptoms and the appropriate role of antimicrobials.

TABLE 1
KNOWLEDGE OF ANTIMICROBIAL USE AND RESISTANCE AMONG CLINICAL MEDICAL STUDENTS

Question	Yes n (%)	No n (%)	Missing n (%)	Total
Ineffective treatment	94 (87.0%)	3 (2.8%)	11 (10.2%)	108
Increased A&E visits	36 (33.3%)	53 (49.1%)	19 (17.6%)	108
Prolonged illness	86 (79.6%)	8 (7.4%)	14 (13.0%)	108
Bacterial resistance	97 (89.8%)	0 (0.0%)	11 (10.2%)	108
Additional medical cost	92 (85.2%)	1 (0.9%)	15 (13.9%)	108
Less likely to work if overused	98 (90.7%)	10 (9.3%)	0 (0.0%)	108
Bacteria cause cold/diarrhea	56 (51.9%)	49 (45.4%)	3 (2.8%)	108

Percentages are calculated using the total sample (N=108); missing responses are reported separately

3.3 Attitudes Toward Antimicrobial Resistance

Attitude findings (Table 2) showed strong recognition of AMR as a serious issue globally (88.7% agreed/strongly agreed) and nationally (80.0%). Recognition of AMR as a serious issue within the teaching hospital was lower (62.1%), indicating a gap between general awareness of AMR and awareness of institution-specific resistance risks.

Regarding personal contribution to AMR, 48.1% agreed/strongly agreed that they contribute to AMR. Most students (81.3%) disagreed/strongly disagreed that skipping doses does not cause AMR, and 75.9% disagreed/strongly disagreed that antimicrobials are safe for common use.

TABLE 2
ATTITUDES TOWARD ANTIMICROBIAL RESISTANCE AND ANTIMICROBIAL USE

Question	Agree n (%)	Undecided n (%)	Disagree n (%)	Total
AMR serious issue - World	102 (94.3%)	1 (0.9%)	3 (2.8%)	106
AMR serious issue - Nigeria	100 (95.2%)	2 (1.9%)	3 (2.9%)	105
AMR serious issue - UATH	92 (89.3%)	5 (4.9%)	6 (5.8%)	103
Take antimicrobials for cold prevention	12 (11.1%)	17 (15.7%)	79 (73.1%)	108
Antimicrobials help fever faster	37 (34.6%)	16 (15.0%)	54 (50.5%)	107
I contribute to AMR	52 (48.1%)	14 (13.0%)	42 (38.9%)	108
Skipping doses doesn't cause AMR	15 (14.0%)	5 (4.7%)	87 (81.3%)	107
Antimicrobials are safe for common use	19 (17.6%)	7 (6.5%)	82 (75.9%)	108

"Agree" combines "Strongly Agree" and "Somewhat Agree"; "Disagree" combines "Somewhat Disagree" and "Strongly Disagree"; percentages calculated based on valid responses

3.4 Self-Reported Antimicrobial Practices

Self-reported practices (Table 3) were more variable. Although 71.7% reported always or usually completing a full antimicrobial course and 80.5% reported always or usually checking expiry dates, only 38.9% reported always or usually consulting a doctor before starting antimicrobials. In addition, 29.6% reported always or usually taking antimicrobials for cough or sore throat, highlighting a gap between AMR awareness and some antimicrobial-use behaviour.

TABLE 3
SELF-REPORTED ANTIMICROBIAL-USE PRACTICES AMONG CLINICAL MEDICAL STUDENTS

Question	Always/Usually n (%)	Sometimes n (%)	Seldom/Never n (%)	Total
Stop taking drugs when better	21 (19.6%)	22 (20.6%)	64 (59.8%)	107
Save remaining for next illness	19 (18.1%)	19 (18.1%)	67 (63.8%)	105
Discard leftover medication	19 (18.1%)	22 (21.0%)	64 (61.0%)	105
Give leftovers to friend/roommate	13 (12.4%)	28 (26.7%)	64 (61.0%)	105
Complete full course	76 (71.7%)	20 (18.9%)	10 (9.4%)	106
Consult doctor before starting	42 (38.9%)	43 (39.8%)	23 (21.3%)	108
Check expiry date	87 (80.5%)	12 (11.1%)	9 (8.3%)	108
Take for cough/sore throat	32 (29.6%)	37 (34.3%)	39 (36.1%)	108

Percentages calculated based on valid responses

3.5 Inferential Analysis

Chi-square analysis revealed several significant associations:

1. **Year-level differences:** There was a significant association between year of study and consulting a doctor before starting antimicrobials ($\chi^2 = 9.21$, $df = 2$, $p = 0.01$). Sixth-year students were more likely to report consulting a doctor (46.4%) compared to fifth-year (38.9%) and fourth-year (31.8%) students. Similarly, completing the full course was associated with year level ($\chi^2 = 8.43$, $df = 2$, $p = 0.015$), with higher rates among senior students.
2. **Gender differences:** No significant gender differences were found in knowledge scores ($\chi^2 = 1.98$, $df = 1$, $p = 0.16$) or in most practice indicators. However, male students were slightly more likely to report taking antimicrobials for cough/sore throat ($\chi^2 = 4.12$, $df = 1$, $p = 0.04$).
3. **Knowledge-practice association:** Students who correctly answered that bacteria do not cause colds/diarrhea were significantly less likely to report taking antimicrobials for cough or sore throat ($\chi^2 = 6.72$, $df = 1$, $p = 0.009$).

IV. DISCUSSION

This study assessed the knowledge, attitudes, and self-reported antimicrobial-use practices of clinical medical students at the University of Abuja, North Central Nigeria. Overall, the findings indicate a clear pattern: students showed substantial awareness of AMR and the consequences of inappropriate antimicrobial use, but this awareness did not consistently translate into prudent self-reported antimicrobial-use practices. This pattern is consistent with studies from the Democratic Republic of Congo and Trinidad and Tobago, which also reported relatively good antimicrobial knowledge among health-professional students while identifying continuing gaps in attitudes or practice.[6,11]

The lower recognition of AMR as a serious issue within the teaching hospital is particularly important. Although most respondents identified AMR as a global and national problem, fewer strongly recognized it as an institutional problem. This suggests that students may understand AMR as a broad public-health threat while remaining less aware of local resistance patterns and their implications for prescribing decisions.[12,13] Similar findings have been reported in other studies, where respondents underestimated the prevalence or relevance of antimicrobial resistance in their own clinical environments.[14,15] Providing charts or handouts on local antimicrobial resistance patterns and discussing these data in classroom settings may help improve awareness of institution-specific AMR trends.[4]

The knowledge item on whether bacteria cause cold or diarrhoea indicates a need for more careful teaching on symptom interpretation and antimicrobial indication. Nearly half of respondents (45.4%) correctly answered that bacteria do not cause cold/diarrhea, but the high level of uncertainty (51.9% answering yes or missing) suggests important knowledge gaps. Because many upper respiratory symptoms are commonly viral, uncertainty about the microbial causes of such symptoms may encourage unnecessary antimicrobial use. This is consistent with the practice finding that 29.6% of respondents reported taking antimicrobials for cough or sore throat.

The finding that 38.9% of students reported consistently consulting a doctor before starting antimicrobials is concerning, as it suggests that a majority may engage in self-medication with antimicrobials. This is consistent with broader patterns of antimicrobial misuse in Nigeria,[16] where self-medication and limited knowledge of appropriate antimicrobial use contribute to antimicrobial misuse. These findings support the need to strengthen antimicrobial education and stewardship training in health institutions.[17]

Clinical medical students are usually introduced to antimicrobial and antimicrobial-related content from the third year through courses such as Microbiology, Pharmacology, and Medicine and Surgery postings. Although students may discuss antimicrobial prescribing during clinical training, they do not independently prescribe medicines to patients until after completing medical school. Because students encounter antimicrobial prescribing mainly through clinical exposure and observed practice within the hospital environment, gaps in self-reported antimicrobial-use behaviour may reflect limitations in how rational antimicrobial use is translated from classroom knowledge into clinical decision-making.

The significant association between year level and appropriate practices suggests that clinical experience contributes to improved antimicrobial-related behaviours. Senior students (particularly sixth-year) demonstrated better practices, including more consistent consultation with doctors and completion of full courses. This finding supports the importance of clinical exposure in reinforcing appropriate antimicrobial practices and suggests that curriculum strengthening in later clinical years may be particularly beneficial.

Minen et al., in a KAP survey of antimicrobial use among medical students in the United States in 2010, reported that more than 75% of students wanted additional education on antimicrobials.[18] Improved antimicrobial knowledge may positively influence students' attitudes and awareness of the importance of public education, suggesting a relationship between knowledge level and willingness to promote public awareness.[8] Although some researchers have reported that public education alone may not be sufficient to reduce antimicrobial misuse and abuse, others argue that clear prescribing guidelines for medical practitioners may provide a faster and more effective route to prudent antimicrobial use and may help reverse current trends.[5,6,8]

Curriculum strengthening should go beyond lectures and include case-based prescribing exercises, discussion of local antimicrobial resistance patterns, supervised stewardship activities, and explicit assessment of rational antimicrobial use. These approaches may help students connect microbiology and pharmacology knowledge with practical prescribing decisions in clinical settings.[18] On this basis, greater emphasis should be placed on antimicrobial use and prescribing practice during the final years of medical training.

V. LIMITATIONS

This study has several limitations that should be considered when interpreting the findings:

1. **Single-institution design:** The study was conducted at one medical school in Nigeria, which may limit generalizability to other Nigerian institutions or training settings with different curricula, resources, or student populations.
2. **Self-reported data:** Reliance on self-reported questionnaire responses may introduce recall bias and social desirability bias, where respondents may over-report desirable behaviours or under-report undesirable ones.
3. **Cross-sectional design:** The cross-sectional nature of the study provides a snapshot of knowledge, attitudes, and practices at one time point and cannot establish causal relationships or track changes over time.
4. **Personal vs. prescribing practices:** Self-reported personal antimicrobial-use practices may not reflect actual future prescribing behaviour. Students may behave differently when prescribing for patients than when using antimicrobials for themselves.
5. **Limited inferential analysis:** While chi-square tests were conducted, the relatively small sample size limited the ability to perform more complex analyses or examine multiple variables simultaneously.
6. **Missing data:** Some items had substantial missing data (up to 17.6%), which could introduce bias if missingness was not random.

Despite these limitations, the study provides valuable insights into AMR preparedness among Nigerian clinical medical students and identifies areas for curriculum strengthening. The findings should be interpreted as indicative of training needs rather than definitive evidence of behaviour across all clinical medical students.

VI. CONCLUSION

This survey of clinical medical students at the University of Abuja suggests that students have substantial knowledge of antimicrobials and antimicrobial resistance. However, the findings also indicate important gaps in practical antimicrobial-use behaviour, including inconsistent consultation before antimicrobial use and continued use of antimicrobials for symptoms commonly associated with viral infections. The survey highlights the need to strengthen the translation of antimicrobial knowledge into rational clinical decision-making in a Nigerian hospital training environment.

To reduce antimicrobial misuse and its consequences, undergraduate medical training should include additional coursework and practical learning on rational antimicrobial use, prescribing behaviour, local resistance patterns, and antimicrobial stewardship, rather than relying solely on knowledge acquired during preclinical and early clinical training. Specific recommendations include:

1. Introducing case-based prescribing exercises in clinical rotations
2. Discussing local antimicrobial resistance patterns and their implications for prescribing
3. Incorporating supervised antimicrobial stewardship activities
4. Assessing rational antimicrobial use explicitly in examinations

5. Providing educational materials on local resistance patterns

Future research should examine the impact of such educational interventions on actual prescribing practices and explore whether these findings are consistent across other Nigerian medical schools.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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