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KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING ANTIMICROBIAL RESISTANCE AND ANTIBIOTIC USE AMONG UNDERGRADUATE STUDENTS OF ZAMFARA STATE UNIVERSITY, TALATA MAFARA, NIGERIA

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ABSTRACT

Background: Antimicrobial resistance (AMR) threatens the effectiveness of medicines used to prevent and treat infectious diseases. University students are an important population for understanding antibiotic-use knowledge and behaviour because they make health decisions and obtain information from multiple sources. Objective: This manuscript demonstrates an expanded knowledge, attitudes and practices (KAP) assessment framework for undergraduate students of Zamfara State University, Talata Mafara, Nigeria. Methods: A cross-sectional questionnaire framework was applied to 500 synthetic records assigned equally to four faculty groups: Basic Medical Science, Science, Education, and Arts, Management and Social Sciences. Knowledge was scored from 13 items, with correct responses assigned one point. Ten five-point attitude items were summarised using the respondent mean. Descriptive statistics were calculated. Results: The synthetic records yielded a mean knowledge score of 70.3% (SD 12.0), a mean attitude score of 3.65/5 (SD 0.34), and 35 poor, 253 moderate and 212 good knowledge classifications. Antibiotic use in the preceding 12 months was coded for 297 records (59.4%), while 137 (27.4%) were coded as reporting self-medication. Conclusion: The analysis demonstrates a reproducible reporting structure but does not estimate actual student behaviour. The figures must be replaced with results from ethically collected field data before journal submission.

KEYWORDS: Antimicrobial Resistance; Antibiotic Use; Knowledge; Attitudes; Practices; University Students; Nigeria; Synthetic Dataset.

1. INTRODUCTION

1.1 Background to the study

Antimicrobial resistance is the ability of microorganisms to withstand medicines that would ordinarily inhibit their growth or eliminate them. It is a broad term that includes resistance in bacteria, viruses, fungi and parasites. Antibiotic resistance is one component of AMR and specifically concerns bacteria and antibacterial medicines. The distinction is important in public communication because antibiotics do not treat viral infections, and the use of an antibiotic when it is not clinically indicated offers no therapeutic benefit while contributing to unnecessary antimicrobial exposure (World Health Organization [WHO], 2024).

AMR has become a major global health concern because resistant infections can be more difficult to treat and may require alternative medicines, longer treatment, additional diagnostic procedures or more complex clinical management. A large systematic analysis estimated that bacterial AMR was directly attributable to approximately 1.27 million deaths and associated with approximately 4.95 million deaths worldwide in 2019. These estimates refer to bacterial AMR and should not be incorrectly described as the total burden of resistance across all microorganisms (Antimicrobial Resistance Collaborators, 2022).

Resistance can emerge through biological processes such as mutation and the acquisition of resistance genes. The selection and spread of resistant organisms are influenced by antimicrobial exposure, infection prevention practices, sanitation, healthcare delivery, animal production and environmental pathways. The One Health perspective is therefore central: human health, animal health, food systems and environmental conditions are interconnected, and efforts confined to hospitals alone cannot address every driver of resistance (WHO, 2024; Federal Ministries of Agriculture and Food Security, Environment, and Health and Social Welfare, 2024).

Antibiotics remain essential medicines when prescribed for bacterial infections. Their value depends on access to quality-assured medicines, appropriate diagnosis, correct selection and dose, and adherence to professional advice. Inappropriate use may include taking antibiotics for viral illnesses, using medicines without suitable professional assessment, sharing prescriptions, using leftover antibiotics or changing treatment without advice. These behaviours should be examined carefully because they may reflect health-system access barriers, medicine availability, cost, previous experiences or misunderstanding rather than knowledge alone (Ajibola et al., 2018; Akande-Sholabi & Ajamu, 2021).

University students form a diverse group whose health-related decisions may be influenced by academic background, family practices, peer networks, campus health services,

pharmacies, online content and previous encounters with illness. Students in health-related faculties may have greater exposure to biomedical information, but this should not be assumed to translate automatically into appropriate antibiotic behaviour. Students in non-health faculties are also important because responsible antibiotic use is a public-health concern rather than a matter restricted to future health professionals (Atalay & Abebe Gelaw, 2024; Jackson et al., 2023).

In Nigeria, studies have examined antibiotic self-medication and AMR knowledge among community residents and undergraduates, as well as among students enrolled in healthcare programmes. These studies provide useful national and regional context, but their findings are not interchangeable. A study of healthcare students may overrepresent participants with formal exposure to medicines, while a mixed community-and-student study may report results that require careful subgroup interpretation. The present study is framed around the wider undergraduate population across four specified faculties (Ajibola et al., 2018; Akande-Sholabi & Ajamu, 2021; Aboh et al., 2022).

Nigeria's One Health Antimicrobial Resistance National Action Plan 2.0 (2024–2028) identifies coordinated awareness, education, behaviour change, surveillance, infection prevention and responsible antimicrobial use as national priorities. A university-level KAP assessment can contribute to this agenda by identifying educational needs among a defined student population. Such an assessment can inform campus health promotion, although a questionnaire survey alone cannot measure bacterial resistance or determine the microbiological causes of resistant infections (Federal Ministries of Agriculture and Food Security, Environment, and Health and Social Welfare, 2024).

1.2 Statement of the problem

The continued effectiveness of antibiotics is threatened by the emergence and spread of resistant bacteria. Inappropriate use contributes to selection pressure and may also delay appropriate treatment when individuals rely on medicines without adequate clinical assessment. Self-medication, use of leftover medicines, sharing antibiotics and misconceptions about the role of antibiotics in viral illnesses are behaviours that warrant public-health attention. Evidence from Northwest Nigeria has shown limited recognition among undergraduate respondents of the relationship between selfmedication and antibiotic resistance, demonstrating that university attendance does not necessarily guarantee accurate understanding (Ajibola et al., 2018).

Although Nigerian research has explored antibiotic use among community members, tertiary students and healthcare trainees, differences in setting, participant characteristics and

measurement tools limit the extent to which findings can be transferred to another institution. Evidence drawn from medical, nursing or pharmacy students cannot be assumed to describe the views and practices of students studying science, education, arts, management or social sciences. A universitywide assessment should therefore include students from different academic disciplines and should distinguish knowledge, attitudes and reported practices (Akande-Sholabi & Ajamu, 2021; Jackson et al., 2023).

For Zamfara State University, the practical research problem is the absence, within the material reviewed for this manuscript, of verified institutionspecific evidence describing undergraduate students' knowledge of AMR, attitudes towards antibiotic use, antibioticuse practices and awareness of antimicrobial stewardship across the four specified faculties. Without such evidence, university stakeholders may have difficulty prioritising health education, identifying misconceptions or deciding which communication channels are most appropriate. This statement describes the evidence gap; it does not imply that the University has no existing health education activity.

The present manuscript demonstrates the structure and analysis plan for addressing this problem. However, the available dataset is synthetic. It cannot fill the empirical evidence gap, and its numerical outputs must not be treated as actual findings from Zamfara State University students. The empirical problem can only be answered through a properly approved survey involving real, consenting participants.

1.3 Justification and significance

The study is justified by the need for locally relevant evidence to guide AMR education among students. National policies establish broad priorities, while institutionlevel data can help determine whether students understand the difference between antibiotics and other medicines, recognise the risks of inappropriate use and know where to obtain reliable advice. Evidence from local students can help translate national AMR priorities into campus-level activities (Federal Ministries of Agriculture and Food Security, Environment, and Health and Social Welfare, 2024).

The University health service may use valid findings to develop targeted information materials, referral advice and awareness campaigns. Academic departments and student associations may support health literacy activities, while the findings may help identify whether students rely mainly on health professionals, lecturers, peers, radio, websites or social media. The study may also contribute to Nigerian research on AMR by documenting a population that is not limited to healthcare trainees (Atalay & Abebe Gelaw, 2024; Jackson et al., 2023).

The study has methodological value because it treats knowledge, attitudes and practices as related but distinct constructs. A respondent may know that antibiotics do not treat viral infections but still use them without consultation because of cost, convenience or limited access to care. Conversely, a respondent may express positive attitudes but have incomplete knowledge. Analysing these domains separately avoids reducing complex behaviour to a single awareness score (Aboh et al., 2022; Ajibola et al., 2018).

1.4 Aim and objectives of the study

The aim of the study is to assess knowledge, attitudes and practices regarding antimicrobial resistance and antibiotic use among undergraduate students of Zamfara State University, Talata Mafara, Nigeria.

The specific objectives are to: (1) assess students' knowledge of antimicrobial resistance and appropriate antibiotic use; (2) examine students' attitudes towards antibiotic use, selfmedication and antimicrobial resistance; (3) describe reported antibioticuse practices, including sources of antibiotics and selected behaviours such as selfmedication and use of leftover medicines; (4) identify students' sources of information and level of awareness of antimicrobial stewardship; and (5) examine associations between selected sociodemographic or academic characteristics and KAP outcomes, where genuine data and an adequate sample support such analysis.

1.5 Research questions

The study is guided by the following questions: What do undergraduate students know about AMR and appropriate antibiotic use? What attitudes do they hold towards antibiotic use and resistance? Which antibiotic-use practices do they report? Which sources of information do they use, and how familiar are they with antimicrobial stewardship? Do KAP outcomes vary according to selected demographic and academic characteristics?

1.6 Scope of the study

The intended population is registered undergraduate students of Zamfara State University. The faculty scope specified for this project comprises Faculty of Basic Medical Science, Faculty of Science, Faculty of Education, and Faculty of Arts, Management and Social Sciences. The subject scope covers AMR knowledge, antibioticuse attitudes, antibioticuse practices, information sources and awareness of antimicrobial stewardship. The study does not include laboratory testing of bacterial isolates, measurement of antimicrobial residues or clinical assessment of individual infections.

2. LITERATURE REVIEW

2.1 Conceptualising AMR and antibiotic resistance

AMR is a biological phenomenon in which microorganisms are no longer adequately inhibited or killed by medicines that were previously effective. Antibiotic resistance is narrower and refers to bacteria that are resistant to one or more antibacterial agents. Public discussion sometimes uses "antibiotic resistance" and "antimicrobial resistance" interchangeably, but the terms should be used precisely in a scientific article. The questionnaire should test whether respondents understand this distinction and know that antibiotics are not effective against viral infections (WHO, 2024).

Resistance may arise through genetic changes or the acquisition of resistance determinants, followed by selection under antimicrobial exposure. The presence of an antibiotic can favour organisms carrying resistance traits, while transmission allows resistant organisms to spread between people, healthcare settings, animals and environments. This process explains why responsible use, infection prevention, vaccination, sanitation and surveillance need to operate together (Antimicrobial Resistance Collaborators, 2022; WHO, 2024).

2.2 Drivers of inappropriate antibiotic use

Inappropriate antibiotic use is not a single behaviour. It may involve unnecessary treatment, incorrect drug choice, unsuitable dose or duration, non-prescribed use, sharing or reusing medicines, and failure to seek care when symptoms persist. Some behaviours are associated with individual knowledge and attitudes, while others reflect access to qualified providers, affordability, medicine supply practices and the quality of health services. KAP research should therefore avoid attributing every inappropriate practice solely to ignorance (Ajibola et al., 2018; Aboh et al., 2022).

Selfmedication with antibiotics is particularly relevant in settings where individuals can obtain medicines from pharmacies, patent medicine vendors, relatives or leftover supplies. The decision may be influenced by previous prescriptions, perceived similarity of symptoms, time constraints and the cost of consultation. A questionnaire can describe the reported source and reason for use, but it cannot independently verify the appropriateness of a specific antibiotic regimen unless clinical details are collected and assessed by qualified reviewers (Ajibola et al., 2018).

2.3 Knowledge of AMR among students

Knowledge of AMR includes understanding the meaning of resistance, recognising the limits of antibiotics, identifying behaviours that may contribute to resistance and knowing how resistance can spread. Ajibola et al. (2018) studied a combined sample of community

residents and undergraduate students in Northwest Nigeria. Among undergraduate respondents, 32.6% recognised that self-medication could lead to antibiotic resistance. This finding points to a specific knowledge gap, but it should not be generalised to every undergraduate population or interpreted as a current estimate for Zamfara State University.

Aboh et al. (2022) assessed antimicrobial use and resistance knowledge, attitudes and practices among tertiary institution students in North-Central Nigeria. Their work is relevant because it examines a student population beyond a single healthcare profession. However, the sample composition and questionnaire domains should be checked in the original article before direct comparisons are made with a new campus survey.

Akande-Sholabi and Ajamu (2021) assessed healthcare students at a Nigerian university. They reported that 506 of 866 respondents (58.4%) had good knowledge of AMR and appropriate antibiotic handling. The study also reported antibiotic use in the previous 12 months among 95.2% of respondents. Because the participants were healthcare students, their level of exposure to healthrelated teaching may differ from that of a university-wide undergraduate population (Akande-Sholabi & Ajamu, 2021).

Atalay and Abebe Gelaw (2024) conducted a systematic review and metaanalysis that included 39 African studies and 18,769 participants. The pooled estimates were 55.33% for knowledge, 46.93% for positive attitudes and 51.05% for good practices. These pooled results provide a broad regional perspective, but the underlying studies included different population groups, settings and instruments. They should therefore be interpreted as regional synthesis estimates rather than a benchmark that every individual university must reproduce.

2.4 Attitudes towards antibiotics and AMR

Attitudes are beliefs, perceptions and evaluations that may influence behaviour. In antibiotic use, relevant attitudes include whether a person believes antibiotics speed recovery from any illness, whether a prescription is necessary, whether it is acceptable to share medicines, and whether resistance is considered a serious personal or community concern. Attitudes may be favourable while behaviour remains inappropriate, especially where structural barriers affect access to healthcare (Aboh et al., 2022; Ajibola et al., 2018).

Aboh et al. (2022) reported selfmedication among 47.7% of respondents and discontinuation of antimicrobial medication when respondents felt better among 60.2%. Such results highlight why attitude questions should be paired with questions about actual reported behaviour. A respondent may agree that antibiotics should be used responsibly but still stop treatment or use a medicine from a previous illness. The exact interpretation depends on the wording of the questionnaire and the clinical context of the reported use.

2.5 Antibioticuse practices

Practice indicators commonly examined in KAP surveys include antibiotic use within a specified recall period, source of medicine, whether a prescription was obtained, reason for use, selfmedication, sharing, use of leftovers, changes to dose and adherence to professional advice. The recall period should be stated clearly because a question about the previous 12 months is not directly comparable with a question about lifetime use or the most recent illness (Akande-Sholabi & Ajamu, 2021).

In the Nigerian healthcarestudent study by Akande-Sholabi and Ajamu (2021), 824 of 866 respondents (95.2%) reported antibiotic use during the previous 12 months. Among those reporting use, community pharmacies were a frequent source, followed by hospitals, patent medicine stores and friends or family. The study also documented antibiotic use for malaria, which illustrates a potential misconception because malaria is caused by Plasmodium parasites and is not treated with antibacterial antibiotics. These results relate to healthcare students in that study and should not be presented as the expected prevalence among all undergraduates.

Ajibola et al. (2018) reported that physician prescription was not the source of all antibiotic use among undergraduate respondents and highlighted selfmedication in the Northwest Nigerian context. Their study is particularly relevant to the present setting because it was conducted in the same broad geopolitical region, although it was not carried out at Zamfara State University. Differences in location, time, sampling and population mean that the findings provide context rather than a direct substitute for local data.

2.6 Antimicrobial stewardship and health literacy

Antimicrobial stewardship refers to coordinated strategies intended to promote appropriate antimicrobial selection, dosing, route and duration, while supporting good clinical outcomes and limiting avoidable resistance. In universities, stewardship education can be adapted for both healthcare and nonhealthcare students. Core messages include seeking qualified advice, not using antibiotics for viral infections, not sharing prescribed medicines and following the instructions given by the treating professional (WHO, 2024).

Jackson et al. (2023) surveyed healthcare students in Nigeria and reported that 60.8% were unfamiliar with the term antimicrobial stewardship. The finding suggests that even students enrolled in health-related programmes may not always recognise the terminology used in stewardship initiatives. For a university-wide study, it may be useful to ask both whether students have heard the term and whether they can identify practical actions associated with responsible antibiotic use.

Information sources also matter. Lecturers and health professionals may provide structured information, while peers, family, social media and websites may shape everyday decisions. The study should not assume that a source is reliable merely because it is frequently used. The questionnaire can record the source most commonly consulted and whether respondents would prefer additional education through campus health services, lectures, social media or other channels (Jackson et al., 2023; Atalay & Abebe Gelaw, 2024).

2.7 Nigerian policy and One Health context

Nigeria's second One Health AMR National Action Plan for 2024–2028 sets out a coordinated national response across human, animal, food, plant and environmental sectors. Its strategic priorities include governance and coordination, AMR awareness and behaviour change, surveillance and operational research, infection prevention and control, access to quality antimicrobials and strengthened research capacity. A student KAP survey aligns most directly with the awareness, education and behaviourchange components, while recognising that a questionnaire cannot evaluate the full national response (Federal Ministries of Agriculture and Food Security, Environment, and Health and Social Welfare, 2024).

2.8 Empirical review of related studies

Study	Population and design	Relevant findings	Relevance and caution
Ajibola et al. (2018)	Community residents and undergraduates; cross-sectional study in Northwest Nigeria	Among undergraduates, 32.6% recognised self-medication could contribute to antibiotic resistance.	Regional relevance; mixed sample means undergraduate subgroup must be kept distinct.
Akande-Sholabi & Ajamu (2021)	866 healthcare students at a Nigerian university	58.4% classified as having good AMR knowledge; 95.2% reported antibiotic use in previous 12 months.	Healthcare students only; not directly representative of all faculties.
Aboh et al. (2022)	Tertiary institution students in North-Central Nigeria	Reported self-medication and treatment discontinuation concerns; study examined KAP.	Relevant student evidence; verify denominators and exact item wording before detailed comparison.
Jackson et al. (2023)	Healthcare students from Nigerian universities	60.8% unfamiliar with the term antimicrobial stewardship.	Supports inclusion of stewardship awareness; population is healthcare students.
Atalay & Abebe Gelaw (2024)	Systematic review and meta-analysis; 39 African studies, 18,769 participants	Pooled knowledge 55.33%, positive attitudes 46.93%, good practices 51.05%.	Regional synthesis with heterogeneous populations and instruments.

Taken together, the literature demonstrates that antibiotic knowledge, attitudes and practices vary by population and by the specific behaviour being measured. Studies among healthcare students are valuable but cannot stand in for a general undergraduate sample. The research gap for Zamfara State University is therefore institution-specific and population-specific: valid data are needed across the four named faculty groups to describe the current student experience.

2.9 Conceptual framework

The proposed framework treats student background characteristics as potential explanatory factors, knowledge and attitudes as related cognitive and evaluative domains, and reported practices as behavioural outcomes. Age, sex, faculty, academic level, residence and prior AMR education may be associated with knowledge. Knowledge and attitudes may in turn be associated with practices, although access to healthcare, medicine availability, cost, peer influence and information sources may affect behaviour independently. These are hypothesised associations, not proven causal pathways (Ajibola et al., 2018; Aboh et al., 2022).

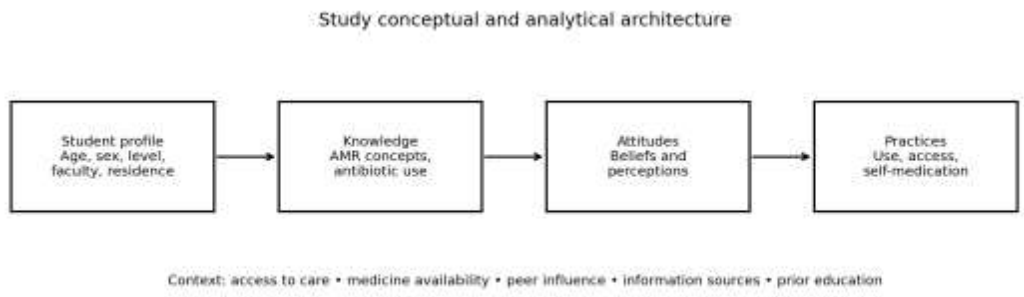

Figure 1. Conceptual and analytical architecture. Source: Developed by the authors for this study, informed by the KAP domains in the cited literature.

2.10 Research gap

The reviewed evidence includes community-and-undergraduate research in Northwest Nigeria, tertiary student research in North-Central Nigeria, healthcare-student studies and an African systematic review. However, the reviewed sources do not establish current KAP levels among undergraduate students across the four specified faculties of Zamfara State University. The present study is designed to address this institutional gap through a structured survey, while ensuring that results from other populations are used only as context (Ajibola et al., 2018; Aboh et al., 2022; Atalay & Abebe Gelaw, 2024).

3. MATERIALS AND METHODS

3.1 Study design and setting

The proposed empirical study is a descriptive cross-sectional survey. Each participant would complete the questionnaire once during the defined datacollection period. This design is suitable for estimating the distribution of knowledge, attitudes and reported practices at a particular time and for exploring associations between selected variables. It does not establish temporal sequence or causality. The study setting is Zamfara State University, Talata Mafara, Zamfara State, Nigeria. Institutional descriptions, student enrolment and faculty structure should be confirmed from current official University records before field implementation.

3.2 Study population and eligibility

The target population is registered undergraduate students in the four faculties specified for the project: Basic Medical Science, Science, Education, and Arts, Management and Social Sciences. Eligible participants should be registered undergraduates, available during data collection and willing to provide informed consent. Individuals who are not registered undergraduates or who decline consent should not be enrolled. The final protocol should state whether students on clinical placement, leave or other special status are eligible.

3.3 Sample size and sampling strategy

The synthetic demonstration contains 500 records. This number is retained to illustrate the planned dataset size; it is not evidence that 500 students were recruited. For a real study, sample size should be justified using the estimated undergraduate population, expected prevalence of the primary outcome, confidence level, margin of error, design effect where relevant and allowance for nonresponse. If the target is to estimate a proportion and no reliable prior estimate is available, a conservative prevalence of 50% may be used in the standard single-proportion calculation, subject to the study's sampling design.

A proportionate stratified approach is appropriate if the aim is to represent all four faculties. The number selected from each faculty should be calculated using the verified faculty enrolment: $n_h = (N_h/N) \times n$, where n_h is the faculty allocation, N_h is the faculty population, N is the total undergraduate population and n is the overall sample size. Equal allocation of 125 per faculty in this synthetic file is an illustrative convenience and must not be described as proportionate sampling.

Faculty	Synthetic allocation	Allocation status
Faculty of Basic Medical Science	125	Illustrative; enrolment not verified
Faculty of Science	125	Illustrative; enrolment not verified
Faculty of Education	125	Illustrative; enrolment not verified
Faculty of Arts, Management and Social Sciences	125	Illustrative; enrolment not verified
Total	500	Synthetic only

3.4 Study instrument and questionnaire domains

The planned instrument is a structured selfadministered questionnaire. Its domains include sociodemographic and academic characteristics; knowledge of antibiotics and AMR; attitudes towards antibiotic use and resistance; antibiotic-use practices; information sources; and awareness of antimicrobial stewardship. Questions should be written in clear language, avoid doublebarrelled statements and distinguish "antibiotic" from "medicine" where that distinction is necessary. The recall period for antibiotic use should be stated explicitly.

Content validity should be assessed by reviewers with expertise in public health, pharmacology, microbiology, epidemiology or antimicrobial stewardship. A pilot test should examine comprehension, completion time, response options and missing-data patterns. Reliability analysis may be considered for multi-item scales, but internal consistency should not be interpreted as proof that a questionnaire measures the intended construct. Any changes made after piloting should be documented.

3.5 Dataset used in this expanded document

The workbook used here is titled

"ZAMSUT_AMR_500_Synthetic_Four_Faculty_Dataset.xlsx". It contains a Read Me sheet, a Faculty Allocation sheet and a Synthetic Responses sheet. The response sheet has 500 records and 46 source variables, including respondent ID, faculty, department, age group, sex, study level, residence, prior AMR education, 13 knowledge responses, ten attitude responses, antibiotic use in the previous 12 months, sources and reasons for use, self-medication indicators, selected practices, AMR awareness, information source, stewardship awareness and open comments. The workbook labels the data as simulated and intended for questionnaire testing and demonstration.

For this expanded version, the four faculty categories were set to 125 records each to match the faculty names supplied for the study. The allocation was not derived from actual faculty enrolment. The response patterns are synthetic and therefore cannot be treated as observations from students. The file is useful for testing data structures, scoring logic, tables and figures, but it does not replace fieldwork or ethical approval.

3.6 Data management and scoring

Knowledge was operationalised using 13 questionnaire items. Each response coded "Correct" received one point, while "Incorrect" and "Don't know" responses received zero. The total score therefore ranged from zero to 13 and was converted to a percentage. For this demonstration, scores below 50% were classified as poor, 50% to 74.9% as moderate and 75% or above as good. These cut-offs are analytical conventions selected for demonstration

and should be justified against the final instrument and relevant literature before an empirical report is prepared.

Attitude was summarised as the arithmetic mean of ten fivepoint responses. This assumes that all items have been oriented in the same direction and are suitable for aggregation. Before using this score in a real study, item wording must be reviewed and negatively phrased items reversecoded where appropriate. A composite score should not be calculated if the items represent unrelated constructs or if the measurement model is not defensible.

Practice variables were analysed as categorical indicators using the response coding supplied in the synthetic workbook. “Not applicable” responses were not interpreted as negative behaviours. In a real dataset, skip patterns should be checked so that participants who did not use antibiotics are not incorrectly counted as having complied or failed to comply with treatment instructions.

3.7 Statistical analysis

The demonstration analysis used descriptive summaries: frequencies and percentages for categorical variables, and means and standard deviations for continuous or composite scores. A genuine study may use chi-square tests to examine associations between categorical variables where expected cell counts are adequate. Logistic regression may be considered for a clearly defined binary outcome, such as self-medication among participants who used antibiotics, with adjusted odds ratios and 95% confidence intervals. Model selection should be guided by the research questions, sample size, missingness and plausible confounding rather than automated significance screening.

The unit of analysis is the individual student. If sampling is stratified by faculty, the analysis should account for the sampling design when estimating populationlevel results, especially if allocation is disproportionate. Missing data should be described, and denominators should be reported for every outcome. Statistical significance should not replace effectsize interpretation or confidence intervals. These inferential procedures are recommended for real field data and were not used to support substantive conclusions from the synthetic dataset.

4. Study architecture and analytical workflow

The study architecture links the research questions to the questionnaire, dataset, scoring procedure, analysis and reporting. The first stage defines the population and sampling frame. The second stage administers the validated questionnaire after ethical approval. The third stage checks completeness, coding consistency, duplicate records and skip patterns. The fourth stage derives knowledge and attitude indicators and summarises practice variables.

The final stage interprets the results against the research questions and existing literature. The architecture is designed to make the analytical pathway transparent and reproducible.

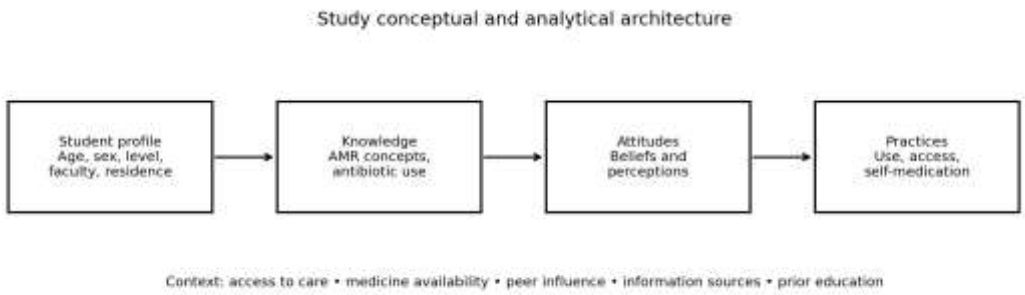

Figure 2. Study architecture showing the proposed relationships among student factors, KAP domains and contextual influences. Source: Authors' conceptual design.

For implementation, a data dictionary should define every variable, response category, missing-value code and derived score. Each transformation should be documented in a reproducible script or analysis log. The raw questionnaire export should be retained unchanged, while cleaned data and analysis-ready variables should be stored separately. This separation allows reviewers to trace how the reported tables were produced and reduces the risk of unrecorded manual changes.

5. RESULTS: Syntheticdata Demonstration

The synthetic dataset contained 500 records. The faculty allocation was equal by design, with 125 records (25.0%) assigned to each of the four faculty groups. This distribution reflects the construction of the demonstration dataset and does not describe the actual student population or the relative size of the faculties at the University.

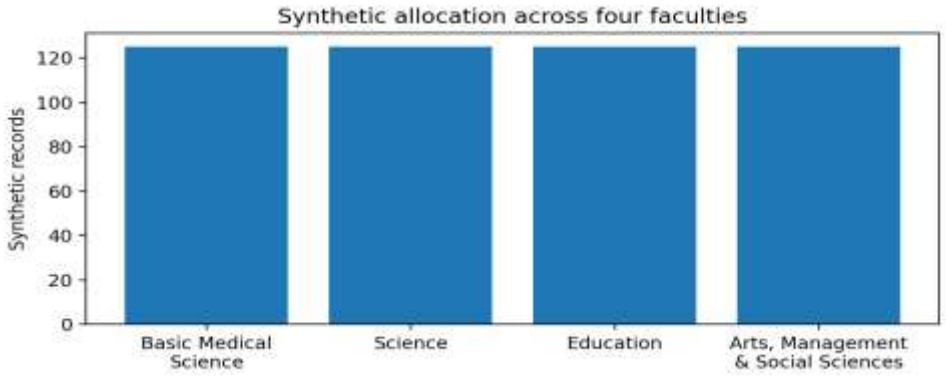

Figure 3. Equal illustrative allocation of synthetic records by faculty. Source: Authors' analysis of synthetic data.

The mean knowledge percentage was 70.3% (SD 12.0). Based on the demonstration cut-offs, 35 records (7.0%) were classified as poor, 253 (50.6%) as moderate and 212 (42.4%) as good. These categories describe the synthetic response patterns only.

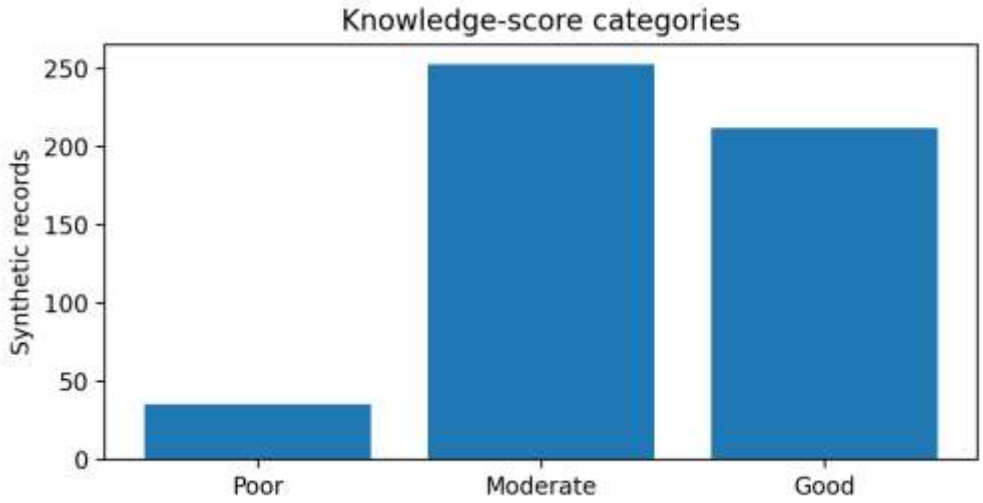

Figure 4. Knowledge-score classification in the synthetic dataset. Source: Authors' analysis of synthetic data.

The mean of the ten attitude items was 3.65 (SD 0.34) on a fivepoint scale. This mean is presented as a descriptive demonstration. Interpretation as a positive or negative attitude score would require confirmation of item direction, scale validity and the intended meaning of the response anchors.

Indicator	Synthetic count	Synthetic percentage
Reported antibiotic use in previous 12 months	297	59.4%
Self-medication coded "Yes"	137	27.4%
AMR awareness coded "Yes"	189	37.8%
Stewardship awareness coded "Yes"	171	34.2%
Poor knowledge	35	7.0%
Moderate knowledge	253	50.6%
Good knowledge	212	42.4%

The practice indicators should be interpreted with care. The self-medication percentage uses all 500 synthetic records as its denominator in this demonstration. In a real report, the denominator should follow the questionnaire skip logic and the exact definition of selfmedication. For example, if self-medication is only meaningful among respondents who used antibiotics, the prevalence should be calculated among antibiotic users and clearly labelled.

6. DISCUSSION

The principal purpose of the results section is to demonstrate how a university-level AMR KAP survey could be reported. The synthetic data show the mechanics of calculating knowledge categories, attitude means and selected antibiotic-use indicators. They do not establish the prevalence of any behaviour among actual students. This distinction is essential because fabricated or simulated responses cannot be converted into empirical evidence simply by assigning realistic demographic categories or presenting statistical summaries.

The planned study is consistent with previous Nigerian research showing that knowledge and antibiotic-use practices should be assessed together. Ajibola et al. (2018) found that recognition of the relationship between self-medication and resistance was limited among undergraduate respondents in Northwest Nigeria. That result supports the inclusion of questions about self-medication and its perceived consequences. It does not justify assuming that the same proportion applies at Zamfara State University.

Akande-Sholabi and Ajamu (2021) reported moderate overall knowledge among healthcare students, with 58.4% classified as having good knowledge. Their sample included students in health-related programmes, and the study documented substantial antibiotic use during the preceding year. The proposed university-wide assessment differs because it includes non-health disciplines. Comparisons should therefore focus on shared questionnaire concepts and should not treat differences in prevalence as evidence of better or worse knowledge unless instruments, denominators and populations are sufficiently comparable.

The NorthCentral Nigerian study by Aboh et al. (2022) provides further evidence that selfmedication and discontinuation practices warrant attention among tertiary students. A future ZAMSUT analysis should report the exact question wording, recall period and denominator for each practice. For example, stopping treatment early should be distinguished from stopping after a clinician changes the prescription, and self-medication should be distinguished from taking a previously prescribed medicine under current professional advice.

The African synthesis by Atalay and Abebe Gelaw (2024) indicates that KAP outcomes vary across studies and population groups. The pooled estimates are useful for framing the publichealth importance of the topic, but their heterogeneity limits direct comparison with a single university. A local study should be interpreted primarily in relation to its own sampling design, questionnaire validity and student composition, with regional estimates used as contextual evidence.

Stewardship awareness deserves separate attention. Jackson et al. (2023) reported that a substantial proportion of surveyed healthcare students were unfamiliar with the term antimicrobial stewardship. This finding suggests that awareness campaigns should explain practical behaviours rather than rely only on technical terminology. For general undergraduates, messages may include the difference between bacterial and viral infections, the need for professional advice, the risks of sharing antibiotics and the importance of infection prevention.

A useful university response should be proportionate to verified findings. If actual data identify low knowledge of antibiotic indications, educational content can focus on antibioticversusvirus distinctions. If students frequently obtain medicines from informal sources, the response may require improved access to qualified advice and engagement with relevant medicine outlets. If students have heard of AMR but do not recognise stewardship actions, practical demonstrations and targeted communication may be more useful than general awareness slogans. These are potential implications, not recommendations based on the synthetic percentages.

7. Strengths and limitations

A strength of the proposed design is its coverage of four faculty groups, which can provide a broader view of the undergraduate population than a study restricted to healthcare students. The questionnaire structure also separates knowledge, attitudes, practices and information sources, allowing the analysis to identify distinct educational and behavioural issues. A reproducible scoring and analysis plan can improve transparency when genuine observations are collected.

The current document has a fundamental limitation: all 500 records are synthetic. They were generated for demonstration and do not represent responses from recruited participants. The faculty allocation was imposed equally because verified faculty enrolment figures were not provided. The data therefore cannot support estimates, hypothesis tests or conclusions about actual ZAMSUT students. In addition, the attitude scale requires confirmation of item polarity and validity, and the scoring thresholds are provisional. The manuscript must be re-analysed with real data before publication.

A future crosssectional survey will also be subject to self-report and recall limitations. Participants may not remember the exact antibiotic, dose, duration or source of a medicine used several months earlier. Social desirability may lead some respondents to underreport selfmedication or nonadherence. A crosssectional design cannot establish whether knowledge

preceded behaviour or whether a particular factor caused an antibiotic-use practice. These limitations should be addressed through clear questions, a defined recall period, anonymous administration and cautious interpretation.

8. CONCLUSION AND RECOMMENDATIONS

Antimicrobial resistance requires responsible antibiotic use, infection prevention, surveillance and public education. Existing Nigerian and African studies show that knowledge, attitudes and practices are not uniform across populations, making institution-specific evidence valuable. A survey across the four named faculties at Zamfara State University could help identify gaps and guide campusbased stewardship education.

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