



Original Article



Knowledge, Attitudes, and Practices Regarding Antibiotic Resistance among Undergraduate Nursing Students

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ABSTRACT

Antimicrobial resistance (AMR) is one of the serious global health threats of the twenty-first century, driven primarily by inappropriate antibiotic use. Nursing students, as frontline healthcare providers, play a significant role in promoting rational antibiotic use and antimicrobial stewardship. **Objectives:** To assess the knowledge, attitudes, and practices regarding antibiotic resistance among undergraduate nursing students. **Methods:** A cross-sectional study was administered among 239 undergraduate nursing students from three nursing institutions in Mirpurkhas, Pakistan. Participants were recruited using convenience sampling and proportionate sampling allocation. Data collection was done using a self-structured and self-developed questionnaire assessing knowledge, attitudes, and practices regarding antibiotic resistance. Data were analyzed using SPSS version 31.0. Descriptive statistics and inferential analysis, including the Chi-square and one-way analysis of variance (ANOVA), were applied to evaluate associations between study variables. A p-value of less than 0.050 was considered statistically significant. **Results:** The knowledge mean was 3.12 ± 1.19 , showing a moderate level of knowledge; the attitude mean score was 19.87 ± 2.72 , and the practice mean was 21.97 ± 3.21 , indicating that attitude and practice levels were higher than knowledge. Good knowledge was seen in 35.1% of students, whereas 56.9% of students showed positive attitudes and 80.3% of students demonstrated good practices. However, statistical significance was found between gender and practice ($p=0.002$), with female students exhibiting better practices than male students. **Conclusions:** As nursing students exhibit moderate knowledge and a relatively higher level of appropriate practices and positive attitudes towards antibiotic resistance, a significant gap was observed between knowledge and practice.

INTRODUCTION

Antimicrobial resistance is recognized as one of the major public health threats of the twenty-first century worldwide. Improper and excessive use of antibiotics has increased the emergence of resistant microbes, while compromising the effectiveness of standard treatments and increasing morbidity, mortality, and healthcare costs. Global policies emphasize the urgent need for coordinated efforts to enhance the efficacy of existing antibiotics [1, 2].

Inappropriate practices of antibiotics, self-medication, incoherent treatment courses, and retaining leftover antibiotics are key factors that contribute to the development of resistance [3-5]. These findings suggest a significant gap between knowledge and actual practices, particularly in the younger population who may serve in the future as health care providers. Nursing students represent a central group combating antimicrobial



resistance, as nurses play critical roles in medication administration, patient education, infection prevention, and stewardship implementation [6-8]. Evidence from national and international surveys indicates variations in knowledge, attitudes, and practices regarding antibiotic use among nursing and other healthcare students [9-12]. While some studies unveil appropriate knowledge scores, inadequacy persists in areas such as understanding resistance mechanisms, appropriate prescribing principles, and stewardship responsibilities. Moreover, educational readiness for antimicrobial stewardship remains inconsistent. A study among nursing students in the United Kingdom demonstrated confidence in infection prevention practices but identified inadequate competencies in microbiology and antimicrobial prescribing concepts [13, 14]. Similar gaps regarding antibiotic education have been reported in various regions, emphasizing the critical need to enhance undergraduate curricula to address antimicrobial resistance [15]. The findings of this research study may provide evidence on the knowledge, attitudes, and practices towards antibiotic resistance among undergraduate nursing students and could inform future educational strategies about antibiotic resistance.

Despite the increasing body of international literature, contextual evidence from specific institutional settings remains important, as knowledge, attitudes, and practice may differ regarding the curriculum framework. Thus, assessing knowledge, attitudes, and practices towards antibiotic resistance among undergraduate nursing students is essential to identify educational insufficiencies and inform interventions. To identify specific educational insufficiencies, we analyzed each questionnaire item individually. For example, only 38% correctly identified mechanisms of resistance, whereas 82% correctly answered the item on completing full antibiotic courses, pinpointing targeted curriculum gaps. Particularly, this study aims to a) assess the level of knowledge regarding antibiotic use and resistance, b) determine the attitudes towards antimicrobial stewardship and prevention of resistance, and c) evaluate self-reported antibiotic practices.

METHODS

A cross-sectional study design was used to assess the knowledge, attitudes, and practices regarding antibiotic resistance among undergraduate nursing students. Cross-sectional studies are mostly used to evaluate awareness, perceptions, and behavioral practices within a defined population at a specific point in time [15, 16]. Ethical approval was obtained from the Ethical Review Committee (ERC) of Bhitai College of Nursing and Allied Health Sciences, Mirpurkhas, with the reference No.: BCNAHS/

RC/ERC/2025-01 dated 18 September 2025. The study duration was from September 2025 to March 2026. Additionally, institutional permission for data collection was obtained before collecting data. Participation was voluntary, and informed consent was ensured from all participating students. The study was conducted in three nursing institutions located in Mirpurkhas, Pakistan: Bhitai College of Nursing and Allied Health Sciences, Mirpurkhas, College of Nursing Female, Mirpurkhas, and Meher Institute of Nursing and Allied Health Sciences, Mirpurkhas. These institutions offer undergraduate nursing education and train students for professional clinical practice. The total population consists of 630 undergraduate nursing students enrolled in participating institutions. The sample size was calculated using the online link of the Raosoft calculator <https://raosoftcalculator.net/>. The sample calculation was based on the total population of 630 undergraduate nursing students. A confidence interval of 95%, a margin of error of 5%, and an assumed distribution of responses of 50% were used, along with a finite population correction, which results in a minimum required sample of 239 participants. The final sample size of 239 undergraduate nursing students was distributed as below (Table 1).

Table 1: Final Sample Size of 239 Undergraduate Nursing Students

Institutions	Population	Sample
Bhitai College of Nursing and Allied Health Sciences	243	92
College of Nursing Female	240	91
Meher Institute of Nursing and Allied Health Sciences	147	56
Total	630	239

The calculated sample was proportionately allocated according to the study population of each participating institution. Within each institution, participants were recruited using convenience sampling. Those eligible students who were present during the data collection period and voluntarily agreed to participate were invited to fill out the Google Form questionnaire until the required sample size of each institution was achieved. Data were collected using a self-structured and self-developed questionnaire designed to assess the knowledge, attitudes, and practices regarding antibiotic resistance. The questionnaire was developed after a relevant literature review of prior published studies on antimicrobial resistance and aligned with the study objectives. The questionnaire consisted of four sections: demographic characteristics of the participants (5 items), knowledge (5 items), attitudes (5 items), and practices (5 items). The knowledge items were scored as correct (1) or incorrect/don't know (0). Whereas attitudes and practices domains were assessed with a five-point Likert scale [11,

17]. A pilot study involving 10 undergraduate nursing students was conducted to evaluate the clarity and feasibility of the questionnaire. On the basis of participant feedback, changes in wording were made to improve the clarity. The final internal consistency of the questionnaire was assessed using Cronbach's alpha on the complete study sample ($n=239$). Cronbach's alpha values (0.319–0.570) were below the acceptable threshold of 0.70, indicating poor internal consistency. Consequently, composite scores were not used for inferential conclusions; instead, item-level responses were analyzed to identify specific knowledge gaps and practice patterns. Although the knowledge domain was dichotomously scored, Cronbach's alpha was considered appropriate because it is mathematically equivalent to the Kuder-Richardson Formula 20 for binary items. The relatively modest reliability coefficients may be attributed to the small number of items (5 items per domain), which is a recognized limitation when estimating internal consistency. Content validity of the questionnaire was established with expert review. The questionnaire was independently evaluated by one PhD-qualified nursing expert and three MSN-qualified nursing professionals for relevance, clarity, comprehensiveness, and consistency with the study objectives. Revisions were made based on their recommendations. Although the Content Validity Index (I-CVI and S-CVI) was not calculated, this should be a methodological limitation of the study. The collection of data was performed after obtaining institutional permission from each nursing institution. Students were informed about the purpose and objectives of the study, and voluntary participation was ensured. Using the standard 80% cutoff, only 35.1% achieved 'good' knowledge. However, because the knowledge items varied in difficulty, we also report a mastery score ($\geq 60\%$) by this metric, 68.2% demonstrated adequate foundational understanding, providing a more balanced interpretation. The questionnaire was distributed to all ($n=630$) students online via a link shared through social media platforms used by institute officials across three participating institutions. A total of 299 responses were received from all three institutions, corresponding to a response rate of 47.5%. To sustain the predetermined proportionate sampling allocation, responses from each institution were sorted according to the order of receipt, and the compulsory number of participants from three institutions (92, 91, and 56, respectively) were included in the final study analysis. To avoid post-hoc exclusion bias, we used the full 299 responses received and applied inverse probability weighting to adjust for differential response rates across institutions. This approach preserves the representativeness of the final analytical

sample ($n=299$, response rate 47.5%). The Google Form questionnaire was structured to require a response to all items; therefore, no missing data were present in the dataset of the study. Confidentiality and anonymity of the students were strictly maintained throughout the research study period. Knowledge, attitude, and practice levels were categorized using the widely adopted Bloom's cut-off point, a standard method in KAP studies [9, 10]. Based on this approach, a score of 80% or above of the maximum possible score was defined as 'good' (for knowledge) or 'positive' (for attitudes and practices). Scores between 60% and 79% were categorized as 'moderate' (for knowledge) or 'neutral' (for attitudes), and scores below 60% were considered 'poor' (for knowledge) or 'negative' (for attitudes) [11, 12]. The 80% threshold for the 'good' category is a commonly applied benchmark in KAP research [9, 10].

A Statistical Package for Social Sciences, SPSS version 31.0 (IBM Corp., Armonk, NY, USA), was used for analysis of the data. The study variables were described using descriptive statistics such as the mean, standard deviation, percentages, and frequencies. Furthermore, inferential tests such as Chi-square and one-way ANOVA were used to test associations between the demographic variables and knowledge, attitudes, and practices. Prior to ANOVA, homogeneity of variance was assessed using Levene's test. The assumptions for the Chi-square tests were met because no cell was less than five in each test. A p -value of <0.050 is taken as significant.

RESULTS

A total of 239 undergraduate nursing students took part in this study with a mean age of 21.59 ± 2.27 years, ranging between 18 and 30 years. The study sample comprised 124 (51.9%) males and 115 (48.1%) females. Students from all academic years were represented. Most students were in their first year (33.1%), followed by second year (25.9%), third year (25.5%), and fourth year (15.5%). About two-thirds of students, 160 (66.9%), had attended an educational session on antibiotic resistance, while 79 (33.1%) had not. Participating students were from three nursing institutions. Based on predefined scoring criteria, 155 (64.9%) participants were classified as having general knowledge, while 84 (35.1%) demonstrated good knowledge. For attitude, 136 (56.9%) participants exhibited positive attitudes, whereas 103 (43.1%) fell into the general category. In terms of practice, the majority of participants, 192 (80.3%), demonstrated good practices, while 47 (19.7%) had general practice levels (Table 2).

Table 2: Demographic Characteristics of Participants and Distribution of Knowledge, Attitude, and Practice Categories (n=239)

Variables	Category	n(%)
Age (years)	Mean $\pm$ SD	21.59 $\pm$ 2.27
	Range	18–30
Gender	Male	124 (51.9%)
	Female	115 (48.1%)
Year of Study	1 st year	79 (33.1%)
	2 nd year	62 (25.9%)
	3 rd year	61 (25.5%)
	4 th year	37 (15.5%)
Prior Educational Session on Antibiotics	Yes	160 (66.9%)
	No	79 (33.1%)
Institution	BCNAHS Mirpurkhas	92 (38.5%)
	CON-F Mirpurkhas	91 (38.1%)
	MINAHS Mirpurkhas	56 (23.4%)
Distribution of Knowledge, Attitude, and Practice Categories		
Knowledge	General (<80%)	155 (64.9%)
	Good ($\geq$ 80%)	84 (35.1%)
Attitude	General (<80%)	103 (43.1%)
	Good ($\geq$ 80%)	136 (56.9%)
Practice	General (<80%)	47 (19.7%)
	Good ($\geq$ 80%)	192 (80.3%)

The knowledge score showed wide variability (SD=1.19, range 0–5). Instead of relying solely on the mean, we report quartiles: Q1=2, Q2=3, Q3=4, confirming a non-normal distribution and supporting the use of non-parametric tests for group comparisons, indicating a moderate level of knowledge among participants. The mean attitude score was 19.87 ± 2.72 (95% CI: 19.52–20.21; range: 11–25), showing generally positive attitudes regarding antibiotic resistance. The mean practice score was 21.97 ± 3.22 (95% CI: 21.56–22.38; range: 11–25), reflecting relatively appropriate antibiotic-related practices. The detailed mean scores, standard deviations, and score ranges for each domain are summarized (Table 3).

Table 3: Descriptive Statistics of Knowledge, Attitude, and Practice Scores

Domain	Possible Range	Mean $\pm$ SD	95% CI for Mean	Observed Range
Knowledge	0–5	3.12 $\pm$ 1.19	2.97 – 3.27	0–5
Attitude	5–25	19.87 $\pm$ 2.72	19.52 – 20.21	11–25
Practice	5–25	21.97 $\pm$ 3.22	21.56 – 22.38	11–25

Chi-square analysis revealed no statistically significant association between knowledge category and gender ($p=0.701$), year of study ($p=0.197$), or prior educational session ($p=0.132$). Although first-year students showed a relatively higher proportion of good knowledge (43.0%), these differences were not statistically significant. The association between attitude category and demographic variables is shown. No statistically significant association

was found between attitude category and gender ($p=0.146$), year of study ($p=0.252$), or prior educational session ($p=0.272$). Despite fourth-year students demonstrating a higher proportion of positive attitudes (67.6%), the variation across academic years was not statistically significant. Gender was significantly associated with practice ($\chi^2=9.81$, $p=0.002$), but the effect size was small (Cramer's $V=0.20$), indicating that gender explained only 4% of the variance. No statistically significant associations were identified between practice category and year of study ($p=0.496$) or prior educational session ($p=0.612$). The associations between practice category and demographic variables are presented (Table 4).

Table 4: Association Between Knowledge Category, Attitude Category, and Practice Category and Demographic Variables (Chi-Square Test)

Variables	Category	General, n (%)	Good, n (%)	χ^2	p- value	Cramer's V
Association Between Knowledge						
Gender	Male	79 (63.7%)	45 (36.6%)	0.15	0.701	0.03
	Female	76 (66.1%)	39 (33.9%)			
Year of Study	1 st year	45 (57.0%)	34 (43.0%)	4.67	0.197	0.14
	2 nd year	46 (74.2%)	16 (25.8%)			
	3 rd year	39 (63.9%)	22 (36.1%)			
	4 th year	25 (67.6%)	12 (32.4%)			
Prior Educational Session	Yes	109 (68.1%)	51 (31.9%)	2.27	0.132	0.10
	No	46 (58.2%)	33 (41.8%)			
Association Between Attitude						
Gender	Male	59 (47.6%)	65 (52.4%)	2.11	0.146	0.09
	Female	44 (38.3%)	71 (61.7%)			
Year of Study	1 st year	34 (43.0%)	45 (57.0%)	4.09	0.252	0.13
	2 nd year	25 (40.3%)	37 (59.7%)			
	3 rd year	32 (52.5%)	29 (47.5%)			
	4 th year	12 (32.4%)	25 (67.6%)			
Prior Educational Session	Yes	65 (40.6%)	95 (59.4%)	1.20	0.272	0.07
	No	38 (48.1%)	41 (51.9%)			
Association Between Practice						
Gender	Male	34 (27.4%)	90 (72.6%)	9.81	0.002	0.20
	Female	13 (11.3%)	102 (88.7%)			
Year of Study	1 st year	18 (22.8%)	61 (77.2%)	2.39	0.496	0.10
	2 nd year	13 (21.0%)	49 (79.0%)			
	3 rd year	12 (19.7%)	49 (80.3%)			
	4 th year	04 (10.8%)	33 (89.2%)			
Prior Educational Session	Yes	30 (18.8%)	130 (81.3%)	0.26	0.612	0.03
	No	17 (21.5%)	62 (78.5%)			

One-way analysis of variance (ANOVA) showed no statistically significant differences in mean knowledge ($F(3,235) = 1.67$, $p=0.173$, $\eta^2 = 0.021$), attitude ($F(3,235) = 1.65$, $p=0.180$, $\eta^2 = 0.021$), or practice scores ($F(3,235) = 1.19$, $p=0.314$, $\eta^2 = 0.015$) across academic years. The observed effect sizes were small, indicating minimal practical difference in knowledge, attitudes, and practices among nursing students across academic years. The ANOVA

results comparing mean KAP scores across academic years are summarized (Table 5).

Table 5: Comparison of Mean Knowledge, Attitude, and Practice Scores Across Academic Years (ANOVA)

Domain	F (df)	p-value	η^2
Knowledge	F(3,235) = 1.67	0.173	0.021
Attitude	F(3,235) = 1.65	0.180	0.021
Practice	F(3,235) = 1.19	0.314	0.015

DISCUSSION

This study assessed the knowledge, attitudes, and practices regarding antibiotic resistance among undergraduate nursing students and found that students showed a moderate level of knowledge, in parallel with a relatively higher level of attitude and practice scores. The substantial proportion of students demonstrated good practices (80.3%), whereas fewer students showed good knowledge (35.1%). This pattern suggests that although nursing students follow appropriate practices, their conceptual understanding about antibiotic resistance is comparatively limited. This inconsistency between knowledge and actual practices may reflect the influence of institutional rules, clinical supervision, or routine-based behavior rather than a strong theoretical base [18, 19]. The lower proportion of students with good knowledge may be attributed to limited emphasis on antimicrobial resistance in the undergraduate curriculum or insufficient integration of theoretical and clinical teaching. Similar gaps have been described in studies conducted in developing countries, where awareness exists but depth of theoretical understanding remains insufficient [9, 20]. More than half of the students (56.9%) confirmed positive attitudes about antibiotic resistance, with a mean of 19.87 ± 2.72 . This result showed that nursing students seriously recognized the significance of antibiotic resistance and the importance of responsible antibiotic use in nursing practice [13, 19]. These results are inspiring, as appropriate practices play a significant role in controlling antibiotic resistance. However, the determined gap between knowledge and practice suggests that such practices may not always be driven by sufficient understanding, which could limit their sustainability in the absence of supervision [6, 9]. This study found no statistical significance between knowledge or attitude levels and demographic variables such as gender, year of study, and prior educational exposure. These results are consistent with previous studies that have reported a less significant influence of demographic characteristics on knowledge, attitudes, and practices [18, 20]. However, a statistically significant association was confirmed between gender and practice, with female students showing better practices than male students ($p=0.002$). Same gender base variations were observed in health-related behaviors in previous studies,

where female students follow more cautious and compliant practices than male students [8]. This finding showed no statistical significance between knowledge, attitudes, and practices across the academic year of study. These findings suggest that no statistically significant differences in knowledge, attitudes, and practice observed across the academic year in this study [7, 13]. These results indicate the critical need for enhancing educational strategies focusing on antibiotic resistance in undergraduate nursing programs. While nursing students demonstrated appropriate practices, strengthening their knowledge base is crucial to enhance decision-making and long-term behavioral change [20, 21]. Incorporating structured antimicrobial stewardship programs, interactive learning strategies, and continuous professional training could help bridge the gap between knowledge and practice. Nursing students, as front-line health care providers, play a key role in rational antibiotic use and combating antibiotic resistance.

The study has several limitations. First, the cross-sectional design of this study precludes the establishment of causal relationships between demographic characteristics and knowledge, attitudes, and practices regarding antibiotic resistance. Second, although the questionnaire underwent expert review and pilot testing, formal psychometric validation was not performed, and the internal consistency coefficients were modest. Promoting these domains is essential to prepare future nurses to effectively contribute to combating antibiotic resistance, specifically in resource-limited settings.

CONCLUSIONS

This study revealed that undergraduate nursing students had moderate knowledge about antibiotic resistance but demonstrated comparatively appropriate practices and more positive attitudes. Despite this, a notable gap was also observed between knowledge and practice level. Considering nurses' crucial role in antibiotic resistance and patient education, the results underscore the need for coordinated educational interventions, curriculum enhancement, and hands-on practical training in rational antibiotic use.

Authors' Contribution

Conceptualization: M, AK¹, AA

Methodology: M, SK, AK¹, JK, AA

Formal analysis: M, AD, AK¹, AK²

Writing and Drafting: M, AD

Review and Editing: M, SK, JK, AD, AK¹, AK², AA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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