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Antibiotic use among university students in malaria therapy and its implications for antimicrobial resistance in Nigeria: a quantitative cross-sectional study

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Abstract

Background Antimicrobial resistance (AMR) is a global health crisis, driven partly by inappropriate antibiotic use. In Nigeria, malaria remains highly prevalent and often mismanaged with antibiotics, particularly in presumed malaria-typhoid co-infections. This study examined patterns of antibiotic use in malaria treatment among university students, highlighting implications for AMR.

Methods A cross-sectional survey was conducted among undergraduates purposively selected from 12 universities across Nigeria's six geopolitical zones. Data were collected via validated online questionnaires (February–March 2025) and analysed using descriptive statistics, chi-square tests, logistic regression, and Spearman correlation (SPSS v26).

Results Of 646 respondents, > 97% demonstrated general antibiotic knowledge, yet 27.6% misidentified chloroquine as an antibiotic. While 94.6% correctly recognised antibiotics for bacterial infections, about one-fifth believed they were effective against fungal, parasitic, or viral diseases. Despite 84.7% AMR awareness, 49.1% reported using antibiotics for malaria treatment. Misuse was highest in the Northeast (62.3%), Northwest (63.7%), and South-South (32.9%). In the Northeast, key drivers included prior experience (35.4%), pharmacist advice (29.9%), and peer influence (28.0%), while only 6.7% followed physician prescriptions. Misuse correlated with the belief that antibiotics treat all illnesses ($r_s = 0.329$, $p < 0.001$). Nearly half (49.5%) accessed antibiotics without prescriptions.

Conclusions High AMR awareness contrasts with persistent misuse of antibiotics for malaria, reflecting misconceptions, regional disparities, and weak regulation. Targeted education, stricter antibiotic controls, and improved diagnostics are urgently needed to curb AMR in Nigeria.

Keywords Antibiotic misuse, Antimicrobial resistance, Malaria, Nigeria

1 Introduction

Malaria continues to pose a major public health threat, especially across Africa, causing substantial morbidity, mortality, and economic burden. A considerable rise in the number of malaria cases in the African region was reported post-COVID-19 pandemic era, increasing from 218 million cases in 2019 to 233 million in 2022 [1]. This region bears a disproportionate share of the global malaria burden, with the World Health Organization (WHO) estimating that in 2022, 94% and 95% of all malaria cases and deaths, respectively, occurred in the African continent[2]. Within the African continent, the sub-Saharan region accounts for almost half of the cases worldwide, with Mozambique, Uganda, and the Democratic Republic of Congo making up 4.2%, 5.1% and 12.3% of the total estimate, respectively. Similarly, Tanzania, Niger, and the Democratic Republic of Congo accounted for 4.4%, 5.6% and 11.6% of global malaria deaths, respectively [2]. In Nigeria, the situation is particularly severe, with the country accounting for approximately 27% of all malaria cases and 31.1% of mortality attributed to malaria globally as of 2022 [2].

Plasmodium falciparum (*P. falciparum*) is the predominant malaria parasite species in Sub-Saharan Africa, accounting for most infections[3]. Compared to other species, *P. falciparum* is associated with severe disease and death, especially among vulnerable populations such as children under five years of age and pregnant women [4]. The high transmission rates, particularly in Sub-Saharan Africa, are attributed to favourable climatic conditions for mosquito vectors, primarily *Anopheles gambiae*, and limited access to effective prevention and treatment measures[5]. Despite notable progress in malaria control over the past two decades, the disease continues to exact a heavy toll in this region [3]. According to Shi et al. [6], children under five years of age are particularly vulnerable, accounting for 67% of all malaria deaths worldwide, while malaria in pregnancy has also been linked with adverse outcomes such as maternal anaemia, low birth weight, and increased infant mortality.

The economic burden of malaria in Sub-Saharan Africa is substantial. Direct costs, such as expenses for prevention, diagnosis, and treatment, and indirect costs comprising lost productivity due to illness and premature death, exert a huge burden on an already disadvantaged population [7]. Among children, the disease impedes economic development by affecting school attendance, while in adults, the effects include a reduction in workforce productivity and discouraging foreign investment and tourism[8]. Furthermore, it is estimated that malaria costs African economies billions of dollars annually in lost GDP[7–9]. Unfortunately, many affected populations in this region have inadequate access to prompt, accurate diagnosis and effective treatment, particularly in rural and remote areas, where it is further compounded by socio-economic factors such as poverty, poor housing conditions and limited education that contribute to increased malaria risk and hamper prevention efforts [10].

The standard treatment protocol for malaria includes artemisinin-based combination therapies (ACTs), while more serious cases are managed using injectable artesunate or artemether [11]. ACTs have become the most important medication for malaria treatment worldwide, particularly for uncomplicated *P. falciparum* malaria. The WHO recommended ACTs as the first-line treatment due to their high efficacy, rapid action, and ability to slow the development of drug resistance [12]. Artemether-lumefantrine (AL) and Artesunate-amodiaquine (ASAQ) are two of the most widely used ACTs in

Sub-Saharan Africa. Both combinations have proven highly effective in treating uncomplicated *P. falciparum* malaria and are recommended by the WHO as first-line treatments [12]. These ACTs have played a crucial role in reducing malaria morbidity and mortality across the region. Their widespread adoption has been facilitated by their efficacy, relatively good safety profiles, and availability as fixed-dose combinations, which improve treatment adherence and reduce the risk of using monotherapies [13].

Although antibiotics are not part of recommended malaria treatment, they are sometimes prescribed—often inappropriately—when bacterial infections are assumed to coexist or when malaria is wrongly diagnosed [14, 15]. In Nigeria, there is a common belief in 'malaria-typhoid co-infections', which, combined with limited access to proper diagnostics, has led to the frequent misuse of antibiotics [16, 17]. This misuse of antibiotics in the empirical treatment of 'malaria-typhoid co-infections' adds to the already serious problem of antimicrobial resistance (AMR), a challenge that has gained global attention. Antimicrobial resistance (AMR) represents a significant global health issue that jeopardises the effectiveness of antibiotics, the advancements in modern medicine, and the health of populations across the globe [18]. In 2019, AMR was linked to more than 1.27 million fatalities globally, surpassing the cumulative mortality rates associated with malaria and AIDS [19]. West sub-Saharan Africa bears the greatest burden of AMR, with a mortality rate of 27.3 in every 100,000 deaths attributable to AMR [20]. According to the WHO and other recent studies, sub-Saharan Africa currently experiences the highest death rates linked to drug-resistant infections [19, 21].

In Nigeria, the situation is worsened by factors such as self-medication, over-the-counter access to antibiotics without prescriptions, and a general lack of reliable diagnostic services [22]. In addition, the supervision of prescriptions remains inadequate, resulting in the routine sales of prescription medications, including antimicrobials and antimalarials, over the counter in pharmacies and by vendors of patent proprietary medicines [18]. Enhancing public awareness and understanding of antimicrobial resistance (AMR) among healthcare providers, policymakers, agricultural professionals, and the public remains a cornerstone of both global and national strategies to combat AMR and curb its spread [23, 24]. In addition, it is necessary to increase investments in laboratory infrastructure and manpower training in Nigeria to ensure appropriate diagnostic testing and widespread antibiotics susceptibility testing in hospitals, as these will decrease empirical treatment and the misuse of antibiotics [18].

Therefore, this study investigated how antibiotics are used in the context of malaria treatment among Nigerian undergraduate university students and pharmacists. It examined the spread of this practice, the driving factors, and the associated public health risks. By evaluating the prescribing habits, patient perceptions, and knowledge of antibiotic stewardship, the research hopes to support more focused strategies to reduce misuse and help tackle AMR.

2 Methods

2.1 Study design and sites

This descriptive cross-sectional study employed a structured questionnaire to obtain data from undergraduate students enrolled in Nigerian universities. To ensure geographical representation, universities were purposively selected across Nigeria's six geopolitical zones. The selection of universities was based on the presence of an active

Antimicrobial Resistance (AMR) club, as students in such settings provide a baseline to demonstrate distinct knowledge and practices, making them a valuable group for this preliminary study. Two universities were chosen from each zone, yielding a total of 12 participating institutions:

- **North East**: Abubakar Tafawa Balewa University, Bauchi State, and University of Maiduguri, Borno State.
- **North West**: Ahmadu Bello University, Kaduna State, and Federal University Dutsin-Ma, Katsina State.
- **North Central**: University of Abuja, Federal Capital Territory, and University of Jos, Plateau State.
- **South East**: University of Nigeria, Enugu State, and Enugu State University of Technology, Enugu State.
- **South South**: University of Uyo, Uyo State, and University of Calabar, Cross River State.
- **South West**: University of Ibadan, Oyo State, and Oduduwa University, Osun State.

Within these institutions, the questionnaire was distributed online. The specific social media platforms used included WhatsApp and Telegram, leveraging student group chats and pages. Convenience sampling was used, as participation was voluntary.

2.2 Study participants and eligibility criteria

Undergraduate students were eligible to participate if they:

- Were enrolled in any of the 12 selected universities,
- Could read and write in English, and.
- Provided informed consent to participate.

Students who did not meet all these criteria were excluded.

2.3 Sample size determination

The minimum sample size was calculated using the single proportion formula as employed by Huang and Eze [18], which is $n = Z2P(1 - P)/d2$. For this calculation, a 95% confidence level was used ($Z = 1.96$), and the margin of error (d) was fixed at 0.05. The expected prevalence (P) was set at 50% to maximise the sample size, a standard methodological approach.

2.4 Data collection procedure

The survey questionnaire was administered via Google Forms. The online questionnaire provided a summary of study information, screening questions to verify eligibility, and participant consent. Participation was voluntary, and submissions were anonymous. Participants were also informed that they could withdraw at any time before submitting the questionnaire. Data collection was conducted over a five-week period, from February 22nd to March 31 st, 2025.

While convenience sampling was employed due to the online distribution method, we acknowledge that this approach could introduce selection bias by potentially excluding students without reliable internet access or those who are less active on the designated platforms. To mitigate this, efforts were made to reduce bias by sharing the questionnaire across multiple student groups and platforms in each university. This approach aimed to capture a wide range of respondents across different faculties and levels of study, ensuring diversity while acknowledging the limitations of self-selection. The final sample included all students who responded during the data collection window, providing sufficient data for descriptive and statistical analysis of the study objectives.

2.5 Study instrument

The study instrument consisted of a pre-tested and validated self-administered online questionnaire (Supplementary file 1), which was adapted from the World Health Organization's 2015 'Antibiotic Resistance: Multi-Country Public Awareness Survey' [25] and modified to address antibiotic use in malaria therapy among Nigerian university students.

We adapted the original WHO instrument to align with the local context and study objectives. Key modifications included:

- Introducing a new section (Section D) on malaria therapy practices, with questions on malaria treatment history and the use of antibiotics for malaria, which were absent in the original tool.
- Replacing the demographic questions with items more relevant to Nigerian students, such as university and geopolitical zone.
- Streamlining the extensive list of AMR-related terms into a single, straightforward question on awareness of 'antimicrobial resistance (AMR)' to enhance clarity and improve response rates.
- Adding questions to capture local drivers of antibiotic misuse, including the roles of pharmacists, friends, and family in influencing decisions to use antibiotics for malaria.

The revised questionnaire was pre-tested with 20 pharmacy students from the University of Nigeria (UNN), Enugu Campus. UNN was chosen as it ranks in the top 1% of universities in Nigeria and the primary author works there, allowing for quick administration and feedback collection. Minor wording adjustments were made following the pre-test to improve comprehension. The internal consistency of the knowledge and attitude scales was then evaluated using Cronbach's Alpha, which produced a coefficient of 0.78, indicating acceptable reliability.

The questionnaire consisted of five sections (A–E):

- **Section A**: Collected demographic data, including gender, age group, and geopolitical zone.
- **Section B**: Assessed respondents' knowledge of antibiotics, including recognition of antibiotics, their uses, and awareness of antimicrobial resistance (AMR).
- **Section C**: Evaluated respondents' attitudes toward antibiotic use.
- **Section D**: Examined respondents' practices related to malaria therapy, including malaria treatment history and use of antibiotics in malaria treatment.
- **Section E**: Assessed awareness and understanding of antimicrobial resistance (AMR) and its link to antibiotic misuse.

2.6 Ethical considerations

Ethical approval for the study was obtained from the Research Ethics Committee of the Enugu State Ministry of Health (Approval number: MH/MSD/REC21/747) before the commencement of the study. No identifiable data was collected, and all information was securely handled and used exclusively for research purposes. Informed consent was obtained from all participants which included the publication of data collated in anonymised form. The study complied with all ethical regulations outlined in the approval letter and the Helsinki declaration for human research.

2.7 Data analysis

Data collected were exported in Microsoft Excel spreadsheet (Microsoft Office 2016) for analysis. IBM SPSS version 26 was employed to further code, clean, and analyse the data. The data was summarised using descriptive statistics, which included frequencies, percentages, means, and standard deviations.

The Chi-square test was used to assess associations between categorical socio-demographic variables (such as age group, gender, and geopolitical zone) and awareness of antibiotics. Binary logistic regression was conducted to identify predictors of antibiotic resistance knowledge. Additionally, Spearman correlation analysis was performed to examine the relationship between beliefs and practices regarding the use of antibiotics in the treatment of malaria. A p-value of < 0.05 was considered statistically significant.

3 Results

A minimum sample size of 422 was estimated, but a total of 646 undergraduate students participated in the study, giving a response rate above the calculated requirement. Although responses were obtained from all six geopolitical zones, the distribution was not balanced across regions.

3.1 Socio-demographic characteristics of participants

The socio-demographic characteristics of 646 study participants, stratified by their awareness of antibiotics, are presented in Table 1. Most participants were aged 18–24 years (71.7%), with high antibiotic awareness across all age groups: 98.7% in both the 18–24 and 25–30 age groups, and 90.9% among those above 30 years of age. A

Table 1 Socio-demographic characteristics of study participants ($N = 646$) by antibiotics awareness

Characteristics	Frequency (%)	Antibiotic awareness (%)	*p*-values
Age group			0.014
18–24	463 (71.7)	457 (98.7)	
25–30	161 (24.9)	159 (98.7)	
Above 30	22 (3.4)	20 (90.9)	
Gender			0.176
Male	315 (48.8)	308 (97.8)	
Female	331 (51.2)	328 (99)	
Geopolitical zone			0.001
North Central	145 (22.4)	144 (99)	
North East	69 (10.7)	68 (99)	
North West	102 (15.8)	95 (93)	
South East	165 (25.5)	165 (100)	
South South	85 (13.2)	85 (100)	
South West	80 (12.4)	79 (98.8)	

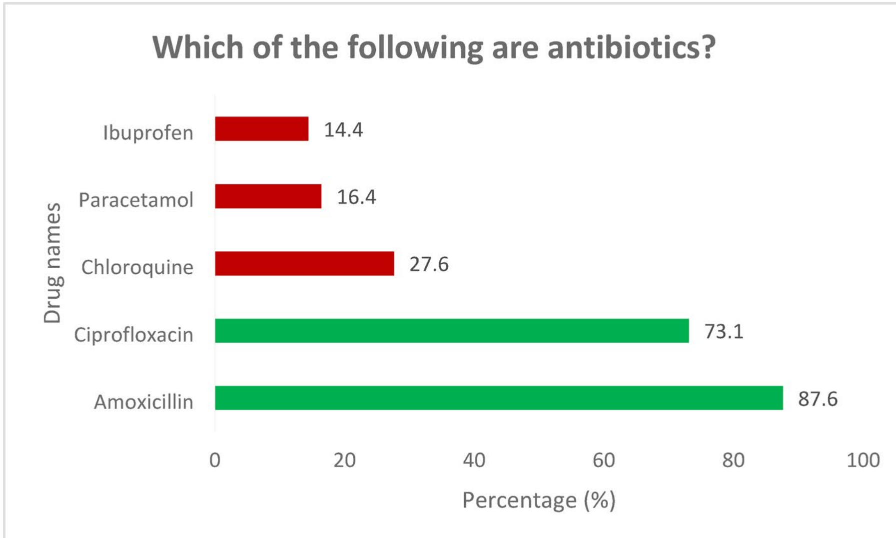

Fig. 1 Participants' identification of antibiotics: correct vs. misclassified drugs

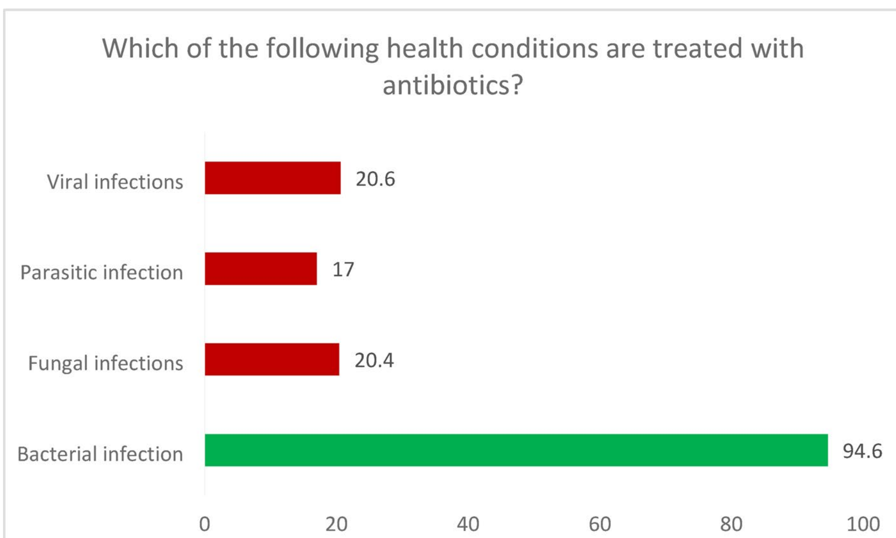

Fig. 2 Participants' understanding of health conditions treated with antibiotics: correct vs. misclassified conditions

statistically significant difference was observed ($p = 0.014$), though awareness remained high across all groups. In terms of gender, awareness was high among both males (97.8%) and females (99%), but the difference was not statistically significant ($p = 0.176$), indicating that gender did not significantly influence antibiotic awareness (Table 1).

Antibiotic awareness was high across all geopolitical zones, with the lowest awareness observed in the Northwest (93%) and the highest in the Southeast and South-south (100%). A statistically significant difference was found between geographical zones ($p = 0.001$), though the overall variation in awareness levels remains small (Table 1).

3.2 Knowledge, perception, and attitudes towards antibiotics

Figures 1 and 2 illustrate key insights into Nigerian undergraduates' knowledge and perception regarding antibiotics, including common misconceptions. While most participants correctly identified Amoxicillin (87.16%) and Ciprofloxacin (73.1%) as antibiotics, a considerable number of participants misclassified drugs like Chloroquine (27.6%), Paracetamol (16.4%), and Ibuprofen (14.4%) as antibiotics, indicating notable gaps in understanding. Similarly, although the majority recognized that antibiotics treat bacterial infections (94.6%), many respondents mistakenly believed they are effective against fungal (20.4%), parasitic (17%), or viral infections (20.6%) infections as shown in Fig. 2.

Table 2 presents data on attitudes and access-related behaviours. Attitudes varied regarding the belief that antibiotics are always needed when sick, with 33.6% disagreeing and 21.4% agreeing. Furthermore, access to antibiotics was not always prescription-based (49.5%) and 35.2% of participants agreed that antibiotics are always needed when sick, suggesting opportunities for misuse.

3.3 Knowledge, perception and attitude of antibiotics use in malaria treatment

Table 3 explores Nigerian undergraduates' knowledge, perceptions, and attitudes toward using antibiotics for malaria treatment. Over half of the participants (57.1%) reported treating malaria with a doctor's prescription, while 35.2% relied on over-the-counter (OTC) self-medication, and 7% used herbal remedies. Notably, 43.7% incorrectly believed antibiotics work against malaria, while 38.1% correctly stated they do not, and 18.3% were unsure. This misconception is reflected in the finding that 49.1% admitted to using antibiotics for malaria treatment, highlighting a concerning misuse of antibiotics for a condition they cannot treat.

3.4 Distribution of the use of antibiotics in malaria therapy among study participants across geographical zones

Figure 3 highlights the use of antibiotics for treating malaria among the participants across different geographic regions. Nearly half of the respondents (49.1%) reported using antibiotics for malaria treatment, despite the fact that antibiotics are not recommended for malaria management. The highest rates of antibiotic use were observed in the North East (62.3%) and North West (63.7%) regions, while the lowest was in the South-South (32.9%).

Conversely, 50.9% of respondents reported not using antibiotics for malaria. The highest proportion of those who refrained from antibiotic use was in the South-South (67.1%) and North Central (60.0%) regions (Fig. 3).

Table 2 Study participants' knowledge, perception, and attitude towards antibiotics

Where do you usually get your antibiotics from?	
Pharmacist with prescription	484 (74.9)
Pharmacist without prescription	207 (32.0)
Leftovers from previous prescriptions	57 (8.8)
Friends/Family	56 (8.7)
Are antibiotics always needed when you are sick?	
Agree	138 (21.4)
Disagree	217 (33.6)
Neutral	96 (14.9)
Strongly Agree	89 (13.8)
Strongly Disagree	106 (16.4)

Table 3 Study participants' (Nigerian undergraduates) knowledge, perception, and attitude of antibiotics towards malaria treatment

Questions	Frequency (%)
Last Malaria treatment	
Within the past month	197 (30.5)
3 months ago	212 (32.8)
4–6 months ago	104 (16.1)
More than 6 months ago	126 (19.5)
Never	7 (1.1)
How did you treat the malaria?	
Chemist	1 (0.2)
Pharmacist	4 (0.6)
Herbal remedies	50 (7.7)
Doctors' prescription	406 (62.9)
OTC self-medication	250 (38.7)
Treated by a Nurse	1 (0.2)
Do antibiotics work against malaria?	
Yes	282 (43.7)
No	246 (38.1)
Not sure	118 (18.3)
Have you ever used antibiotics to treat malaria?	
Yes	317 (49.1)
No	329 (50.9)

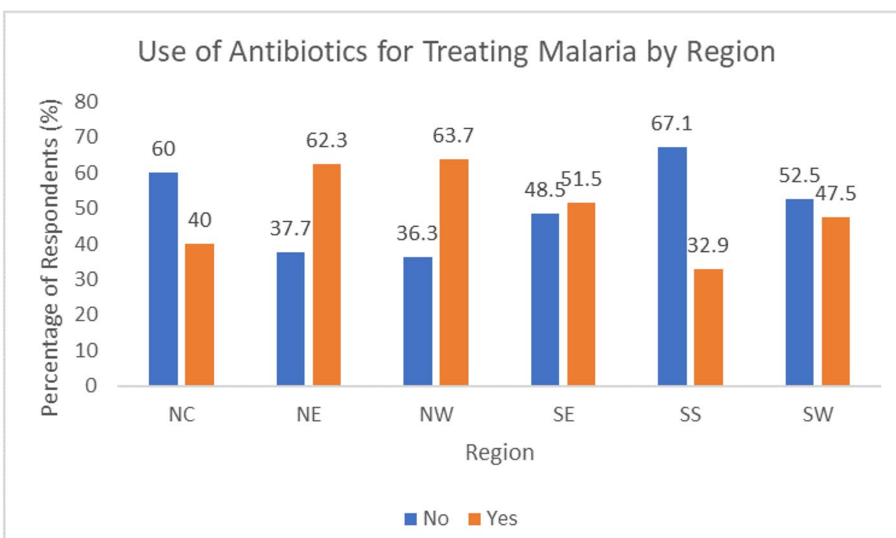

Fig. 3 Use of antibiotics for treating malaria among Nigerian undergraduates by region. NE, North East; NW, North West; NC, North Central; SE, South East; SS, South South; SW, South West

3.5 Factors affecting the use of antibiotics in malaria therapy among participants from various geopolitical zones

Figure 4 highlights the factors influencing Nigerian undergraduates' decision to use antibiotics for treating malaria. The most common reason cited was previous experience (35.4%), followed closely by advice from pharmacists (29.9%) and recommendations from friends or family (28.0%). Only a small proportion (6.7%) relied on a doctor's prescription.

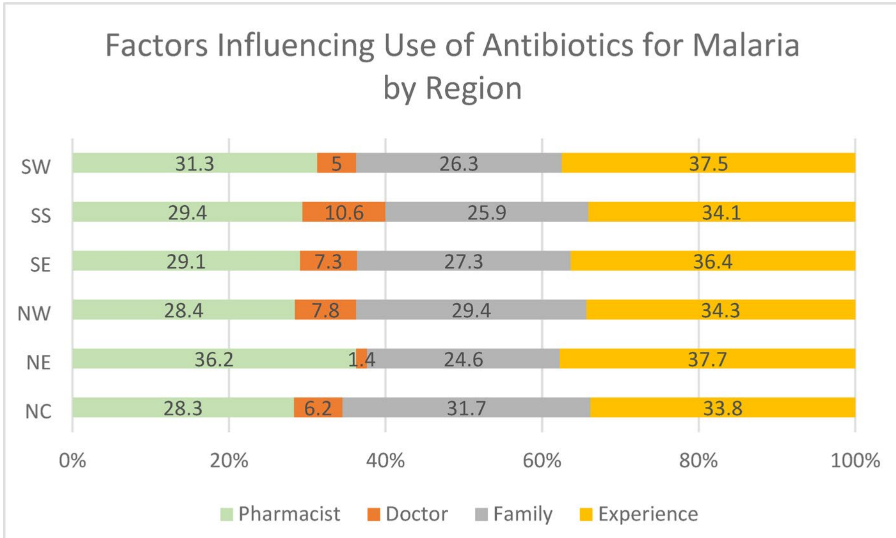

Fig. 4 Proportional factors influencing the use of antibiotics for malaria treatment among Nigerian undergraduates by region

Table 4 Antimicrobial resistance knowledge among undergraduates in Nigeria

Questions	Frequency (%)
Are you aware of antimicrobial resistance (AMR) and its consequences?	
Yes	547 (84.7)
No	99 (15.3)
Can the misuse of antibiotics contribute to AMR?	
Yes	539 (83.4)
No	107 (16.6

Variation across regions was noted in the decision-making patterns. The North East (37.7%) and South West (37.5%) had the highest reliance on previous experience, while the North Central (31.7%) and North West (29.4%) showed a strong influence from friends and family. Pharmacist advice played a significant role across all regions, ranging from 28.3% to 36.2% (Fig. 4).

3.6 Awareness and Knowledge of antimicrobial resistance among the participants

Table 4 highlights the participants' knowledge and understanding of antimicrobial resistance (AMR). Majority of the students (84.7%) reported being aware of AMR and its consequences, indicating a relatively high level of knowledge about this critical public health issue. Furthermore, 83.4% correctly recognized that the misuse of antibiotics contributes to AMR, whereas. a notable minority (15.3%) were unaware of AMR, and 16.6% did not believe that antibiotic misuse contributes to resistance.

No statistically significant associations were found between AMR awareness and gender, age group, or geopolitical zone (Table 5). Logistic regression analysis similarly indicated no significant predictors of AMR awareness. However, Spearman correlations revealed significant associations between antibiotic use for malaria and two beliefs: that antibiotics are always needed when sick ($r = 0.329$, $p < 0.001$), and that stopping antibiotics when feeling better is acceptable ($r = 0.087$, $p = 0.026$). Other factors showed no significant relationships (Table 5 & Supplementary file 2).

Table 5 Summary of statistical analyses on AMR awareness and antibiotic use factors

Analysis Type	Variable/Comparison	Test Statistic	*p*-value	Effect Size/Exp(B)	Significance interpretation
Chi-Square	Gender	χ^2 (1, $N=646$) = 0.077	0.781	—	Not significant
	Age Group	χ^2 (2, $N=646$) = 2.072	0.355	—	Not significant
	Geopolitical Zone	χ^2 (5, $N=646$) = 5.822	0.324	—	Not significant
Logistic Regression	Male vs. Female	Wald = 0.095	0.758	Exp(B) = 0.931	Not significant
	Age 18–24 vs. 31+	Wald = 1.742	0.187	Exp(B) = 3.939	Not significant
	Age 25–30 vs. 31+	Wald = 0.010	0.922	Exp(B) = 0.974	Not significant
	Geopolitical Zones vs. Southeast (all groups)	Wald = 0.200–0.932	> 0.3	Exp(B) = various	Not significant
Spearman Correlation	**Belief**: Antibiotics always needed when sick	ρ = 0.329	< 0.001	—	Moderate positive, statistically significant
	Belief: OK to stop when feeling better	ρ = 0.087	0.026	—	Weak positive, statistically significant
	Complete full course	ρ = 0.026	0.509	—	Not significant
	AMR awareness	ρ = −0.041	0.299	—	Not significant
	Belief: misuse causes AMR	ρ = −0.008	0.844	—	Not significant

4 Discussion

4.1 Use of antibiotics in malaria therapy

To our knowledge, the current study is the first to investigate antibiotic misuse specifically for malaria treatment among Nigerian university undergraduates. Our findings indicate that malaria remains a significant health challenge, with 79.4% of participants reporting treatment within the past six months and 63.3% within the last three months. This high frequency of malaria episodes often leads to self-medication and reliance on easily accessible drugs, including antibiotics [26–28]. Despite their ineffectiveness against malaria, nearly half (49.1%) of participants reported using antibiotics for treatment. This misuse is primarily driven by prescriptions from doctors (6.7%), advice from friends and family (28.0%), pharmacists (29.9%), and personal experience (35.4%). These findings suggest that both healthcare professionals and social networks perpetuate misconceptions about antibiotic misuse in malaria treatment. The high reliance on OTC self-medication and the widespread misuse of antibiotics underscores the need for targeted education and awareness campaigns to address these gaps and promote appropriate malaria treatment practices.

Our study findings show that 43.7% of participants believed antibiotics work against malaria, 38.1% correctly stated they do not, and 18.3% were unsure. The misconception that antibiotics are effective for malaria treatment persists as a significant public health challenge in the tropical regions where malaria is endemic. While the WHO recommends empirical antibiotic use in children with severe malaria due to potential bacterial co-infections [29, 30] this guideline applies primarily to hospitalized patients [31] and does not explain the widespread belief that antibiotics treat malaria. Our study participants are mostly young adults (71.7% aged 18–24 years; 24.9% aged 25–30 years), underscoring that this misconception extends beyond paediatric cases. The high rate of antibiotic misuse in our study may be attributed to a combination of diagnostic uncertainty, overlapping symptoms with other febrile illnesses, limited access to reliable laboratory tests, and widespread self-medication practices. These factors are well-documented contributors to inappropriate antibiotic use in Nigeria [18, 32].

This current study also shows that the highest rates of antibiotic use in malaria treatment were observed in the North East (62.3%) and North West (63.7%) regions, while the lowest was in the South-South region (32.9%). These regional differences may be driven by broader healthcare inequities, including disparities in healthcare access, diagnostic availability, and public health awareness [33]. In northern regions, limited access to healthcare facilities often leads to presumptive treatment of febrile illnesses with antibiotics, a pattern that may influence students' health-seeking behaviours [33]. In contrast, the southern regions benefit from better healthcare infrastructure and stronger public health interventions, which may contribute to lower misuse rates among students [34]. In previous studies conducted in Northern Nigeria, 21.3% of respondents considered malaria a condition requiring antibiotics, while 14.5% of undergraduates admitted to self-medicating with antibiotics for treatment [35, 36]. Similarly, in urban centres like Lagos and Abuja, 55.3% of adults incorrectly attributed malaria to bacterial causes, and 48.0% believed antibiotics were necessary for treatment [37]. This issue of antibiotic misuse in malaria treatment is not confined to Nigeria. For instance, 42% of malaria patients received unnecessary antibiotic prescriptions in Uganda [38], while antibiotics were frequently used for non-bacterial infections, including malaria in India [39]. In Japan, similar patterns of antibiotic misuse have been documented [40].

4.2 Knowledge, awareness, and attitudes towards antibiotic use

High levels of antibiotic awareness among Nigerian undergraduates, as observed in this study, reflect trends reported in similar populations both within and outside Nigeria. Previous research involving pharmacy students, non-healthcare students, and university residents has consistently reported moderate to high awareness, though often alongside significant misconceptions about proper use and indications [23, 35, 36]. In this study, the near-universal recognition of commonly used antibiotics such as Amoxicillin (87.6%) and Ciprofloxacin (73.1%) is encouraging. However, the misidentification of non-antibiotics like Paracetamol (16.4%), ibuprofen (14.4%), and Chloroquine (27.6%) echoes findings from other studies, indicating persistent gaps in basic knowledge of antibiotics [23, 35]. Although the majority of participants in our study recognized that antibiotics treat bacterial infections (94.6%), many respondents mistakenly believed they are effective against fungal (20.4%), parasitic (17%), or viral infections (20.6%).

A consistent concern across multiple studies is the belief that antibiotics are general-purpose remedies, used even when not medically indicated. This includes common use for conditions such as malaria, colds, and flu — illnesses not typically caused by bacteria [23, 34–36]. Such misuse is often rooted in limited pharmacological understanding and a failure to appreciate antibiotic specificity, despite high self-reported awareness. Even among final-year pharmacy students in northern Nigeria, less than half felt confident that their knowledge of antibiotic use and antimicrobial resistance (AMR) was sufficient for their future roles [35]. These findings suggest that awareness, while necessary, does not guarantee accurate application. The issue of informal and unregulated antibiotic access further complicates responsible use. Our study reinforces previous reports that antibiotics are frequently obtained without prescriptions, with students relying on unlicensed outlets or advice from non-professionals [36]. In Zambia, 76.7% of university students admitted to self-medicating with antibiotics without proper guidance[23]. These patterns reflect broader regulatory gaps and ingrained individual behaviours that treat antibiotics as routine medication.

Attitudes captured in this study — such as the belief that antibiotics are always needed when sick — mirror earlier findings from both healthcare and non-healthcare contexts. For instance, Nigerian healthcare workers have acknowledged their role in AMR but still prescribe antibiotics unnecessarily for viral infections like sore throats and measles, often "to be on the safe side."[34]. Likewise, many pharmacy students have expressed a desire for further training, reflecting self-perceived inadequacies despite exposure to relevant content [35]. This dissonance between knowledge and attitude underscores the complexity of antibiotic misuse, particularly in malaria treatment, where misconceptions remain prevalent.

4.3 Knowledge and awareness of antimicrobial resistance (AMR)

In this study, 84.7% of participants reported awareness of AMR and its consequences, while 83.4% correctly identified that misuse of antibiotics contributes to resistance. Despite these figures, the continued use of antibiotics for treating malaria illustrates a recurring pattern: awareness does not consistently translate into responsible behaviour [41]. This aligns with existing literature, where awareness levels, though high, coexist with poor antibiotic practices [23, 35]. Similar trends have been observed among healthcare professionals, who, despite recognising AMR as a global threat, frequently engage in inappropriate prescribing [34, 42]. Among student populations, both medical and non-medical, awareness of AMR often fails to lead to rational antibiotics use, revealing persistent knowledge-practice gaps [43–45]. While educational interventions have improved awareness to some extent, misconceptions remain, limiting their effectiveness [45].

System-level constraints further complicate AMR management. Inadequate laboratory facilities, high costs of testing, and limited access to rapid diagnostics encourage empirical antibiotic use [18, 34]. For example, medical laboratory scientists in Nigeria often face obstacles in performing susceptibility testing, reducing the ability to make evidence-based prescribing decisions [18]. These infrastructural limitations partly explain why even informed individuals may engage in antibiotic misuse. In addition, public misunderstanding also plays a role. Many remain unaware that antibiotics do not treat viral infections and that improper use worsens resistance [23, 32, 36]. The widespread availability of antibiotics through informal providers — including patent medicine vendors and unregulated sellers — perpetuates this problem [32, 36], highlighting regulatory and public health communication deficits.

Taken together, the findings from this study and broader literature reflect a consistent pattern: high awareness of antibiotics and AMR does not automatically translate into proper use. Misconceptions about malaria treatment, unregulated access, and structural barriers all contribute to this disconnect, emphasising that knowledge alone is insufficient to ensure rational antibiotic use.

This study has some limitations. The selection of participants from universities with active AMR clubs may limit generalizability, as it excludes non-student populations, rural communities, younger adolescents, and older adults who might have different antibiotic use behaviours. However, the persistence of inappropriate antibiotic use even among this presumably informed group underscores that awareness alone does not guarantee proper practice. Despite these limitations, the study highlights critical gaps between knowledge and behaviour, emphasizing the urgent need for targeted, context-specific interventions.

The findings of this study suggest several avenues for targeted interventions against antibiotic misuse in malaria therapy. In Nigeria, public health campaigns should directly confront the widespread myth of 'malaria-typhoid co-infection' and emphasize that antibiotics are not effective against malaria. At the same time, regulatory authorities need to strengthen enforcement of prescription-only policies to reduce over-the-counter access to antibiotics. Beyond Nigeria, the results point to a regional challenge shared across malaria-endemic countries in Africa. Regional health bodies can build on these insights by creating standardized educational resources and developing cross-border antimicrobial stewardship initiatives that specifically address this form of misuse. At the global level, the study highlights that awareness of antimicrobial resistance (AMR) on its own is not enough. Global health policy must therefore prioritize investment in affordable, rapid diagnostic tools and in reliable access to effective antimalarials in low-resource settings. Such measures address the root drivers of empirical treatment and move the response from awareness-raising alone toward sustainable system-level solutions.

5 Conclusion

This study presents information on antibiotic misuse specifically for malaria treatment among Nigerian university undergraduates across various Universities and geographical zones. Our findings indicate that malaria remains a significant health challenge, and the misuse of antibiotics in malaria treatment is prevalent among the surveyed students. There were high levels of awareness among the participants, but the misidentification of non-antibiotics highlights persistent gaps in basic knowledge of antibiotics. Also, majority of the participants had high awareness of AMR and its consequences and correctly identified that misuse of antibiotics contributes to resistance. However, the continued use of antibiotics by nearly half of the students for treating malaria illustrates that awareness does not consistently translate into responsible behaviour. Diagnostic challenges, financial constraints, and lack of regulatory mechanisms are known to exacerbate the misuse of antibiotics in malaria therapy. Therefore, there is a need for increased investments in laboratory infrastructure, targeted education and awareness campaigns to address these gaps, and promote appropriate malaria treatment practices.

Supplementary Information

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Additional file 1.

Additional file 2.

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Author contributions
VEA: Conceptualisation, Formal analysis, Project administration, Writing—review & editing. USN, AH, IO, AEO, HYA: Data curation (investigation). AH, OSU: Writing—original draft, Writing—review & editing. MOA: Conceptualisation, Writing—review & editing. JO, UE : Methodology, Writing—review & editing.

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Data availability
All data generated or analysed during this study are included in this published article [and its supplementary information files].

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the ethical standards of the institutional and national research committees, and with the 1964 Helsinki Declaration and its later amendments. Ethical approval for the study was obtained from the Research Ethics Committee of the Enugu State Ministry of Health (Approval number: MH/MSD/REC21/747). Informed consent was obtained from all participants before their involvement in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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