Original Research

GAPS IN KNOWLEDGE OF ANTIMICROBIAL RESISTANCE AMONG NURSING STUDENTS: URGENT NEED FOR EDUCATIONAL INTERVENTIONS

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ABSTRACT

Background: Antimicrobial resistance (AMR) is a global health threat, which leads to increased morbidity, mortality, and healthcare expenses. Effective antimicrobial stewardship (AMS) is pivotal to control its spread. Nurses play a significant role in addressing AMR, but knowledge deficiency among undergraduate nursing students can hinder their preparedness for stewardship responsibilities. This study aims to determine the knowledge level of undergraduate nursing students about AMR.

Methods: A cross-sectional study was conducted among 87 undergraduate nursing students, using a self-administered questionnaire. Data were analyzed using appropriate statistical methods. Descriptive statistics and chi-square tests were done.

Results: None of the participants had a good level of knowledge on AMR. Majority (82.76%) of the participants were found to have poor knowledge regarding AMR and 17.24% of students had moderate knowledge. No significant association was found between awareness of AMS and Antibiotic Policy with level of knowledge of participants

Conclusion: The study reveals significant gaps in undergraduate nursing students' knowledge of AMR, highlighting the need for changes in curriculum and innovative educational strategies.

Keywords: Antimicrobial Resistance, Antimicrobial Stewardship, Nursing Undergraduates, Nursing Education, Knowledge Assessment.

INTRODUCTION

Antimicrobials are agents that either kill or inhibit the growth of viruses, bacteria, fungi, or other microorganisms. Despite several decades of seeking for antimicrobial substances, successful drugs did not emerge until the 19th century, when a great deal of research led to the development of antimicrobials in the form of antiviral, antifungal, and antibiotic medications(1). Without the availability of efficient antimicrobial therapies, modern medical advancements like major surgery, organ transplants, the care of premature infants, or cancer chemotherapy would not be feasible(2).

Antimicrobial resistance (AMR) is the ability of microbes to resist the action of drugs that once killed them or hindered their growth.

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The overuse and misuse of these pharmaceuticals in humans, animals and environment are the major contributors of this issue(3–5). Inappropriate antibiotic use might be affected by many factors such as unregulated drug availability, relaxed health policies concerning regulations on antibiotic use, over the-counter availability, patients' knowledge and attitudes towards antibiotic use, self-medication, health care worker's knowledge, experiences and interaction with patients (5).Now AMR is recognized as a global health threat, which is leading to increased morbidity, mortality, and healthcare expenses. Concerning resistance rates among prevalent bacterial infections are emphasized in the 2022 Global Antimicrobial Resistance and Use Surveillance System (GLASS) report (6). Research from various medical centres shows that rising antibiotic resistance is a critical issue in India also (3).

Multimodal approaches have been suggested to be most effective in controlling the rise and spread of AMR, as the underlying reasons of resistance are multifaceted, ranging from the biology of bacteria to the behavioural dynamics of healthcare

professionals(7). Antimicrobial Stewardship (AMS) has come up as a crucial strategy to combat AMR, aiming to optimize antibiotic use and improve patient safety (4).

As front-line medical professionals, nurses are essential in ensuring that antibiotics are used appropriately, teaching patients how to use them, and cooperating with interdisciplinary teams to improve efficient antimicrobial practices (4,8). Their frequent patient contact and direct involvement in infection prevention make them essential for the successful implementation of AMS strategies (9) . However, to fulfil this role, nurses need to have a thorough knowledge of AMR, proper prescription guidelines, and efficient infection prevention and control strategies. Numerous studies often demonstrate that nursing students tend to have substantial gaps in their understanding on AMR and AMS, despite the critical role nurses have to fulfil. Their ability to contribute effectively to the fight against AMR is directly hampered by this disadvantage(4).

According to a South African study, even graduating nursing students, after completing their clinical training, lacked basic understanding of antibiotics and AMR principles (10). Similarly, a study conducted in Spain revealed that nursing students' awareness of AMR was noticeably lacking, pointing to deficiencies in their curriculum (8). A study from Jordan have also reported low to moderate baseline knowledge levels, with improvements only occurring after targeted educational programs were implemented (11). A study conducted among undergraduate nursing students in India, revealed a significant gap in undergraduate nursing students' understanding of antibiotics, AMR, and AMS(4). These collective findings from various global contexts point to a widespread gap in nursing education regarding the skills needed to address AMR and implement AMS strategies effectively(4).

This study was conducted to assess the knowledge of AMR among undergraduate nursing students in our institution with an aim to obtain insights that can lead to new educational interventions, ultimately aiming to prepare nurses for their pivotal role in AMS and, in turn improve patient care.

Aims & Objectives

- To assess the knowledge regarding antimicrobial resistance (AMR) among nursing students in a tertiary healthcare centre.

MATERIALS AND METHODS

This cross-sectional study was conducted over a period of 1 month (March 2026) in the Department of Microbiology at Sree Mookambika Institute of Medical Sciences, Kulashekharam. A total 87 second year nursing students, were enrolled using Universal sampling. Written informed consent was obtained from all participants. Confidentiality and anonymity were ensured throughout the study.

Inclusion criteria comprised all second-year nursing students present during the study period who consented to participate. Students who declined participation, were absent during data collection, or submitted incomplete questionnaires were excluded.

The study procedure was carried out in a structured manner. Initially, students were briefed about the purpose and importance of the study, and their voluntary participation was emphasized. A pre-validated, structured questionnaire was distributed in a controlled classroom setting under supervision to avoid discussion among participants. Participants were given 20–25 minutes to complete the questionnaire independently without referring to external sources

The questionnaire contains socio-demographic details of the study participants, followed by 3 questions regarding their awareness of antibiotic policy, AMS and previous attendance of CME on AMR, 17 questions related to knowledge of antimicrobial resistance, of which 15 questions contain yes, no, and uncertain options and for last two questions (19 and 20), yes or no can be selected as the answer. For questions 4 to 18, one mark is given for each correct answer, and zero marks are given for wrong answers and uncertain options. The 19th question is about the causes of AMR in India (9 correct options) and last question is about the solutions for growing problem of antimicrobial resistance (8 correct options). One mark is given for each correct option marked by the participant for the last two questions. The maximum score achievable was 32. The level of knowledge was calculated by dividing the responses into three groups based on a score of more than 75% as good, 50-74% as moderate, and less than 50% was considered as low. The completed questionnaires were collected, the data was organized on an excel spreadsheet, and descriptive statistics were employed to interpret the results as frequency, and percentages.

RESULTS

A total of 87 second year students had participated in the study. All were female participants, with mean age of 19.16 years. None of the students had attended any CME or training on AMR. Some of them claimed to be aware of AMS 34 (39.08%) and Antibiotic policy of India53 (60.92%) (Table 1).

Tabel 2 and Figures1 and 2 shows the response of the participants to the questions regarding knowledge of AMR. Only 34.48% (30) of participants correctly answered that antibiotic are not indicated to reduce any kind of pain and inflammation. 56.32% (49) of students answered that antiretroviral therapy will reduce the viral load in HIV patients. Only 33.33% (29) of participants were of the opinion that second line drugs are not safer than first line antibiotics. 59.77% (52) of them

disagreed with the opinion that antimicrobials can kill "good bacteria" existing in our body. The fact that antimicrobials can lead to secondary infections following the removal of good microorganisms residing in our body was supported by only 35(40.22%) of them. 55 (63.21%) participants did not support full course of antibiotic treatment and agreed with the suggestion to stop antibiotics when symptoms improve. Majority of the students (67 (77.01%), were familiar with the definition of AMR. 48(55.17%) participants correctly responded that skipping antibiotic doses can lead to AMR. More than half of the participants (66 (75.86%) correctly identified AMR as an important and serious public health issue faced by the world. Only a lesser proportion of students (35(40.22%)) acknowledged the fact that resistant bacteria can spread from person to person. Many participants (43(49.42%)) concurred with the fact that multi drug resistance is problem in case of malaria. 47 (54.02%) of them rightly opined that AMR is not limited to any age groups. Still, only 38(43.68%) students expressed agreement that AMR can lead to prolongation of hospital stay and only 36 (41.38%) participants fully supported the claim that AMR could make medical procedure like surgery, organ transplants and cancer treatment much more dangerous. A vast majority of the students (77(88.51%)) accepted the fact that hand hygiene has an important role to play in prevention of AMR.

Majority of participants identified improper hospital infection control 53 (60.92%) and inadequate immunization (47 (54.02%)) as the causes of the AMR in India. Only a limited number of participants selected overuse of antibiotics in hospitals (6 (6.9%)), community (12 (13.79%)) and in animals (4 (4.6%)) as the cause of AMR. Incorrect dosing/duration 39 (44.83%), improper regulations (24 (27.59%)) and poor quality of antimicrobials 23 (26.44%) were considered as causes of AMR by a lesser proportion of participants. Only a limited number of participants 8 (9.19%) chose inadequate diagnostic support as a reason for AMR in India.

Avoiding self-medication was considered as a significant solution for overcoming AMR by the majority (54 (62.07%)). Judicial, careful and rational use of antimicrobials (33 (37.93%)), complete the full course of antimicrobials in the prescribed dose (36 (41.38%)), symptomatic management in self-limiting conditions (21 (24.14%)) and creating awareness among patients by organising public health campaigns (43 (49.42%)) were supported by some participants as the possible solutions of AMR. Meanwhile, multidrug therapy (17 (19.54%)), prescribing using culture sensitivity reports(8 (9.19%)) and new drug discovery (7 (8.05%)) were supported by only a few number of participants.

None of the participants had a good level of knowledge on AMR. Majority (82.76%) of the participants were found to have poor knowledge regarding AMR and 17.24% of students had moderate knowledge (Table 3). No significant association was found between awareness of AMS and Antibiotic Policy with level of knowledge of participants (Table 4).

Table 1: Table on Participants' Response Regarding Awareness of AMS / Antibiotic Policy

Questions	Yes N (%)	No N (%)
1. Have you attended any CME on AMR or Antimicrobial usage in the past?	0	87 (100%)
2. Are you aware of antimicrobial stewardship?	34 (39.08%)	53 (60.92%)
3. Are you aware of antibiotic policy in India?	53 (60.92%)	34 (39.08%)

Table 2: Table Representing the Responses to the Questionnaire (Questions 4- 18)

Parameter	Yes N (%)	No N (%)	Uncertain N (%)
4. Antibiotic are indicated to reduce any kind of pain and inflammation	47 (54.02%)	30 (34.48%)	10 (11.49%)
5. Antiretroviral therapy will reduce the viral load in HIV patients	49 (56.32%)	34 (39.08%)	4 (4.6%)
6. Second-line drugs are generally used for the treatment of resistant strains and are hence safer than first-line drugs	29 (33.33%)	40 (45.98%)	18 (20.69%)
7. Antimicrobials can kill "good bacteria" existing in our body	29 (33.33%)	52 (59.77%)	6 (6.9%)
8. Antimicrobials can lead to secondary infections following the removal of good microorganisms residing in our body	35 (40.22%)	41 (47.13%)	11 (12.64%)

9. It is always better to stop antibiotics once the symptoms of illness get resolved; otherwise, we expose ourselves to unnecessary side effects	55 (63.21%)	24 (27.59%)	8 (9.19%)
10. Antimicrobial resistance is a phenomenon in which a bacterium, virus, fungi losses its sensitivity to an antimicrobial	67 (77.01%)	14 (16.09%)	6 (6.9%)
11. Skipping one or two doses not contribute to the development of antimicrobial resistance	34 (39.08%)	48 (55.17%)	5 (5.75%)
12. Antimicrobial resistance is an important and serious public health issue faced by the world	66 (75.86%)	8 (9.19%)	13 (14.94%)
13. Bacteria which are resistant to antibiotic can spread from person to person	35 (40.22%)	48 (55.17%)	4 (4.6%)
14. Multi drug resistance is not a problem in case of malaria	23 (26.43%)	43 (49.42%)	21 (24.14%)
15. Anti-microbial resistance doesn't affect much, younger people as it is a problem for elderly people only	32 (36.78%)	47 (54.02%)	8 (9.19%)
16. Antimicrobial resistance can lead to prolongation of hospital stay	38 (43.68%)	40 (45.98%)	9 (10.34%)
17. Antibiotic resistance could make medical procedure like surgery, organ transplants and cancer treatment much more dangerous	36 (41.38%)	45 (51.72%)	6 (6.9%)
18. Hand washing in health care setup has got an important role to play in the prevention of anti-microbial resistance	77 (88.51%)	4 (4.6%)	6 (6.9%)

Table 3: Distribution of Knowledge among Nursing Students

Level of Knowledge	Number	Percentage
Good knowledge	0	0
Moderate knowledge	15	17.24
Poor knowledge	72	82.76

Table 4: Knowledge on AMR with Respect to Awareness About AMSP and Antibiotic Policy in India

		Moderate Knowledge	Poor Knowledge	X2	P-Value
Awareness of AMSP	Yes	4	30	1.1732	0.2787
	No	11	42		
Aware of antibiotic policy in India	Yes	8	45	0.4381	0.508
	No	7	27		
p-value >0.05 (not significant)					

Figure 1: Distribution of responses on causes of AMR in India

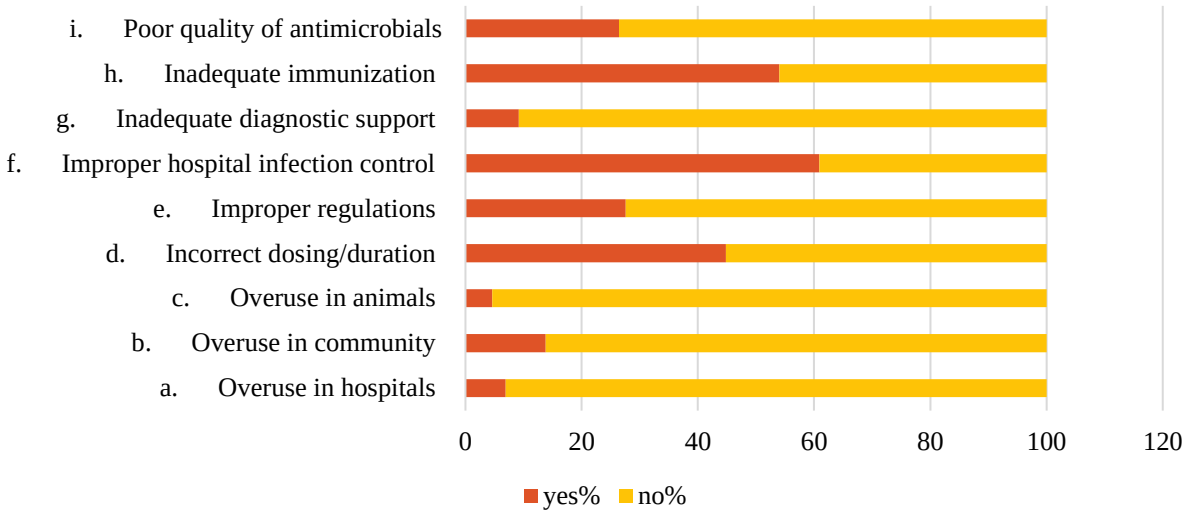
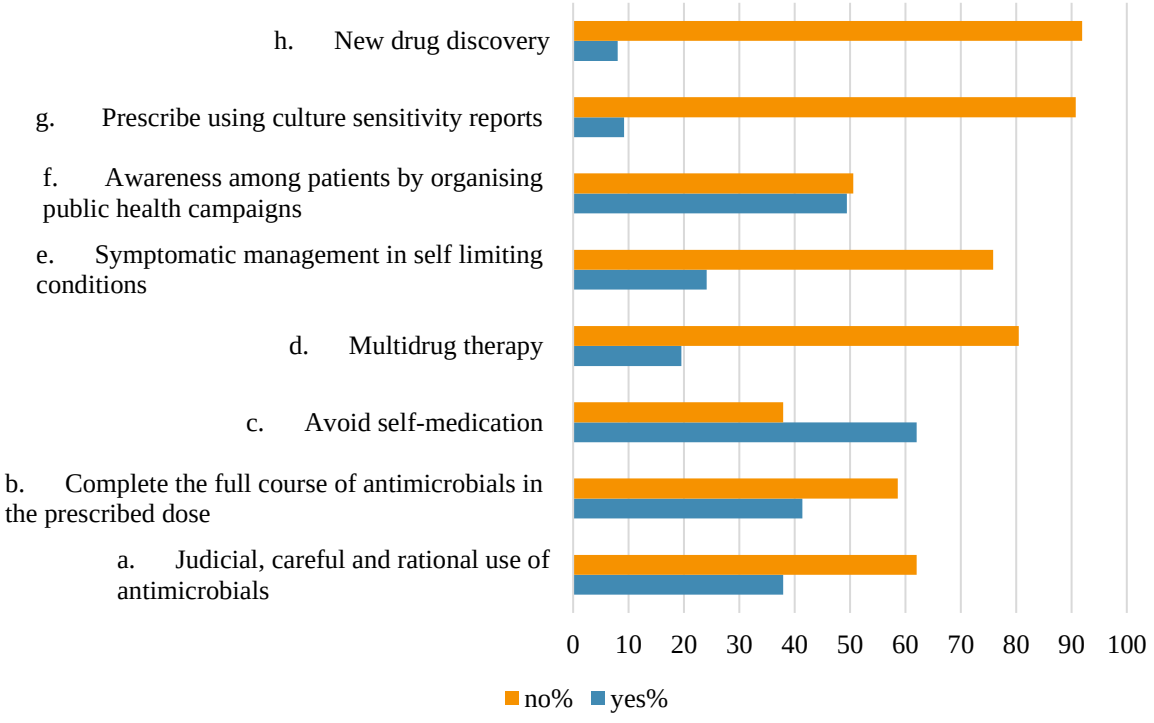


Figure 2: Distribution of responses to solutions of AMR



DISCUSSION

A major problem for today's public health is antibiotic resistance, which is leading to catastrophic rates of morbidity and mortality overall. In order to combat the growing threat of AMR, it is essential to impart knowledge on AMR and the appropriate use of antimicrobials(3). AMS is one major strategy used in the prevention and reduction of AMR by optimizing antibiotic selection, promoting rational prescribing, reducing hospital stay and emphasizing the completion of antibiotic therapy.(12) Nurses are the forerunners of healthcare. Nursing students who are the future of the healthcare needs to have through knowledge of AMR and AMS.

In the present study, 34.48% of participants had correctly answered that antibiotic are not indicated to reduce any kind of pain and inflammation. However, this percentage is much lower compared to the percentages from similar studies conducted among nursing students and undergraduate medical students which showed higher percentages like 70.8% ,75.5%, 69.1% and 89.7% (3,8,13,14). Only

33.33% (29) of participants were of the opinion that second line drugs are not safer than first line antibiotics. In a survey conducted in Spain, only 51.3% of nursing students agreed that prescribing broad-spectrum antibiotics increases antibiotic resistance (8). Majority of participants had taken a neutral stand regarding the superiority of broad-spectrum antibiotics vs narrow spectrum in the study done by Yang et al (15).

In our study, only 40.22% of students supported the fact that antimicrobials can lead to secondary infections following the removal of good microorganisms residing in our body. This finding was similar to the cross-sectional study conducted in China (15). But in an international study the majority of participants (72%) were knowledgeable about secondary infections (8).

Only 27.59% supported full course of antibiotic treatment even when there is symptomatic improvement. Meanwhile in the survey by Rabano-Blanco et al., it was found that a vast majority of students (90.4%) has a strong understanding about continuing full course antibiotic treatment(8). Similar findings were found from another Indian study also(14).

Majority of the students (77.01%), in the current study understood that AMR includes resistance antibiotics, antivirals, antifungals or antiparasitic agents. This was in concordance with the finding (77.4%) from study done by Teague et al., among final year nursing students in South Africa(10). 55.17% of our participants has correctly responded that skipping antibiotic doses is a stepping stone to drug resistance. This was in concordance with a study conducted in the Northern states of India, which showed that 56.8% of nursing students agreed the same(14).

About 40% of participants in our study acknowledged the fact that resistant bacteria can spread from person to person. Similar findings were obtained from a KAP study conducted in China, where only 32.4% of students were aware of the spread of resistant bacteria(15). While in a KAP study conducted among Medical, Nursing and Pharmacy Students in Jordan, 65.2% of them were well-informed about the transmission of drug resistant microbes(11). 88.51% of our participants accepted the fact that hand hygiene has an important role to play in prevention of AMR. Simultaneously, in a South African study, only 67.7% of students agreed that poor infection control practices by healthcare professionals can cause the spread of antibiotic resistance(10).

Majority of our participants considered improper hospital infection control (60.92%) and inadequate immunization (54.02%) as the major causes of the AMR in India. Very few participants considered overuse of antibiotics in hospitals (6.9%), community (13.79%) and in animals (4.6%) as the cause of AMR. On the other hand, in a survey conducted in Spain, 64.4% of subjects considered use of antibiotics in livestock production and agriculture as contributory factors to antibiotic resistance(8). Antibiotic abuse was identified as the main cause of AMR by 75% of students in a KAP study from China (15). Only a limited number of participants (9.19%) chose inadequate diagnostic support as a reason for AMR in India. According to the surveys conducted in Spain and South Africa, more than 80% of students believe that improving techniques for bacterial diagnostics would allow combating antibiotic resistance (8,10).

The most agreed upon solution for overcoming AMR by the majority (62.07%) of our participants was avoiding self-medication. Similarly 77.8% of students from a study conducted by Yang et al., agreed that improper self-medication can cause AMR(15). But in the study done by Bharthi R et al., only 11.63% of nursing students agreed with this(14). The other most commonly agreed upon solutions for AMR were judicial, careful and rational use of antimicrobials (37.93%), complete the full course of antimicrobials in the prescribed dose (41.38%), symptomatic management in self-limiting conditions (24.14%) and creating awareness among patients by organising public health campaigns (49.42%). Multidrug therapy (19.54%), prescribing using culture sensitivity reports (9.19%) and new drug discovery (8.05%) were suggested by only a few. According to the multidisciplinary study conducted in India, only 14.45% of nursing students believed that careful, judicious and rational use of medicines can help in solving AMR, 7.8% supported awareness campaigns, 15.81% supported prescription based on culture sensitivity reports, 4.4% considered new drug discovery and 5% of them considered multidrug therapy as a solution(14).

82.76% of the participants were found to have inadequate knowledge regarding in the present study, indicating significant knowledge gap. This percentage is much higher when compared to the study conducted by Chaudhary S and Singh A, where 59.3% of participants had inadequate knowledge(4). Various international studies also indicate correct response rates ranging from 42% to 57.9%(8,10,11). The inadequate knowledge scores emphasize the flaw in the current educational framework and underlines the need for a comprehensive re-evaluation of teaching techniques for nursing students.

Even though majority of the participants (75.86%) correctly identified AMR as a serious public health issue they have significant knowledge gaps in the key concepts of AMR. Despite the fact that some of the students were aware of AMS or Antibiotic policy, it turned out to be only superficial awareness rather than a clear understanding. Some of them have theoretical knowledge regarding antibiotic use

and AMR, but they lack practical and clinical insights about safe use of antimicrobials.

On comparing the studies conducted among nursing students from different countries, significant variations can be found between the knowledge levels as well as various facets of understanding of AMR. This highlights a global and regional gap in nursing education, and underscores the need for tailored educational strategies to better prepare future nurses for effective AMS. Although medical students are getting more exposure to AMS as part of the CBME curriculum, the same cannot be said for nursing students. Limited literature is available that focuses on AMR and AMS for nursing students(11). Fewer Indian studies conducted among nursing students on AMS and AMR are available. While recent studies identify the presence of stewardship curricula, the effectiveness of these interventions remains sparsely evaluated(16). It's possible that current teaching methods are unduly theoretical in nature, failing to close the knowledge gap between classroom learning and real clinical application. The study brings attention to the need for revising nursing curricula and adopting innovative teaching methods to prepare budding nurses for their roles in AMS. Active learning strategies like role play based learning, problem-based learning, case studies, and simulations can enhance student engagement, promote critical thinking, and facilitate real-world application of knowledge. For more sustained impact, institutional and national policies prioritizing comprehensive AMR and education, adequate funding, faculty training, and new teaching methodologies are also the need of the hour. In addition to curriculum based syllabus, educational awareness programmes like CMEs, seminars and workshops should be made available to students to promote a learning mentality (4,11,17,18).

The American Nurses Association and the Centers for Disease Control and Prevention have jointly urged nurses nationwide to take an active role in antimicrobial medication management(7,15). Moreover, nurses also shoulder important responsibilities in patient education and general public health education. As patients are responsible for taking their medicines while they are not in a healthcare setting, inappropriate behaviour by patients and deficiencies in knowledge can negatively impact antimicrobial resistance (11,15). In order to mold responsible and knowledgeable nurses, the training on AMS should start from their undergraduate period, which should be periodically revised and evaluated.

CONCLUSION

The study reveals a significant gap in nursing students' understanding of AMR and AMS. Majority of the participants demonstrated inadequate knowledge, points out the need for curriculum reform and innovative teaching approaches. Tailored educational interventions are required for undergraduate training to bring behavioural changes as well as to improve knowledge.This will assist future nurses to mitigate the global burden of AMR, enhance patient safety, and strengthen healthcare systems.

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