Original Article

Knowledge on Antimicrobial Resistance and Stewardship in Undergraduate Nursing Students: A Cross-sectional study

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Abstract

Background: Antimicrobial resistance (AMR) is a global health threat, causing increased morbidity, mortality, and healthcare costs. Effective antimicrobial stewardship (AMS) is crucial to limit its spread. Nurses play a critical 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 antibiotics, AMR, and AMS, addressing the challenge of knowledge deficiency among these students.

Methods: A cross-sectional study was conducted on 140 undergraduate nursing students, using a self-administered questionnaire to collect demographic data and knowledge about antibiotics, antimicrobial resistance, and antimicrobial stewardship. Statistical analyses were performed using SPSS version 20.0, with descriptive statistics providing an overview of participants' knowledge and chi-square tests investigating associations between factors like age, gender, semester, and residence with knowledge.

Results: Participants had the mean knowledge score of 7 ± 2.067, and none of the participants had adequate knowledge, 40.7% had moderately adequate knowledge, and 59.3% had inadequate knowledge. Semester of study was the only factor that had significant relations with knowledge on antimicrobial resistance and stewardship ($p = 0.010$).

Conclusion: The study reveals significant gaps in undergraduate nursing students' understanding of antibiotics, antimicrobial resistance, and stewardship, highlighting the need for comprehensive curricular reform and innovative educational strategies to prepare future nurses for addressing antimicrobial resistance and strengthening healthcare systems.

Keywords: Antimicrobial resistance, Antimicrobial stewardship, Nursing undergraduates, Nursing education, Knowledge assessment

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Introduction

Antimicrobial resistance (AMR) is a global health threat that makes infections more difficult to treat, leading to increased morbidity, mortality, and healthcare expenses. AMR is the ability of microbes, including bacteria, viruses, fungi, and parasites, to resist the action of drugs that once killed them or hindered their growth. The overuse and misuse of antibiotics are key drivers of this issue. The World Health Organization predicts that without effective strategies, AMR could result in 10 million deaths annually by 2050, disproportionately affecting low- and middle-income countries, including Southeast Asia.[1-5] This region faces challenges like easy antibiotic availability without doctor's prescription and poor infection control, leading to a high prevalence of multidrug-resistant organisms.[6] Deaths due to AMR are on the rise, estimated to exceed cancer and diabetes death rates.[2,3] In 2019, AMR was directly responsible for over 1.2 million deaths.[5]

In response to the rising crisis of antimicrobial resistance, Antimicrobial Stewardship (AMS) has come up as a crucial strategy to combat AMR, aiming to optimize antibiotic use and improve patient safety.[7] Nurses, as frontline healthcare providers, play a vital role in ensuring the appropriate use of antibiotics, educating patients on proper usage, and collaborating with interdisciplinary teams to promote effective antimicrobial practices. Their frequent patient contact and direct involvement in infection prevention make them essential for the successful implementation of AMS strategies.[8,9] However, to be effective in this role, nurses must have a thorough understanding of AMR, appropriate prescribing protocols, and robust infection prevention and control measures.

Despite the pivotal role nurses play, numerous studies consistently show that nursing students often have significant gaps in their knowledge regarding AMR and AMS. This deficiency directly hinders their ability to contribute effectively in combating AMR. A study in South Africa revealed that even graduating nursing students, despite completing their clinical training, lacked fundamental knowledge of antibiotics and AMR principles.[10] Similarly, research from Spain found a noticeable lack of AMR awareness among nursing students, identifying shortcomings in their nursing curriculum.[11] In Asia, studies from Jordan and India have also reported low to moderate baseline knowledge levels, with improvements only occurring after targeted educational programs were implemented.[12-14] 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.

This study was conducted to assess the knowledge of antibiotics, AMR and AMS among undergraduate nursing students in India with an aim to gain valuable insights that can inform new educational interventions, ultimately helping to prepare nurses for their critical role in AMS and, in turn, in preventing the rise and spread of drug-resistant pathogens.

Methods

Study Design

This study utilized a cross-sectional design by performing a secondary analysis of baseline data. This data was originally gathered for a separate randomized controlled trial (RCT), titled "Impact of Self-Directed Learning Strategy, an Innovative Method in Nursing Undergraduates: A Randomized Controlled Trial." The primary RCT, which was registered with the Clinical Trials Registry - India (CTRI) (registration number: CTRI/2024/01/061599), aimed to compare the effectiveness of game-based learning versus traditional self-directed learning methods in enhancing knowledge and self-directed learning abilities among nursing undergraduates over a 12-week period.[15]

Our strategic decision to conduct a secondary analysis of the pre-intervention data allowed us to address a different, though related, research question. This approach enabled us to efficiently use an existing high-quality dataset to assess students' prior knowledge of antibiotics, antimicrobial resistance (AMR), and antimicrobial stewardship (AMS). By identifying these knowledge gaps, we can inform the development of future educational strategies, independent of the original RCT's primary focus on intervention outcomes. The study took

place from January to April 2024 at Smt. Radhikabai Meghe Memorial College of Nursing (SRMMCON), a constituent nursing college of the Datta Meghe Institute of Higher Education & Research in India.

Participants

The study included 140 undergraduate nursing students. To ensure a balanced representation, participants for the original RCT were selected using stratified random sampling, which included students from both the first and third semesters of the nursing program. The total accessible population was 200 students, with 100 in each semester.Students were included if they were enrolled in a B.Sc. Nursing program, had basic proficiency in English, and had access to a computer, tablet, or smartphone with internet access. Conversely, students with prior training in antibiotics, AMR, or AMS, those with a history of irregular class attendance, and anyone who withdrew consent or didn't participate were excluded from the study.

Data Collection

The study used a structured questionnaire to collect baseline data before randomization in original RCT. The questionnaire was divided into two sections: one for socio-demographic information and one for knowledge. The knowledge questionnaire was a 15-item multiple-choice questionnaire designed to evaluate students' understanding of antibiotics, AMR, and AMS. Participants' scores were categorized into three levels: "Adequate" for scores of 12 points or higher (≥75%), "Moderately Adequate" for scores between 8 and 11 points (51%–75%), and "Inadequate" for scores of 7 points or lower (≤50%). The questionnaire was developed through a rigorous process, including a review of existing literature and refinement based on a pilot study. The questionnaire's reliability was confirmed with a Cronbach's alpha of 0.78 and an intraclass correlation coefficient (ICC) of 0.80. The questionnaire took an average of 15 to 25 minutes to complete, and all responses were anonymized to protect participant confidentiality.

Statistical Analysis

The data was analyzed using SPSS version 20. The study used descriptive statistics to summarize knowledge scores and socio-demographic variables, followed by Chi-square tests to identify significant differences in knowledge scores and categories based on socio-demographic factors. All tests were two-tailed, with a p-value of less than 0.05 indicating statistical significance.

Results

Participant Characteristics

The average age of the participants in this study was 16.2 ± 1.1 years with 70% being female. The sample was evenly split between first and third-semester students, with most living with parents (40%). (Table 1).

Table 1: Socio-demographic Characteristics of Participants (N = 140)

Variable	Frequency (%)
Age (years)	
<17	120(85.7)
18–23	20 (14.3)
>24	0 (0)
Gender	
Female	98(70)
Male	42(30)
Semester	
First	70 (50.0)
Third	70 (50.0)
Place of Residence	
With parents	56 (40)
With relatives	9(6.4)
With friends	9(6.4)
Alone in rented room	34 (24.3)
In college hostel	32(22.9)

Knowledge Level

The study found a mean knowledge score of 7 ± 2.067 out of 15, with a correct response rate of 47.3%. None of the 140 participants achieved an "adequate" level of knowledge, with 59.3% demonstrating inadequate knowledge. However, 40.7% had a moderately adequate level of knowledge, scoring between 8 and 11 points (Figure 1). This data highlights significant knowledge gaps among students.

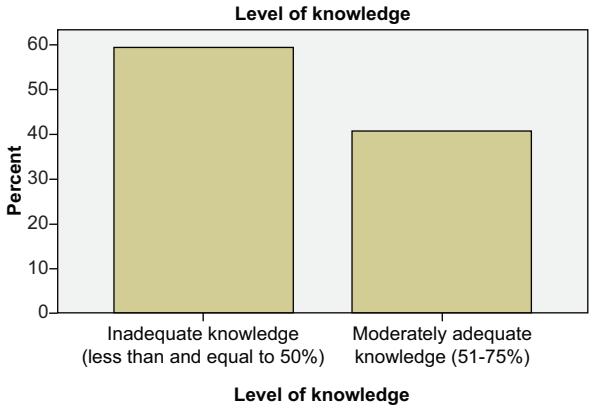

Figure 1. Distribution of Baseline Knowledge Scores (N = 140)

A study reveals that students' understanding of antimicrobial resistance (AMR) varies significantly, with an average of 46.6% of questions correctly answered. The most significant areas of misunderstanding were antibiotic side effects, factors contributing to AMR, and the spread of AMR in healthcare facilities (Table 2). These areas are critical and practical aspects of antimicrobial use and infection control.

However, students showed a relatively better understanding of topics like antimicrobial prescription guidelines, AMR prevention, and the role of healthcare professionals in AMS.

Table 2: Knowledge of participants on antibiotic use, antimicrobial resistance and stewardship

S.N	Items	Correct response n(%)	Incorrect response n(%)
	Antibiotic use		
	Condition that should be treated with antibiotics	55(39.3)	85(60.7)
	Prolonged courses of antimicrobials	70(50)	70(50)
	Common side effects of antibiotics include all the following except	19(13.6)	121(86.4)
	Antimicrobial resistance		
	Antimicrobial resistance is	72(51.4)	68(48.6)
	Gram-positive bacteria have become a threat and is considered a global pandemic in antibiotic resistance	60(42.9)	80(57.1)
	Patients with antimicrobial resistance infections	72(51.4)	68(48.6)
	Antimicrobial resistance in healthcare facilities is spread mainly by	44(31.4)	96(68.6)
	Antimicrobial resistance is promoted by	40(28.6)	100(71.4)
	Antimicrobial resistance can be prevented by	94(67.1)	46(32.9)
	Antimicrobial stewardship		
	Antimicrobial prescription guidelines	95(67.9)	45(32.1)
	Antimicrobial stewardship programmes	66(47.1)	74(52.9)
	Goals of antimicrobial stewardship include	52(37.1)	88(62.9)
	Antimicrobial stewardship programmes can save healthcare facilities money by	85(60.7)	55(39.3)
	An ideal antimicrobial stewardship team should be made up of	70(50)	70(50)
	In antimicrobial stewardship, major role of health professional is to	86(61.4)	54(38.6)

Associations with Socio-demographic Variables

The study found a significant correlation between a student's knowledge level and their semester of study, with third-semester students showing a higher level of moderately adequate knowledge compared to first-semester students. However, no significant association was found between knowledge level and other demographic factors. (Table 3).

Table 3: Associations Between Knowledge Scores and Socio-demographic Variables

Variable	Level of Knowledge		chi-square value	p-value
	Inadequate knowledge	Moderately adequate knowledge		
Age				
<17	71	49	0.005	0.944
18–23	12	8		
Gender				
Male	28	14	1.354	0.245
Female	55	43		
Semester				
First	49	21	6.658	0.010*
Third	34	36		
Place of Residence				
With parents	35	21	3.796	0.434
With relatives	3	6		
With friends	4	5		
Alone in rented room	21	13		
In college hostel	20	12		

Discussion

The global health community acknowledges the importance of antimicrobial stewardship in combating antimicrobial resistance (AMR). This study provides insights into undergraduate nursing students' baseline knowledge, aligning with global trends and highlighting specific deficiencies that require strategic educational reform. The study contributes to the conversation on nursing education and AMS.

The study found that 59.3% of participants had inadequate knowledge, indicating a significant knowledge gap. This is consistent with international studies indicating correct response rates ranging from 42% to 57.9%.[10-12,14,16-25] The lack of adequate knowledge scores suggests a flaw in the current educational framework, highlighting the critical gap in nursing education and the need for a comprehensive re-evaluation of teaching methods.

Further investigation in study found that only 39.3% of nursing students correctly identified conditions requiring antibiotic treatment, indicating difficulty distinguishing between bacterial and viral infections. This is concerning, as inappropriate

antibiotic use for viral infections is a key driver of AMR. Nurses, responsible for patient care and medication management, are at risk due to their limited understanding of antibiotic risks. Similar findings were found in Thailand and China, where students had low correct response rates on antibiotic use with figures as low as 29.7% and 30.0%, respectively. [16,26]

Furthermore, nursing students have significant knowledge gaps in key AMR concepts, with a weak understanding of antibiotic side effects (13.6% correct), causes of AMR (28.6% correct), and the spread of AMR in healthcare settings (31.4% correct). However, they have a stronger grasp of antimicrobial prescription guidelines (67.9% correct), AMR prevention strategies (67.1% correct), and the role of healthcare workers in stewardship (61.4% correct). This suggests that though students have some theoretical knowledge, they lack practical, clinical insight for safe use of antimicrobials and effective infection control. Current educational approaches may be overly focused on theory, failing to bridge the gap between classroom learning and real-world clinical application. These findings are consistent with previous research identifying similar knowledge gaps among nursing students in areas such as AMS principles, appropriate antibiotic use, microbiology, and resistance mechanisms suggesting Interventions to be tailored to local contexts.

For example, a study in Spain found low knowledge levels among nursing students about AMR despite some awareness of general antibiotic use.[11]Similarly In South Africa, final-year nursing students showed inconsistent understanding of antibiotics and AMR/AMS principles, indicating a need for curriculum improvement.[10] In the UK, nursing students showed limited understanding of the microbiological basis of AMR and their roles in stewardship.[27] Likewise, In Jordan, students had moderate knowledge (65.2%) about AMR transmission but a stronger understanding (over 76%) of effective antibiotic use and side effects.[12] In Saudi Arabia, students (67.3%) incorrectly believed that skipping doses would not contribute to resistance.[19] Another study in Thailand, students (93.1%) believed their bodies could develop immunity to antibiotics, revealing a fundamental misunderstanding of resistance mechanisms.[16]

These variations reflect the influence of different curricula and local contexts on student's knowledge. Findings from India align with those from other low- and middle-income countries, where knowledge levels vary but show considerable potential for improvement through targeted interventions.[10,16,26,28] In contrast, high-income countries generally showed greater baseline awareness of AMS concepts but still face significant knowledge deficits.[21,23,24,27] Collectively, These findings highlight a global and regional gap in nursing education, emphasizing the need for tailored educational strategies to better prepare future nurses for effective antimicrobial stewardship,

The study found a significant correlation between students' semester of study and their knowledge on AMR and AMS, with third-semester students having a moderately adequate knowledge compared to first-semester students. This suggests that academic progression and exposure to relevant coursework may improve students' understanding of these concepts. However, even third-semester students did not achieve adequate proficiency, suggesting that the current curriculum may be slow, lack coherence, or fail to address the complexity of AMR and AMS. The study also found no significant associations between knowledge levels and other socio-demographic variables, suggesting persistent knowledge deficits across student demographics and pointing to systemic issues in educational design, such as curriculum structure and teaching methodologies, rather than individual student characteristics.

Implications for nursing education

The study highlights the need for revising nursing curricula and adopting innovative teaching methods to prepare students for their roles in antimicrobial stewardship. Active learning strategies like game-based learning, problem-based learning, case studies, and high-fidelity simulations can enhance student engagement, promote critical thinking, and facilitate real-world application of knowledge. For sustained and widespread impact, policy-level advocacy is also crucial, with institutional and national policies prioritizing comprehensive AMR and AMS

education, adequate funding, faculty training, and new teaching methodologies.

Limitation and future research

The study's small sample size from a single institution limits its generalizability. Future research should focus on larger, multi-center studies involving diverse nursing colleges and regions. Additionally, the study's self-reported questionnaires may introduce response biases, potentially impacting the accuracy of knowledge assessments. To mitigate these limitations, more robust assessment methods should be employed to strengthen the evidence base.

Conclusion

The study reveals a significant gap in undergraduate nursing students' understanding of antibiotics, Antimicrobial Resistance (AMR), and Antimicrobial Resistance (AMS). No participant demonstrated adequate understanding, highlighting the need for curriculum reform and innovative pedagogical approaches. By equipping future nurses with evidence-based knowledge and practical skills, they can contribute to effective antimicrobial stewardship. Strengthening curricula in AMR and AMS will position future nurses to mitigate the global burden of AMR, enhance patient safety, and strengthen healthcare systems. The findings support the development and implementation of evidence-based curricula, positioning nursing education as a cornerstone of public health strategies to combat AMR.

Declarations

- Ethics approval

Ethical approval for the original Randomized Controlled Trial (RCT), from which this baseline data was collected, was granted by the Institutional Ethics Committee of Datta Meghe Institute of Higher Education & Research (DMIHER(DU)/IEC/2023/141C). The study was conducted in accordance with the Declaration of Helsinki 2008.

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Reference

1. WHO. Antimicrobial resistance [Internet]. 2023 [cited 2025 Jun 14]. Available from: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
2. Naylor NR, Atun R, Zhu N, Kulasabanathan K, Silva S, Chatterjee A, et al. Estimating the burden of antimicrobial resistance: a systematic literature review. Antimicrob Resist Infect Control. 2018 Apr 25;7:58. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC5918775/
3. Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial resistance: a global multifaceted phenomenon. Pathog Glob Health. 2015 Oct;109(7):309–18. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC4768623/
4. de Kraker MEA, Stewardson AJ, Harbarth S. Will 10 Million People Die a Year due to Antimicrobial Resistance by 2050? PLoS Med. 2016 Nov;13(11):e1002184. Available from: https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002184
5. Murray CJL, Ikuta KS, Sharara F, Swetschinski L, Robles Aguilar G, Gray A, et al. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. The Lancet [Internet]. 2022 Feb 12;399(10325):629–55. Available from: https://doi.org/10.1016/S0140-6736(21)02724-0
6. Castro-Sanchez E, Moore LSP, Husson F, Holmes AH. What are the factors driving antimicrobial resistance? Perspectives from a public event in London, England. BMC Infect Dis. 2016 Sep 2;16(1):465. Available from: https://doi.org/10.1186/s12879-016-1810-x
7. Dyar OJ, Huttner B, Schouten J, Pulcini C, ESGAP (ESCMID Study Group for Antimicrobial stewardship). What is antimicrobial stewardship? Clin Microbiol Infect. 2017 Nov;23(11):793–8. Available from: https://doi.org/10.1016/j.cmi.2017.08.026
8. Carter EJ, Greendyke WG, Furuya EY, Srinivasan A, Shelley AN, Bothra A, et al. Exploring the nurses' role in antibiotic stewardship: A multisite qualitative study of nurses and infection preventionists. Am J Infect Control. 2018 May;46(5):492–7. Available from: https://doi.org/10.1016/j.ajic.2017.12.016

9. Olans RN, Olans RD, DeMaria A. The Critical Role of the Staff Nurse in Antimicrobial Stewardship—Unrecognized, but Already There. Clin Infect Dis. 2016 Jan 1;62(1):84–9. Available from: https://doi.org/10.1093/cid/civ697

10. Teague E, Bezuidenhout S, Meyer JC, Godman B, Engler D. Knowledge and Perceptions of Final-Year Nursing Students Regarding Antimicrobials, Antimicrobial Resistance, and Antimicrobial Stewardship in South Africa: Findings and Implications to Reduce Resistance. Antibiotics (Basel). 2023 Dec 16;12(12). Available from: https://doi.org/10.3390/antibiotics12121742

11. Rabano-Blanco A, Dominguez-Martis EM, Mosteiro-Miguens DG, Freire-Garabal M, Novio S. Nursing students' knowledge and awareness of antibiotic use, resistance and stewardship: A descriptive cross-sectional study. Antibiotics. 2019 Dec 1;8(4). Available from: https://doi.org/10.3390/antibiotics8040203

12. Al-Taani GM, Karasneh RA, Al-Azzam S, Bin Shaman M, Jirjees F, Al-Obaidi H, et al. Knowledge, Attitude, and Behavior about Antimicrobial Use and Resistance among Medical, Nursing and Pharmacy Students in Jordan: A Cross Sectional Study. Antibiotics. 2022 Nov 5;11(11).1559. Available from: https://doi.org/10.3390/antibiotics11111559

13. Varshney S, Karthika P, Ahmad S, Mehnaz S. Knowledge, Attitude and Practices Regarding Antimicrobial Resistance among Undergraduate Students. Indian J Community Health. 2024;36(4):556–64. Available from: https://doi.org/10.47203/IJCH.2024.v36i04.009

14. Rana S, Kaur KN, Narad P, Walia K, Saeed S, Chandra A, et al. Knowledge, attitudes and practices of antimicrobial resistance awareness among healthcare workers in India: a systematic review. Front Public Health. 2024 July 22;12:1433430. Available from: https://doi.org/10.3389/fpubh.2024.1433430

15. Chaudhary S, Singh AL. Impact of self-directed learning strategy, an innovative method in nursing undergraduates: Study protocol for a randomized controlled trial. PLoS One. 2025;20(7):e0325300. Available from: https://doi.org/10.1371/journal.pone.0325300

16. Jianvitayakij S, Niyomyart A, Junsawang C, Bualoy W, Butsing N, Monkong S, et al. Knowledge of antibiotics and antibiotic resistance, antibiotic use and eHealth literacy among nursing students in Thailand: a cross-sectional study. BMJ Open. 2024 Nov 9;14(11):e090956. Available from: https://doi.org/10.1136/bmjopen-2024-090956

17. Perez R, Hayes JE, Winters AR, Wrenn RH, Moehring RW. Antimicrobial stewardship knowledge, attitudes, and practices (KAP) among nurses. Antimicrobial Stewardship and Healthcare Epidemiology. 2024 Apr 18;4(1):e51. Available from: https://doi.org/10.1017/ash.2024.63

18. Akande-Sholabi W, Ajamu AT. Antimicrobial stewardship: Assessment of knowledge, awareness of antimicrobial resistance and appropriate antibiotic use among healthcare students in a Nigerian University. BMC Med Educ. 2021 Sep 10;21(488). Available from: https://doi.org/10.1186/s12909-021-02912-4

19. Akbar Z, Alquwez N, Alsolais A, Thazha SK, Ahmad MD, Cruz JP. Knowledge about antibiotics and antibiotic resistance among health-related students in a Saudi University. J Infect Dev Ctries. 2021 Jul 31;15(7):925–33. Available from: https://doi.org/10.3855/jidc.12329

20. Hussain I, Yousaf N, Haider S, Jalil P, Saleem MU, Imran I, et al. Assessing knowledge and perception regarding antimicrobial stewardship and antimicrobial resistance in university students of Pakistan: Findings and implications. Antibiotics. 2021 Jul 16;10(7):866. Available from: https://doi.org/10.3390/antibiotics10070866

21. McEwen J, Burnett E. Antimicrobial stewardship and pre-registration student nurses: Evaluation of teaching. J Infect Prev. 2018 Mar 1;19(2):80–6. Available from: https://doi.org/10.1177/1757177417726156

22. Jackson IL, Akpan MR, Adebayo GO. Knowledge and perception of antimicrobial resistance and antimicrobial stewardship among healthcare students in Nigeria. Afr Health Sci. 2023 Dec 27;23(4):195–202. Available from: https://doi.org/10.4314/ahs.v23i4.22

23. Molsaeter A, Henni S, Opheim R, Hoye S, Borosund E. Antibiotic-savvy nursing students? Nursing students' knowledge and self-assessed competence in antibiotic use and resistance. SykepleienForskning. 2023;18(93743) e-93743. Available from: https://doi.org/10.4220/Sykepleienf.2023.93743en

24. Bouchoucha SL, Kilpatrick M, Phillips NM, Hutchinson AF. Nursing students' awareness and perceptions of nurses' role in antimicrobial stewardship. Nurse Educ Pract. 2021 Mar;52:103036. Available from: https://doi.org/10.1016/j.nepr.2021.103036

25. De Vita E, Segala FV, Frallonardo L, Civile G, De Scisciolo D, Novara R, et al. Knowledge, Attitudes, and Practices toward Antimicrobial Resistance among Young Italian Nurses and Students: A Multicenter, Cross-Sectional Study. Ann Glob Health. 2024 Jul 22;90(1):46. Available from: https://doi.org/10.5334/aogh.4488

26. Yang C, Xie J, Chen Q, Yuan Q, Shang J, Wu H, et al. Knowledge, Attitude, and Practice About Antibiotic Use and Antimicrobial Resistance Among Nursing Students in China: A Cross Sectional Study. Infect Drug Resist. 2024 Mar 19;17:1085–98. Available from: https://doi.org/10.2147/IDR.S454489

27. Courtenay M, Hawker C, Gallagher R, Castro-Sanchez E, Gould DJ, Al Salti F, et al. The application of antimicrobial stewardship knowledge to nursing practice: A national survey of United Kingdom pre-registration nursing students. J Adv Nurs. 2025 Jan;81(1):198–209. Available from: https://doi.org/10.1111/jan.16195

28. Elsayed Hosny S, Mosaad Ali M, Fathy Mohamed R. Effect of Educational Guidelines regarding Preventive Measures of Antibiotic Resistance on Nursing Students' Knowledge and Attitude. Journal of Nursing Science Benha University. 2022 Jul 1;3(2):842–55. Available from: https://doi.org/10.21608/jnsbu.2022.247767