



KNOWLEDGE, ATTITUDES AND PRACTICES REGARDING ANTIBIOTIC USE AND ANTIMICROBIAL RESISTANCE AMONG STUDENTS

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Abstract:

The present survey-based research paper evaluates knowledge, attitudes and practices (KAP) regarding antibiotic use and antimicrobial resistance (AMR) among 288 student respondents. AMR is a major public health concern because inappropriate antibiotic exposure can contribute to the selection and spread of resistant microorganisms. Previous KAP studies have shown that awareness of AMR does not always translate into appropriate antibiotic-use behaviour. The present study used a structured questionnaire to assess students' awareness, knowledge, attitudes, antibiotic-use practices, information sources and willingness to participate in AMR education. The findings are presented as primary survey results and are compared with published research. This design helps identify both strengths and specific areas requiring further educational attention among the participating students.

Keywords Gut Antibiotics, Antimicrobial Resistance, KAP, Students, Survey-Based Research, Antimicrobial Stewardship, Antibiotic Use.

1. Introduction

Antibiotics are essential medicines for the treatment of bacterial infections, but their effectiveness is increasingly threatened by antimicrobial resistance. Antimicrobial resistance develops when microorganisms change in ways that reduce the effectiveness of medicines used against them, making infections more difficult to treat [1]. Inappropriate antibiotic use, including unnecessary treatment and incorrect use, is an important behavioural factor associated with antimicrobial resistance [2]. Knowledge, attitudes and practices surveys are useful for identifying misconceptions, patterns of antibiotic use and areas where interventions may be needed [2]. Research among university students has reported that antibiotic knowledge can vary according to academic background and level of study [3].

Studies among pharmacy students have also shown that misconceptions about antibiotic use for viral respiratory illnesses can remain despite professional education [4]. Similarly, research among veterinary students has

highlighted the importance of antimicrobial education because antibiotic use in animals is part of the wider One Health AMR problem [5]. Medical students may recognize AMR as an important issue but can still require additional practical learning about appropriate antibiotic decision-making [6]. The present work is therefore designed as a survey-based research paper in which primary data from 288 students are analysed and interpreted in relation to previous published evidence.

Assessing knowledge, attitudes, and practices (KAP) can therefore help identify misconceptions, risky behaviours, and areas where awareness needs to be improved. Previous KAP studies among university students have demonstrated the value of examining these three aspects together rather than focusing only on knowledge of AMR [7, 8]. Therefore, the present study aims to assess the knowledge, attitudes, and practices regarding antibiotic use and antimicrobial resistance among students. The findings may help identify existing gaps in awareness and inappropriate practices and can provide useful information for developing educational activities that encourage responsible antibiotic use and contribute to efforts to reduce antimicrobial resistance.

2. Materials and methods

2.1 Study design and participants

A descriptive cross-sectional survey was conducted among college students to assess knowledge, attitudes and practices (KAP) regarding antibiotic use and antimicrobial resistance (AMR). A total of 370 students from different academic disciplines participated in the study. Biotechnology, Life Science and Pharmacy students were grouped as life/health-science-related, while students from other disciplines constituted the other academic group.

2.2 Data collection

Data were collected using a structured, self-administered questionnaire distributed electronically through Google Forms. The questionnaire included demographic characteristics, 10 knowledge items, 10 attitude statements, antibiotic-use practices, sources of information and AMR-related educational interests.

2.3 KAP scoring

Knowledge items were scored as 1 for a correct response and 0 for an incorrect or "don't know" response, giving a total score of 0–10. Attitude items were scored on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), giving a total score of 10–50. Practice items reflecting appropriate antibiotic-use behaviour were scored 1, with inappropriate responses scored 0, producing a practice score of 0–9. Higher scores indicated better knowledge, more favourable attitudes and more appropriate practices. For descriptive classification, KAP scores were categorized as poor (<50%), moderate (50–74%) and good (≥75%).

2.4 Statistical analysis

Categorical variables were expressed as frequency and percentage, while continuous KAP scores were summarized as mean ± SD, median and range. The Mann–Whitney U test was used to compare KAP scores between life/health-science-related and other academic groups, and the chi-square test was used to examine associations between categorical variables. Relationships among knowledge, attitude and practice scores were assessed using Spearman's rank correlation coefficient (ρ).

A simple linear regression model was used to examine whether knowledge/awareness predicted attitude scores, with attitude score as the dependent variable and knowledge score as the independent variable. The regression coefficient (B), standardized coefficient (β), R^2 , adjusted R^2 and F-statistic were reported. Statistical significance was set at $p < 0.05$.

2.5 Ethical considerations

Participation was voluntary and responses were collected for academic research purposes. Confidentiality of participant responses was maintained. The applicable institutional ethics approval or exemption should be reported according to the actual study approval status.

3. Results

3.1 Study participants

A total of 370 students participated in the study. The age distribution comprised 238 (64.3%) participants aged 19–20 years, 74 (20.0%) aged 21–22 years, 25 (6.8%) aged 22–23 years and 24 (6.5%) aged above 23 years. Female students comprised 264 (71.4%) of the participants, while 103 (27.8%) were male and 1 (0.3%) selected other. The academic-stream distribution included 143 (38.6%) Biotechnology students, 31 (8.4%) Life Science students, 20 (5.4%) Pharmacy students and 174 (47.0%) students from other disciplines. Biotechnology, Life Science and Pharmacy students were combined as the life/health-science-related group ($n = 194$), while 174 students constituted the other-discipline group. The age and academic-stream distributions are presented in Figures 1 and 2.

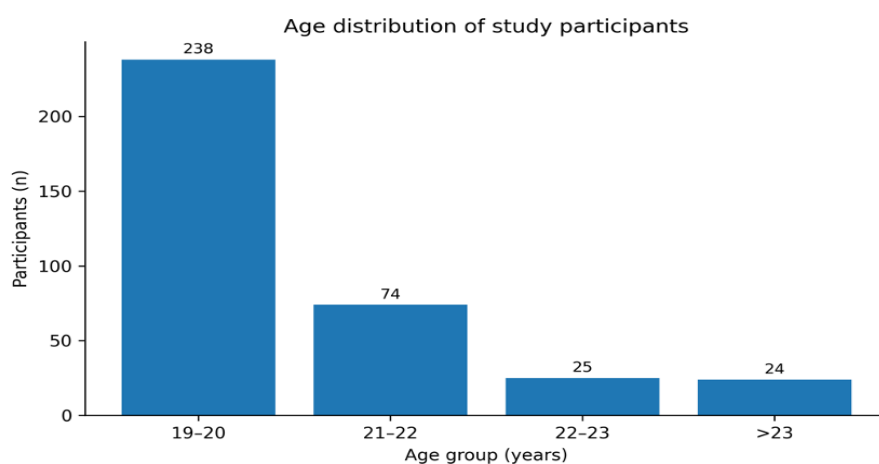


Figure 1: Age distribution of study participants (N = 370)

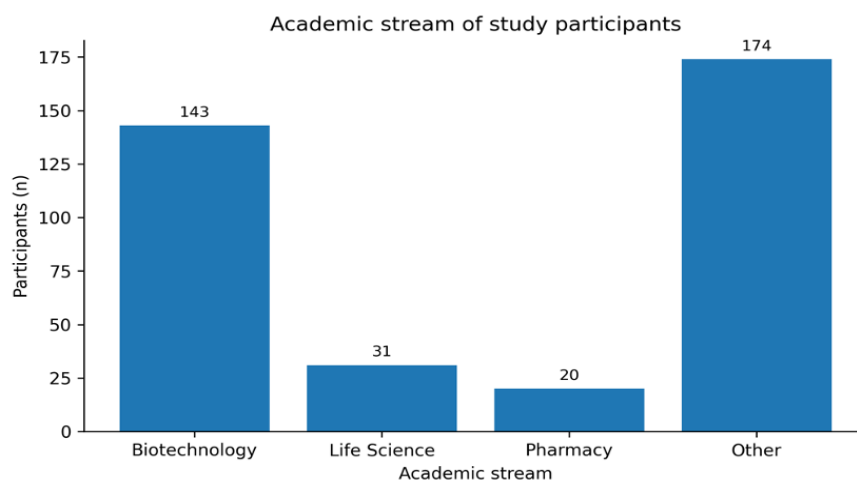


Figure 2: Academic stream of study participants (N = 370)

3.2 Descriptive KAP scores

The mean knowledge score was 7.23 ± 2.22 out of 10, with a median of 8 and a range of 0–10, corresponding to 72.3% of the maximum possible score. The mean attitude score was 44.55 ± 4.53 out of 50, with a median of 45 and a range of 29–50, corresponding to 89.1%. The mean practice score was 6.57 ± 1.94 out of 9, with a median of 7 and a range of 0–9, corresponding to 73.0% (Table 1). Thus, attitude scores were comparatively higher than knowledge and practice scores.

Table 1: Descriptive statistics of knowledge, attitude and practice (KAP) scores among study participants (N = 370)

Domain	N	Mean $\pm$ SD	Median	Range	Mean %
Knowledge /10	370	7.23 ± 2.22	8	0–10	72.3%
Attitude /50	370	44.55 ± 4.53	45	29–50	89.1%
Practice /9	370	6.57 ± 1.94	7	0–9	73.0%

Using the predefined categories of poor (<50%), moderate (50–74%) and good ($\geq 75\%$), 199 (55.9%) participants had good knowledge, 104 (29.2%) had moderate knowledge and 53 (14.9%) had poor knowledge. Attitude scores were predominantly favourable, with 340 (93.7%) participants classified as having a good attitude and 23 (6.3%) having a moderate attitude; no participant was classified in the poor-attitude category. For practice, 201 (56.1%) participants demonstrated good practices, 95 (26.5%) moderate practices and 62 (17.3%) poor practices (Figure 3).

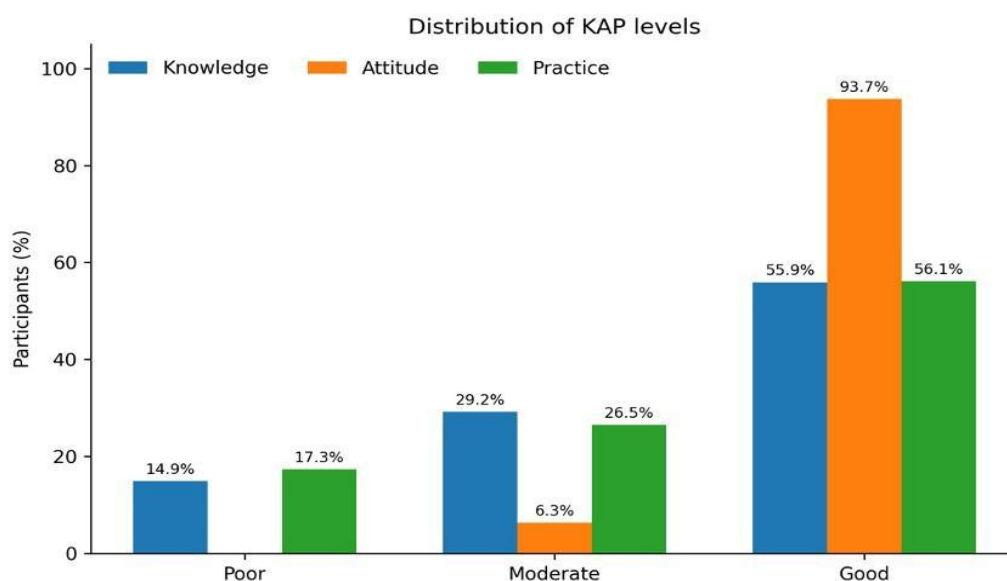


Figure 3: Distribution of knowledge, attitude and practice levels among study participants

3.3 Comparison of KAP scores according to academic background

KAP scores were compared between students from life/health-science-related disciplines ($n = 194$) and those from other academic disciplines ($n = 174$). Students in the life/health-science-related group had higher mean knowledge scores (8.18 ± 1.45 vs. 6.12 ± 2.45), attitude scores (45.32 ± 4.47 vs. 43.72 ± 4.46) and practice scores (7.15 ± 1.81 vs. 5.95 ± 1.86) than students from other disciplines. All three comparisons were statistically

significant ($p < 0.001$). The corresponding effect sizes were 0.502 for knowledge, 0.236 for attitude and 0.387 for practice, with the largest between-group effect observed for knowledge (Table 2).

Table 2: Comparison of knowledge, attitude and practice scores between life/health-science-related (n = 194) and other academic groups (n = 174).

Domain	Life/ health science-related (n = 194)	Other disciplines (n = 174)	p-value	Effect size
Knowledge	8.18 ± 1.45	6.12 ± 2.45	<0.001	0.502
Attitude	45.32 ± 4.47	43.72 ± 4.46	<0.001	0.236
Practice	7.15 ± 1.81	5.95 ± 1.86	<0.001	0.387

3.4 Antibiotic use according to academic background

Among the 370 participants, 291 (78.6%) reported using antibiotics during the previous 12 months, 60 (16.2%) reported no use and 14 (3.8%) were unsure. Antibiotic use was reported by 165 (85.1%) participants in the life/health-science-related group and 125 (71.8%) in the other-discipline group. The distribution of responses differed significantly between the two academic groups ($\chi^2(2) = 7.51$, $p = 0.023$) (Table 3).

Table 3: Antibiotic use during the previous 12 months according to academic background (N = 370)

Response	Overall (N 370)	Life/health science-related (n = 194)	Other disciplines (n = 174)	χ^2 , p
Yes	291 (78.6%)	165 (85.1%)	125 (71.8%)	$\chi^2(2) = 7.51$, $p = 0.023$
No	60 (16.2%)	24 (12.4%)	36 (20.7%)	
Don't know	14 (3.8%)	5 (2.6%)	9 (5.2%)	
Total	370 (100%)	194 (100%)	174 (100%)	

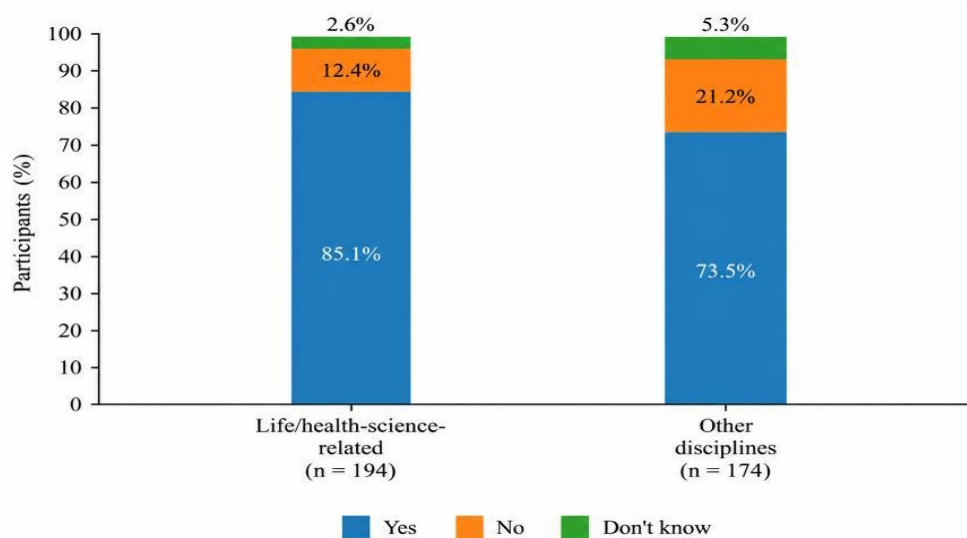


Figure 4: Antibiotic use during the previous 12 months by academic group

3.5 Correlation between KAP domains

Spearman correlation analysis demonstrated significant positive relationships among all three KAP domains. Knowledge showed a moderate positive correlation with attitude ($\rho = 0.575$, $p < 0.001$) and a positive correlation with practice ($\rho = 0.377$, $p < 0.001$). Attitude was also positively correlated with practice ($\rho = 0.266$, $p < 0.001$). Thus, higher knowledge scores were associated with more favourable attitudes and, to a lesser extent, more appropriate practices (Table 4; Figure 5).

Table 4: Spearman correlations between knowledge, attitude and practice scores

Variables	Spearman ρ	p-value
Knowledge–Attitude	0.575	<0.001
Knowledge–Practice	0.377	<0.001
Attitude–Practice	0.266	<0.001

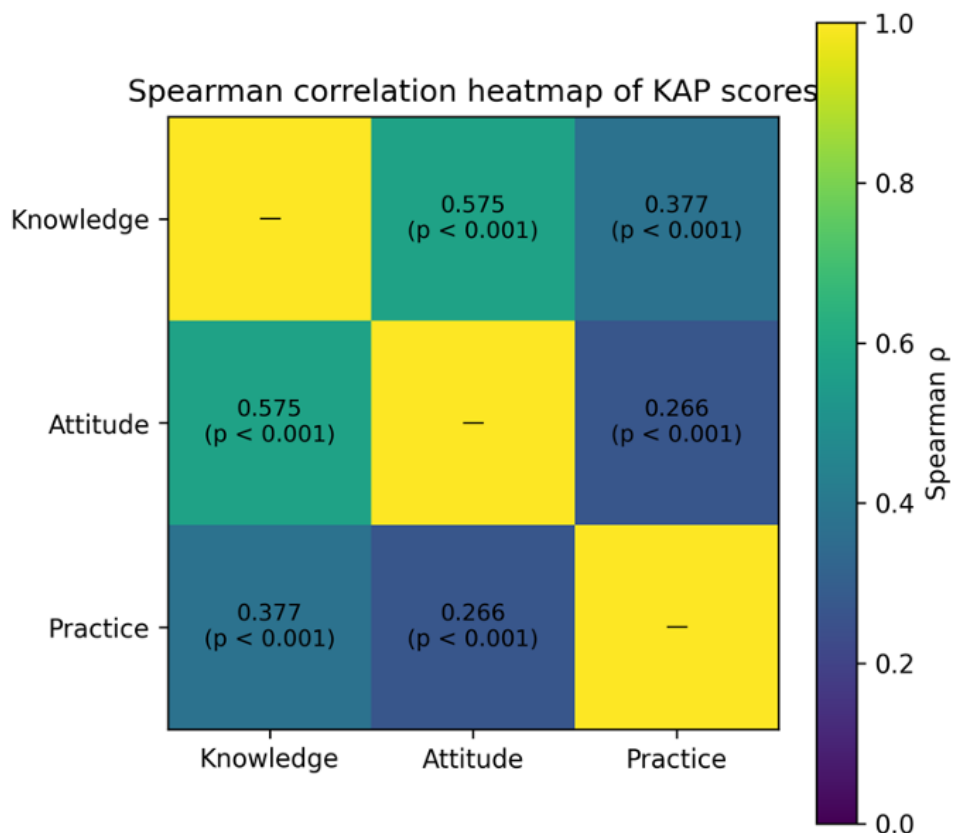


Figure 5: Spearman correlation heatmap of knowledge, attitude and practice scores

3.6 Simple linear regression analysis

A simple linear regression model was used to examine whether knowledge/awareness was associated with attitude scores. Knowledge/awareness was a significant positive predictor of attitude ($\beta = 0.556$, $B = 1.128$, $p < 0.001$). The model explained 30.9% of the variance in attitude scores ($R^2 = 0.309$; adjusted $R^2 = 0.307$), with a significant overall model fit, $F(1,351) = 156.90$, $p < 0.001$. Thus, each one-point increase in the knowledge score was associated with an estimated 1.13-point increase in the attitude score (Table 5).

Table 5: Simple linear regression model of attitudes based on awareness and understanding of antibiotic resistance (N = 370).

Variable	β	B	p-value
Knowledge/awareness score	0.556	1.128	<0.001
R ²		0.309	
Adjusted R ²		0.307	
N		370	
F(df)		156.90 (1,351)	<0.001

Note: β = standardized regression coefficient; B = unstandardized regression coefficient; R² = coefficient of determination. The dependent variable was the total attitude score (10–50), and the independent variable was the total knowledge/awareness score (0–10).

4. Discussion

The present study of 370 college students showed a generally favourable profile of antibiotic-related knowledge, attitudes, and practices, although important gaps remained. The mean knowledge score was $7.23 \pm 2.22/10$ (72.3%), compared with $44.55 \pm 4.53/50$ (89.1%) for attitude and $6.57 \pm 1.94/9$ (73.0%) for practice. Thus, favourable attitudes were more pronounced than knowledge and practice, indicating that positive perceptions regarding antibiotic use do not necessarily ensure consistently appropriate behaviour. Similar differences between knowledge, attitudes, and practices have been reported among university students in Lebanon, Bangladesh, and zambia.[7,9,10]

Although more than half of the students demonstrated good knowledge, specific misconceptions were evident. Only 155 (41.9%) identified bacterial infections as the principal indication for antibiotics, while 174 (47.0%) correctly recognised that antibiotics should not be used for common cold or influenza. These findings are consistent with the systematic review by Nogueira-Uzal *et al.* [11], which identified persistent misconceptions among students regarding antibiotic treatment of common infections, particularly upper respiratory tract infections. Similar misconceptions have also been documented among the general public, where incomplete understanding of antibiotic resistance and its causes remains common [12]. The high attitude score in the present study is encouraging, with 93.7% of students classified as having a good attitude. Students largely recognised the importance of professional guidance, responsible antibiotic use, prevention of resistance, and further education. [13], using a comparable student population, also reported generally favourable awareness and attitudes while identifying misconceptions about the appropriate use of antibiotics. Their study further demonstrated differences in antibiotic-related knowledge across academic disciplines, particularly with health-science students showing higher knowledge than students from non-health disciplines.

Practice scores were lower than attitude scores, with 56.1% of students classified as having good practices. Several behaviours nevertheless indicated potential areas of concern. While 232 students reported never taking antibiotics without professional consultation and 311 reported always following prescribed dose and timing, 99 students had saved leftover antibiotics, 95 had shared antibiotics, and 63 had used someone else's antibiotics. Such behaviours are important from an antimicrobial-stewardship perspective because appropriate knowledge may not consistently translate into medication practices. In [10] similarly found that students could demonstrate moderate knowledge while continuing to report inappropriate practices, including self-medication and retention or sharing of leftover antibiotics.

Antibiotic exposure was also substantial, with 291 of the 370 students reporting antibiotic use during the previous 12 months. This finding is comparable with the high level of antibiotic exposure reported among Indian medical students [13]. In the present study, antibiotic use was more frequently reported among students from life/health-science-related disciplines than among those from other disciplines. This finding should be interpreted alongside the KAP comparison rather than as evidence that greater academic exposure causes greater antibiotic consumption. Previous studies have similarly identified differences in antibiotic-related knowledge and behaviour according to academic background [14,3]. A particularly important finding was the significantly higher KAP scores among students from life/health science-related disciplines. Knowledge was higher in this group (8.18 ± 1.45 vs. 6.12 ± 2.45), as were attitude (45.32 ± 4.47 vs. 43.72 ± 4.46) and practice scores (7.15 ± 1.81 vs. 5.95 ± 1.86 ; all $p < 0.001$). The largest effect was observed for knowledge (effect size = 0.502). This pattern is supported [9], who found significantly better antibiotic knowledge among biological-science students than among students from nonbiological disciplines. Similarly, [14] reported differences in antibiotic knowledge and attitudes between pharmacy student groups with different educational backgrounds. These findings suggest that academic exposure to microbiology, pharmacology, infection, and antimicrobial resistance may contribute to stronger understanding, while also highlighting the need to extend AMR education beyond health-related programmes.

The correlation analysis demonstrated significant positive relationships among all three KAP domains. Knowledge was moderately correlated with attitude ($\rho = 0.575$, $p < 0.001$) and positively correlated with practice ($\rho = 0.377$, $p < 0.001$), while attitude showed a weaker correlation with practice ($\rho = 0.266$, $p < 0.001$). The stronger knowledge-attitude association suggests that understanding of antibiotic resistance is closely related to favourable perceptions, whereas the weaker knowledge-practice relationship indicates that behaviour is influenced by factors beyond knowledge alone. [3], similarly reported positive relationships between knowledge and awareness-related domains, while the broader KAP literature emphasises that knowledge gains do not automatically result in appropriate antibiotic-use behaviour.

The regression analysis provided further support for the relationship between knowledge and attitude. Knowledge/awareness was a significant positive predictor of attitude ($B = 1.128$, $\beta = 0.556$, $p < 0.001$), with the model explaining 30.9% of the variance in attitude scores ($R^2 = 0.309$). This finding indicates that stronger understanding of antibiotic resistance is associated with more favourable attitudes. However, the cross-sectional design does not establish causality, and the remaining unexplained variance suggests that other educational, social, and behavioural factors also contribute to attitudes toward antibiotic use.

The findings have practical implications for university-based antimicrobial-stewardship education. The WHO competency framework emphasises education and training as an important component of addressing AMR and recommends the development of competencies related to appropriate antimicrobial use among health workers and students [15]. The present findings suggest that such education should not be restricted to health-related disciplines. Short curriculum-based modules, seminars, awareness campaigns, and practical examples addressing bacterial versus viral infections, appropriate antibiotic indications, adherence to treatment, self-medication, sharing of antibiotics, and disposal of leftovers could be incorporated across undergraduate programmes. This approach is also consistent with recommendations from studies among non-healthcare university students, [10].

5. Limitations

This study has some limitations. The cross-sectional design limits causal interpretation of the observed associations between knowledge, attitudes, and practices. Data were self-reported and may therefore be

influenced by recall and social-desirability bias. The study was conducted among college students, which may limit the generalisability of the findings to other age groups and populations. Nevertheless, inclusion of students from different academic disciplines provides useful insight into antibiotic-related KAP among young adults.

6. Conclusion

According to the study, college students' attitudes towards antibiotic use and antimicrobial resistance were positive, but their knowledge and appropriate practices were relatively moderate. Compared to students from other disciplines, those from life/health science-related fields demonstrated noticeably higher knowledge, attitude, and practice scores. Strengthening antibiotic and AMR education is crucial, as evidenced by the positive correlations between knowledge, attitude, and practice. Young adults may be encouraged to use antibiotics responsibly if targeted antimicrobial stewardship education is integrated across academic disciplines with a stronger focus on converting knowledge into appropriate antibiotic-use practices.

7. Recommendations

Based on the findings of the present study, several measures can be suggested to promote responsible antibiotic use and improve awareness of antimicrobial resistance among students. Regular awareness programmes: Colleges and universities should conduct regular awareness programmes, seminars, workshops, and interactive sessions on appropriate antibiotic use and antimicrobial resistance. Improve knowledge about antibiotic use: Students should be clearly informed that antibiotics are effective against bacterial infections but are not normally used to treat viral illnesses such as the common cold and influenza. Encourage professional consultation: Students should be encouraged to consult a qualified healthcare professional before starting, changing, or stopping antibiotic treatment rather than relying on self-medication or advice from friends and family. Promote completion of prescribed treatment: Educational activities should emphasize the importance of following the prescribed dose and duration of antibiotics and avoiding discontinuation simply because symptoms have improved. Discourage sharing and reuse: Students should be made aware that antibiotics should not be shared with others or reused from previous illnesses without professional advice. Improve disposal practices: Colleges and healthcare facilities should provide information about the safe disposal or return of unused and leftover antibiotics to reduce inappropriate use and environmental contamination. Involve healthcare professionals: Healthcare professionals can play an important role in educating students about appropriate antibiotic use, possible consequences of misuse, and ways to prevent antimicrobial resistance. Include AMR education in academic activities: Basic information about antibiotic resistance and antimicrobial stewardship could be incorporated into relevant college courses, especially for students studying biological and health-related subjects. Encourage further research: Similar studies should be conducted among larger and more diverse student populations to identify differences in knowledge, attitudes, and practices and to evaluate the effectiveness of educational interventions.

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