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Antibiotic use among university students: insights from a Nigerian institution

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Abstract

Background Antimicrobial resistance, anticipated to cause 10 million deaths and cost $100.2 trillion by 2050, is particularly severe in West Africa. While bacteria naturally resist antibiotics over time, their misuse intensifies resistance. Given the rising trend of antibiotic misuse in Nigeria, especially among the youth, this study explores this misuse among Federal University of Technology Owerri (FUTO)undergraduates.

Methods Using a cross-sectional design, the study assessed FUTO undergraduate students' knowledge, misuse, patterns, and perception of prescription needs, and identified commonly misused antibiotics. We categorized faculties as health-based or non-health-based. From these categories, students were randomly chosen and surveyed using a semi-structured questionnaire that was based on established research.

Results Out of 400 students surveyed, 60.0% (240 students) displayed inadequate knowledge (Fair) about antibiotic use and resistance, whereas 33.0% (132 students) demonstrated poor knowledge, and only a handful, 7% had good knowledge. More concerning, 67.0% (268 students) reported fair antibiotic usage practices, 26.5% had poor practice with only 6.5% had good practice. The most frequently misused antibiotics were Amoxcillin, Ampiclox, and Tetracycline, often for conditions like Typhoid, Cough, and Catarrh. A significant correlation ($p < 0.037$) was found between students' antibiotic knowledge and their usage practices. However, no statistically significant difference in knowledge and practices was observed between students from health and non-health-based faculties.

Conclusion Undergraduate students at FUTO exhibit both a knowledge gap and misuse patterns concerning antibiotics. Implementing educational interventions, like antimicrobial stewardship programs, is essential. Given these findings, especially in the West African context, the inclusion and education of undergraduate students remain crucial.

Keywords Antibiotics, Antimicrobial resistance, Antibiotics misuse, University student antimicrobials, Bacteria

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Background

Antimicrobial resistance (AMR) is a pressing global public health crisis, posing substantial societal, economic, and health challenges [1]. Once considered revolutionary "magic bullets" in the fight against bacterial infections, antibiotics significantly advanced modern medicine during their golden era from the 1930s to the 1960s [2]. However, their widespread misuse and overuse have fueled the rise of resistant bacterial strains, undermining the effectiveness of these critical life-saving treatments [3].

Although bacteria can naturally develop resistance, human practices—such as over-the-counter sales, self-medication, and inappropriate prescriptions—accelerate this process [4, 5, 6]. In Nigeria, the situation is particularly alarming. Studies from different geopolitical zones have reported high levels of antibiotic misuse among undergraduates. For instance, research at Ahmadu Bello University in northern Nigeria revealed a high prevalence of self-medication with antibiotics among students [7], investigations in southeastern Nigeria found that even medical undergraduates, despite having good knowledge, often engage in poor antibiotic practices [8]. Similar trends have also been observed in studies from western regions, highlighting a nationwide challenge [9].

The COVID-19 pandemic further compounded the problem, as the increased use of broad-spectrum antibiotics in managing COVID-19 cases may inadvertently promote AMR [10]. Globally, antibiotic-resistant infections contribute to millions of cases of morbidity and thousands of deaths annually, and projections suggest that if unaddressed, AMR could lead to nearly 10 million deaths per year by 2050 [11, 12].

In Nigeria, the misuse of antibiotics extends to unconventional practices as well. For example, the use of Ampicillin-cloxacillin (Ampiclox®) as an emergency contraceptive among young women—based on the mistaken belief that it can prevent conception after unprotected sex—exemplifies the dangerous misconceptions fueling antibiotic resistance [13]. The unregulated distribution of antibiotics and the lack of stringent policies further exacerbate this issue.

Given these concerns, there is an urgent need to assess antibiotic use behaviors among Nigerian undergraduates. Understanding their knowledge, practices, and perceptions is crucial for designing targeted interventions to mitigate AMR. Therefore, this study aims to assess the knowledge, practices, perceptions, and misuse of antibiotics among undergraduate students at the Federal University of Technology Owerri (FUTO), making it the first comprehensive investigation that includes both medical and non-medical students in southeastern Nigeria.

Methods

Study population and design

This study aimed to assess the knowledge, practices, perceptions, and misuse of antibiotics among undergraduate students at the Federal University of Technology Owerri (FUTO) during the 2023 academic session. It encompassed both male and female students from 100 to 500 levels. Only undergraduate students of FUTO as of the 2023 session, from 100 level to final year were included in this study. Also, only students, who gave consent to the study, were included. Both male and female students were recruited for the study. A descriptive cross-sectional research design was employed to evaluate the extent and nature of antibiotic misuse within this population.

Study sample size Estimation

The sample size was determined using the Taro and Yamane formula (1967) for sample size determination.

$n = N/\ 1 + Ne^2$

Where

n = the desired sample size

N = the estimated population size of undergraduates of FUTO (25,520) as obtained from the university student affairs office

e = margin of error at 5% = (0.05)

Therefore,

$n = 393.8$

Adjusting for a 10% rate of non-response and invalid response (i.e. 90% expected response rate = 0.9)

n = n/expected response rate

394/0.9

$n = 437.7$

Sampling techniques

A stratified simple random sampling technique was employed to select faculties from FUTO's registry. The university's 10 faculties were categorized into health-based and non-health-based faculties. Health-based faculties included the School of Basic Medical Science (4 departments), School of Health Technology (6 departments), and School of Biological Sciences (5 departments), totaling 15 departments. Non-health-based faculties included the Schools of Engineering and Engineering Technology (10 departments), Environmental Science (6 departments), Management Technology (5 departments), Information and Communication Technology (4 departments), Physical Sciences (6 departments), Agricultural and Agricultural Technology (7 departments), and Electrical Systems Engineering Technology (5 departments), totaling 43 departments.

A balloting method was used to randomly select 10 departments from the health-based faculties and 21 departments from the non-health-based faculties, ensuring proportional representation. This resulted in a total

of 31 departments selected for the study. From these departments, students who provided informed consent were randomly chosen to participate.

Instrument for data collection

The data collection instrument was a semi-structured questionnaire developed through a comprehensive review of relevant literature. To ensure validity, the questionnaire underwent expert evaluation and was pre-tested among students at Imo State University, a location outside the study area. This pre-test helped assess clarity, reliability, and question structure, leading to minor modifications based on feedback to enhance comprehension. The final questionnaire comprised five sections: socio-demographic characteristics of respondents, knowledge of antibiotic use and resistance, practices related to antibiotic use, perspectives on obtaining prescriptions, and common antibiotics used. To assess internal consistency, a Cronbach's alpha reliability test was conducted, yielding a coefficient of 0.82, indicating good reliability.

Method of data analysis

Data analysis was conducted using SPSS version 22.0. Descriptive statistics, including frequencies and percentages, were used to summarize the data. To assess relationships, inferential statistical tests were applied. Specifically, a Chi-square test was performed to determine the association between knowledge and practice of antibiotic use/resistance. A p-value < 0.05 was considered statistically significant.

Ethical considerations

The study strictly adhered to the ethical principles of the Declaration of Helsinki and received ethical approval from the Public Health Department Ethical Committee at the Federal University of Technology Owerri (FUTO), Nigeria, under approval number: 00010/FUTO/PUHEC/P104. Prior to participation, informed consent was obtained from all participants to ensure ethical compliance and voluntary involvement.

Results

Socio-demographic characteristics

Out of the 434 questionnaires distributed, 400 were completed and analyzed. Most respondents (58.3%) were between 21 and 25 years old. More than half (55.3%) were male, while females accounted for 44.8%. Participants were drawn from 31 departments, 10 belonging to health-related disciplines and 21 from non-health fields. Most respondents (43.5%) were in their final year (500 level), while first-year students (100 level) constituted the smallest proportion (18.8%) (Table 1).

Knowledge of antibiotic use and resistance

Most respondents (79.0%) correctly identified that people, not just bacteria, can develop resistance to antibiotics. Additionally, 78.5% understood that bacteria can become resistant to antibiotics. However, misconceptions were observed; for instance, 60.0% mistakenly believed that antibiotics treat infections caused by fungi, viruses, and bacteria. Awareness of antibiotic resistance as a global issue was mixed, with 50.0% recognizing its severity, while 27.3% underestimated the problem. Furthermore, only 29.8% knew that resistance could spread from animals to humans, and 24.0% knew that resistance could transfer between individuals. Encouragingly, 82.8% acknowledged that proper antibiotic use reduces the risk of resistance (Table 2).

Knowledge level

Respondents' knowledge levels were assessed using a grading system (Poor: 0–4, Fair: 5–7, Good: 8–11). The majority (60.3%, CI: 55.5–65.3) had fair knowledge, while **32.0% (CI: 27.0–36.3)** had poor knowledge, and only **8.0% (CI: 5.5–10.5)** demonstrated good knowledge. These findings highlight a significant gap in antibiotic knowledge, contributing to the risk of misuse.

Attitudes and practices toward antibiotic use

Regarding prescription adherence, nearly half (48.5%) **a**lways obtained a prescription before taking antibiotics, while 49.8% did so sometimes and 1.8% never sought a prescription. A concerning trend was observed in adherence to prescribed antibiotic courses—only 43.8% always completed their treatment, while 45.5% did so sometimes, and 10.8% never completed the full course. Similarly, 25.5% admitted to saving leftover antibiotics for future use, and 16.8% shared leftover antibiotics with family or friends. However, 73% always checked the expiry date before purchasing antibiotics, indicating some level of responsible use (Table 3).

Practice and attitude grading

When categorized into Poor (0–10), Fair [11, 12, 13, 14, 15, 16], and Good (17–20), 67.3% of respondents demonstrated a fair attitude toward antibiotic use (CI: 63.0–71.8), while 26.5% had poor attitudes (CI: 22.0–30.8), and only 6.3% had good attitudes (CI: 4.0–8.8).

Perception of prescription sources

A significant majority (82%) of respondents believed that doctors should be the primary source of antibiotic prescriptions, while 41% considered pharmacists as an alternative source. A smaller proportion (6.25%) believed parents should be a valid source of antibiotic prescriptions, while 4.5% relied on information from the Internet. Additionally, 2.25% mentioned elderly people, 0.75%

Table 1 Socio-demographics of the respondents ($n = 400$)

Variables	Frequency (N)	Percentage (%)
Age Group		
15–20 years	129	32.3
21–25 years	233	58.3
26–30 years	38	9.5
Gender		
Male	221	55.3
Female	179	44.8
Course of study		
Non-health courses		
Agric and Bio-resource Engineering	11	2.8
Chemical Engineering	11	2.8
Chemistry	12	3.0
Civil Engineering	8	2.0
Computer Science	8	2.0
Crop science Technology	16	4.0
Animal Science Technology	12	3.0
Electrical and Electronic Engineering	14	3.5
Environmental management	10	2.5
Fishery	18	4.5
Food Science Technology	16	4.0
Agric Economics	10	2.5
Geology	17	4.3
Material & Metallurgical Engineering	17	4.3
Mathematics	13	3.3
Mechanical Engineering	14	3.5
Building Technology	7	1.8
Petroleum Engineering	24	6.0
Polymer and Textile Engineering	15	3.5
Agric Extension	14	3.8
Urban and Regional Planning	7	1.8
Health-based courses		
Anatomy	8	2.0
Dental technology	11	2.8
Biochemistry	10	2.5
Biology	4	1.0
Biotechnology	6	1.5
Medicine & Surgery	18	4.5
Microbiology	14	3.5
Public Health	24	6.0
Prosthetics & Orthotics	19	4.8
Optometry	11	2.8
Level of Study		
100 Level	75	18.8
200 Level	82	20.5
300 Level	66	16.5
400 Level and Above	177	44.3

relied on friends, and only 0.5% considered nurses as a source of antibiotic prescriptions.

Attitudes toward seeking medical prescriptions

When asked whether medical doctors should be the only source of prescriptions, 38.0% of respondents affirmed this belief, while 57.3% disagreed, and 4.8% were uncertain. Additionally, 68.0% of respondents agreed that one should always seek a prescription from a doctor before using antibiotics, while 30.5% believed it was only necessary sometimes, and 1.5% stated that seeking a doctor's prescription was never necessary.

Table 2 Knowledge about antibiotics use and resistance ($n=400$)

Variables	Frequency	Percentage (%)
People can become resistant to antibiotics.		
Yes	316	79.0
No	34	8.5
I don't know	50	12.5
Antibiotics are not supposed to kill all bacteria in the body.		
Yes	265	66.3
No	101	25.3
I don't know	34	8.5
The body can usually fight mild infections on its own without antibiotics.		
Yes	367	91.8
No	24	6.0
I don't know	9	2.3
Antibiotics treat infections from fungi, virus, and bacteria?		
Yes	240	60.0
No	100	25.0
I don't know	60	15.0
Antibiotics often cause side effects such as diarrhea		
Yes	153	38.3
No	87	21.8
I don't know	160	40.0
Bacteria can become resistant to antibiotics.		
Yes	314	78.5
No	35	8.8
I don't know	51	12.8
Antibiotics resistance is not a big problem in the world?		
Yes	109	27.3
No	200	50.0
I don't know	91	22.8
Antibiotics resistance can spread from animal to humans.		
Yes	119	29.8
No	153	38.3
I don't know	128	32.0
Antibiotics resistance can spread from person to person.		
Yes	96	24.0
No	231	57.8
I don't know	73	18.3
People traveling outside their home country risk bringing resistance upon return to their country		
Yes	141	35.3
No	138	34.5
I don't know	121	30.3
Taking antibiotics correctly may reduce risk of resistance		
Yes	331	82.8
No	43	10.8
I don't know	26	6.5

Commonly used antibiotics without a Doctor's prescription

The study also examined common antibiotics that respondents used without consulting a doctor. Ampiclox was the most frequently used, reported by 71.25% of participants, followed by Amoxicillin at 64.0% and Ciprofloxacin at 45.5%. Other commonly used antibiotics included Tetracyclines (40.5%), Erythromycin (15.25%), and Levofloxacin (7.75%). Only 2.0% of respondents reported that they had never taken antibiotics without a doctor's prescription.

Conditions for which respondents used antibiotics without a prescription

Typhoid fever was the most common illness for which respondents self-medicated with antibiotics, reported by 65.0% of respondents. Cough and catarrh followed

Table 3 Practice and Attitude to antibiotics use ($n=400$)

Variables	Frequency	Percentage (%)
Do you always get a prescription before starting antibiotics?		
Always	194	48.5
Sometimes	199	49.8
Never	7	1.8
Do you stop taking prescribed antibiotics after the symptoms reduced?		
Always	126	31.5
Sometimes	210	52.5
Never	64	16.0
Do you complete the course of the prescribed antibiotic treatment?		
Always	175	43.8
Sometimes	182	45.5
Never	43	10.8
Do you take the correct dose of your antibiotics at the right time for the full duration?		
Always	197	49.3
Sometimes	189	47.3
Never	14	3.5
Do you save the remaining antibiotics for next time you get sick?		
Always	102	25.5
Sometimes	150	37.5
Never	148	37.0
Do you give leftover medication to friends or family if they get sick?		
Always	67	16.8
Sometimes	166	41.5
Never	167	41.8
Do you prefer taking antibiotics when you have a cough or sore throat?		
Always	63	15.8
Sometimes	165	41.3
Never	172	43.0
Do you check the expiry date of the antibiotics before using it?		
Always	292	73.0
Sometimes	76	19.0
Never	32	8.0
Do you buy the same antibiotics you previously used when sick, because they helped you get better when you had the same symptoms?		
Always	177	44.3
Sometimes	199	49.8
Never	24	6.0
Do you always use doctor's prescription to purchase antibiotics?		
Always	147	36.8
Sometimes	232	58.0
Never	21	5.3

closely at 47.5%, while 27.75% reported using antibiotics to treat wounds. Additionally, 25.5% used antibiotics as a preventive measure against diseases, while 20.0% used them to treat diarrhea. A small percentage (2.5%) admitted to using antibiotics as a contraceptive method, and 5.25% used them for various other conditions, including malaria and boils. Meanwhile, 1.5% of respondents indicated that the question did not apply to them.

Association between socio-demographic characteristics, knowledge, and practice

Participants from health-related departments demonstrated significantly higher knowledge and better antibiotic use practices compared to those from non-health-related departments ($p=0.030$ and $p<0.001$, respectively). Additionally, the level of study was significantly associated with better antibiotic use practices,

Table 4 Association between socio-demographics and the level of Knowledge and Practice

Variables	Knowledge Mean ± SD	Beta Coef (95% CI)	*P* value	Practice Mean ± SD	Beta Coef (95% CI)	*P* value
Gender						
Male	5.27 ± 1.54	0.1 (-0.3–0.4)	0.718	12.15 ± 3.05	0.4 (-0.2–0.9)	0.234
Female	5.33 ± 1.68			12.5 ± 2.72		
Age (years)						
15–20 years	5.4 ± 1.66	0.1 (-0.4–0.2)	0.388	12.6 ± 3.16	0.2 (-0.6–0.3)	0.540
21–25 years	5.26 ± 1.55			12.09 ± 2.76		
26–30 years	5.19 ± 1.73			12.73 ± 2.89		
Level of education 100 level						
100 level	5.35 ± 1.69	0.03 (-0.1–0.1)	0.537	12.88 ± 3.03	-0.2 (-0.4 - -0.1)	0.007
200 level	5.56 ± 1.65			12.78 ± 3.17		
300 level	4.92 ± 1.5			12.06 ± 2.47		
400 level	5.67 ± 1.15			12.33 ± 5.03		
500 level	5.29 ± 1.56			11.94 ± 2.81		
Department of study						
Health-based	5.56 ± 1.66	-0.4 (-0.7 - -0.1)	0.030	13.08 ± 2.99	-1.1 (-1.7 - -0.5)	< 0.001
Non health based	5.18 ± 1.56			11.96 ± 2.81		
Knowledge grade						
Poor				11.96 ± 3.01	0.3 (-0.2 – 0.8)	0.284
Fair				12.53 ± 2.86		
Good				12.06 ± 2.83		

Table 5 Association between practice and knowledge of antibiotics use/resistance

			Knowledge of use/resistance		Antibiotic	Pearson/Chisquare	*p*-value (< 0.05)
			Poor	Fair	Good		
Practice usage	Antibiotics	Poor	51(48.1%)	48(45.3%)	7(6.6%)	16.162[a]	0.003
		Fair	72(26.9%)	176(65.7%)	20(7.5%)		
		Good	9(34.6%)	16(61.5%)	1(3.8%)		

indicating that higher academic levels corresponded to improved practices ($p = 0.007$) (Table 4).

Relationship between knowledge and practice of antibiotic use

A statistically significant association was observed between knowledge and practice regarding antibiotic use ($p < 0.05$). Respondents with poor knowledge exhibited poor antibiotic use practices, while those with fair and good knowledge demonstrated correspondingly better practices. This result led to the rejection of the null hypothesis, confirming a positive correlation between knowledge and practice in antibiotic use (Table 5).

Discussion

From the present study, there is evidence of irrational antibiotic use among undergraduates, as many engaged in self-medication practices without proper indication and often prematurely discontinued their antibiotic regimens. The findings indicate that the overall knowledge regarding antibiotic use and resistance was suboptimal, with 60.0% of respondents demonstrating only fair knowledge, 23.0% showing poor understanding, and a mere 7.0% exhibiting good knowledge. Such inadequate knowledge appears to be a major contributor to the misuse of antibiotics. This is in line with *Haque et al.* [14] research which showed that more than half of the respondents had inadequate knowledge about antibiotic use [14].

Notably, several instances of antibiotic use without proper medical guidance were observed. Respondents reported self-medicating with antibiotics for conditions such as typhoid fever (65%), cough and catarrh (47.5%), and for prophylactic purposes (25.5%), as well as for other ailments like diarrhea, malaria, boils, and wounds. While antibiotics are essential for treating bacterial infections such as typhoid fever, their use without proper diagnosis and prescription increases the risk of inappropriate treatment, delayed recovery, and antimicrobial resistance. This pattern of self-medication aligns with previous studies that have documented widespread antibiotic misuse, particularly for respiratory and gastrointestinal infections [15, 16]. The indiscriminate use of antibiotics without diagnostic confirmation highlights a significant gap in awareness and contributes to the growing threat of antibiotic resistance.

The study also revealed that the most common self-prescribed antibiotics were Ampiclox (71.25%), Amoxicillin (64.0%), Ciprofloxacin (45.5%), and Tetracycline

(40.5%). These agents are among the most frequently abused in Nigeria, as previously reported by Igbeneghu [17], who also noted a high incidence of bacterial resistance to these drugs. The predominant use of these antibiotics, especially those that are β-lactamase sensitive, raises concerns about their diminishing efficacy, as their resistance profiles are well documented both locally and in similar settings [9].

Furthermore, the practices surrounding antibiotic adherence were found to be inadequate. A considerable proportion of respondents either did not complete the prescribed or recommended course or discontinued treatment once symptoms subsided. Such non-compliance, whether due to forgetting doses or improper storage and disposal of leftover medications, can lead to subtherapeutic exposure and promote the development of resistant strains. Improper disposal practices, such as discarding leftover antibiotics in household waste or flushing them down the toilet, have also been implicated in the propagation of resistant bacteria in the environment, as documented in previous studies [18].

While these findings align with several aspects of existing literature, particularly the association between poor knowledge and suboptimal antibiotic practices [19], they also highlight critical areas for improvement. The observed discrepancies between knowledge and behavior suggest that even among a relatively educated population, misconceptions and inappropriate practices persist. The evidence from this study corroborates previous research indicating that inappropriate antibiotic use, characterized by self-medication, incorrect indications, and non-adherence to prescribed regimens, is prevalent among undergraduates. This behavior not only contributes to the increasing problem of antimicrobial resistance but also reflects a broader need for enhanced education and stricter regulatory measures in the management of antibiotic use.

Contribution to knowledge

This study has significantly contributed to the body of knowledge by providing evidence-based insights into the knowledge, practices, and perceptions of FUTO undergraduate students regarding antibiotics. To the best of our knowledge, no previous study has explored this aspect among FUTO students, making this the first research to address antibiotic misuse among both medical and non-medical students at a university in southeastern Nigeria. Additionally, this is the first comprehensive study in the region to examine antimicrobial misuse across these two student groups. The findings are crucial in the ongoing efforts to combat antimicrobial resistance.

Conclusion

In conclusion, this study pinpointed the inadequate knowledge and practice of antibiotics use among FUTO undergraduate students. This inadequate practice/misuse of antibiotics is a contributing factor to the growing resistance strains of bacteria. Those from health-based departments who in expectation are meant to have more knowledge, were reported to also have inadequate knowledge in correlation to those in non-health-based departments. This low level of knowledge and inappropriate practice among students calls for an urgent need to improve efforts to mitigate the rising threat of resistance.

Recommendation and future research

Following the evidence provided in this research, we recommend that.

1. Sensitization programs tailored towards antibiotics stewardship should be deployed using all means necessary including social media, physical workshops, etc.
2. Extra-curriculum syllabus or program should be inculcated in the university course load to help improve students' knowledge as adequate knowledge breed's good practice.
3. It is necessary to strategically and effectively implement the National Antimicrobial Action Plan. Agencies such as National Agency for Food and Drug Administration and Control (NAFDAC) should fulfill their duties of controlling or regulating the production and use of these drugs.
4. Further research should be conducted to determine the effectiveness of antimicrobial stewardship programs in improving practice and use of antibiotics as our research showed that knowledge of antimicrobial resistance greatly influences practice, hence experimental research in this area would help in the fight against antimicrobial resistance.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions
FO: Conceptualization, study design, writing - Original draft, second and third draft, and Project administration. MU: Writing - original, data analysis, and second draft - review & editing SE: Conceptualization, study design, Investigation, writing - Original draft, second and third draft, supervision, and intellectual prosperity. CA: Writing - original and second draft - review & editing. CE: Investigation, writing - Original draft, second and third draft, supervision. UD: Investigation, writing - Original draft, second and third

draft, supervision. MD: Writing - original and second draft - review & editing. LF: Writing - original, data analysis and second draft - review & editing. CM: Investigation, writing - Original draft, second and third draft, supervision. Manuscript writing: All Final approval of the manuscript: All Authors.

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Data availability
Available and can be provided if needed. Contact: Stanleyeneh234@gmail.com and onukansifrancisca@gmail.com.

Declarations

Ethics approval and consent to participate
The study strictly adhered to the ethical principles of the Declaration of Helsinki and received ethical approval from the Public Health Department Ethical Committee at the Federal University of Technology Owerri (FUTO), Nigeria, under approval number: 00010/FUTO/PUHEC/P104. Prior to participation, informed consent was obtained from all participants to ensure ethical compliance and voluntary involvement.

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References

1. Essack SY, Desta AT, Abotsi RE, Agoba EE. Antimicrobial resistance in the WHO African region: current status and roadmap for action. J Public Health. 2017;39(1):8–13.
2. Bartlett JG, Gilbert DN, Spellberg B. Seven ways to preserve the miracle of antibiotics. Clin Infect Dis. 2013;56(10):1445–50.
3. Aslam B, Wang W, Arshad MI, Khurshid M, Muzammil S, Rasool MH, et al. Antibiotic resistance: a rundown of a global crisis. Infect Drug Resist. 2018;11:1645.
4. Kasimanickam V, Kasimanickam M, Kasimanickam R. Antibiotics use in food animal production: escalation of antimicrobial resistance: where are we now in combating AMR? Med Sci. 2021;9(1):14.
5. Uddin TM, Chakraborty AJ, Khusro A, Zidan BRM, Mitra S, Emran TB, et al. Antibiotic resistance in microbes: history, mechanisms, therapeutic strategies and future prospects. J Infect Public Health. 2021;14(12):1750–66.
6. Miller-Petrie M, Pant S, Laxminarayan R. Drug-Resistant Infections. In: Holmes KK, Bertozzi S, Bloom BR, Jha P, editors. Major Infectious Diseases [Internet]. 3rd ed. Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2017 [cited 2022 Dec 28]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK525181/
7. Olayemi O, Olayinka B, Musa A. Evaluation of antibiotic Self-Medication pattern amongst undergraduate students of Ahmadu Bello university (Main Campus), Zaria. Res J Appl Sci Eng Technol. 2010;2:35–8.
8. Okedo-Alex I, Madubueze UC, Umeokonkwo CD, Oka OU, Adeke AS, Okeke KC. Knowledge of antibiotic use and resistance among students of a medical school in Nigeria. Malawi Med J. 2019;31(2):133.
9. Sanya T, Titilayo O, Adisa R, Segun J. Use of antibiotics among non-medical students in a Nigerian university. Afr Health Sci. 2013;13(4):1149–55.
10. Hsu J. How covid-19 is accelerating the threat of antimicrobial resistance. BMJ. 2020;369:m1983.
11. Chokshi A, Sifri Z, Cennimo D, Horng H. Global contributors to antibiotic resistance. J Glob Infect Dis. 2019;11(1):36–42.
12. Adedeji WA. THE TREASURE CALLED ANTIBIOTICS. Ann Ib Postgrad Med. 2016;14(2):56.
13. Iheanacho CO. An antibiotic turned contraceptive: the Tale of ampicillin-cloxacillin. Health Sci Rep. 2022;5(1):e481.
14. Haque M, Rahman NAA, McKimm J, Binti Abdullah SL, Islam MZ, Zulkifli Z, et al. A cross-sectional study evaluating the knowledge and beliefs about, and the use of antibiotics amongst Malaysian university students. Expert Rev Anti Infect Ther. 2019;17(4):275–84.
15. Asogwa IE, Offor SJ, Mbagwu HOC, Knowledge. Attitude and practice towards antibiotics use among Non-medical university students in Uyo, Nigeria. J Adv Med Pharm Sci. 2017;1–11.
16. Okolosi-Patani O, Ahwinahwi U. Okoeko[1] O. Use of antibiotics among undergraduate students of Delta State University, Abraka. 2015.
17. Igbeneghu OA. Knowledge and practices in the use of antibiotics among a group of Nigerian university students. Int J Infect Control [Internet]. 2013 Feb 7 [cited 2023 Jan 13];9(1). Available from: https://ijic.info/article/view/10539
18. Sasu S, Kümmerer K, Kranert M. Assessment of pharmaceutical waste management at selected hospitals and homes in Ghana. Waste Manag Res. 2012;30(6):625–30.
19. Wang X, Peng D, Wang W, Xu Y, Zhou X, Hesketh T. Massive misuse of antibiotics by university students in all regions of China: implications for National policy. Int J Antimicrob Agents. 2017;50(3):441–6.

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