Original Research Article

Knowledge, Awareness and Attitude of Pharm.D. Students on Antimicrobial Stewardship- A Report

ABSTRACT

Antimicrobial Stewardship(AMS) is a strategy to optimize antimicrobials and prevent the emergence of antimicrobial resistance(AMR). Pharm.D. students are future Clinical pharmacists who play a key role in promoting rational use and implementing AMS programs. Only a few studies about their knowledge, awareness and attitude regarding AMS exist.A cross-sectional study was conducted in the middle of December 2023, among Pharm.D. students of different academic years from three Pharmacy colleges and Pharm.D. graduates in South India. The survey was conducted online using a validated questionnaire and Pharm.D. students audited the results under the guidance of an Infectious disease specialist. The survey comprised 17 questions covering demographic information, AMS knowledge, attitude and awareness questionnaires. This study included a total of 190 respondents. However, only 32.11% reported having participated in any AMS activity during their period of pharmacy education. Pharm.D. students have a positive attitude (72.48%) and optimal awareness (65.13%) but they lack sufficient knowledge (45.19%) towards AMS, specifically regarding surgical prophylaxis and antibiotic allergy testing. It serves as a valuable resource for educators, policymakers and stakeholders involved in shaping the curricula of Pharm.D. programs to enhance the training and preparedness of students in AMS practices. In the future, AMS education programs should target not only clinicians but also Pharm.D. students and interns.

KEYWORDS: Antimicrobial Stewardship; Antimicrobial Resistance; Pharm.D. Students, Pharmacists

INTRODUCTION

Antimicrobial Stewardship (AMS) is a vital strategy to combat the growing threat of antimicrobial resistance (AMR) and optimize patient outcomes (1). The responsible use of antimicrobial agents requires not only the active participation of healthcare professionals but also the inclusion of future healthcare providers, such as Pharm.D. students. The Pharm.D. program aims to educate and train students on various aspects of healthcare, including AMS, to ensurerational antibiotic therapy. However, not many hospitals have a role for them in AMS (2).

The excessive and inappropriate use of antibiotics in both community and hospital settings is a major contributing factor to the global problem of AMR. Research has revealed that a significant percentage of antibiotics prescribed in hospitals (20% to 50%) are unnecessary, while more than half of the antibiotics dispensed by community pharmacies are not rational (3). Halting the sale of medications without a prescription in retail pharmacies is vital for reducing over-the-counter dispensing of antibiotics compared to the government's implementation of strict measures to encourage adherence to stewardship practices (4). Developing countries face an even more severe situation with AMR due to increasing incidences of infectious diseases, lack of proper diagnostic facilities, insufficient training and knowledge among healthcare professionals, inadequate public awareness and the unrestricted sale of antibiotics without prescriptions. Non-human use of antimicrobials such as in animals for prophylaxis and as growth promoters is also a factor that contributes to AMR which varies from developed countries (5). Additionally, the limited involvement of clinical pharmacists in India results in inadequate patient counselling, contributing to a lack of public awareness about the importance of completing antibiotic courses and the ineffectiveness of antibiotics against viral infections. To tackle these challenges effectively, Pharm.D. students must acquire adequate knowledge of AMS to facilitate comprehensive patient counselling (6).

Given this context, it becomes crucial for healthcare professionals to possess adequate knowledge about rational antibiotic use and the prevention of AMR to curb the rise of AMR and maintain the effectiveness of antibiotics. Enhancing understanding and awareness about antibiotics among healthcare professionals and the public is one of the key elements of the World Health Organization's (WHO) global action plan to manage AMR (7). This can be achieved through effective education, training and communication initiatives. Education and training on appropriate antibiotic use during studies have been shown to positively influence attitudes and behaviors when it comes to antibiotic usage. Therefore, such training is of utmost importance for doctors, pharmacists and nurses (3).

This study aims to assess the knowledge, awareness, and attitude of Pharm.D. students of different academic years and graduates towards AMS. Understanding these factors is crucial in identifying potential gaps in education, and training and determining future clinical pharmacist's readiness to contribute effectively to AMS programs.

MATERIALS AND METHODS

A Cross-sectional study was conducted with a structured questionnaire administered to a randomized sample of Pharm.D. students of different academic years from three different Pharmacy colleges and among PharmD Graduates in South India. The data was collected using Google Forms during the second and third week of Dec 2023. The survey link was distributed online through messaging only among Pharm.D. students and graduates and Pharm.D. students audited the results under the guidance of an Infectious Disease Specialist.

Inclusion Criteria

- All students of Pharm.D. from 1st year to Interns who are willing to participate are included from three universities in South India.
- Pharm.D. graduates working as Clinical Pharmacists, Clinical Research Associates, or Assistant professors.

Exclusion Criteria

- Students and graduates who are not willing to participate.
- Diploma, Bachelor and Master of Pharmacy students.

The sample size is determined from the overall population by the formula:

$n= (Z^2 P(1-P)) / D^2$

Where:

- n- Sample size
- Z- Confidence interval=95% (1.96)
- P- Anticipated proportion=50% (0.5) to allow maximum sample size
- D- Margin of errors=5% (0.05)

On substituting the values:

$n= (Z^2 P(1-P)) / D^2$

$n= ((1.96)^2 X 0.5(1-0.5)) / (0.05)^2$

$n= 384.16$

There was a total of 376 Pharm.D. students and graduates.

So,

N=376 (total population)

Therefore, the corrected sample size (Nf) is calculated as:

$Nf= n / (1+ (n / N))$

$Nf= 384.16 / (1+(384.16 / 376))$

$Nf= 190$

Therefore, the calculated sample size is 190.

The methodology employed involves the utilization of proportional sampling, specifically employing Stratified Random Sampling with proportional allocation to each stratum. The calculation of the candidates' representation in the study is determined based on the proportion from their corresponding academic year.

Approval for the study's ethical conduct was obtained from the Institutional Ethics Committee of Apollo Hospitals in Chennai. Furthermore, individual participant consent is deemed unnecessary since only individuals who willingly participate are included in the study.

For the assessment of the Knowledge, Awareness and Attitude of the participants towards AMS, a questionnaire was initially designed by using basic questions regarding antibiotic usage and resistance.

The questionnaire included multiple choice questions covering key areas such as basic knowledge of AMR, understanding and awareness of rational antimicrobial use, AMS principles, and personal attitudes towards stewardship practicesbased on few previous literatures (3,14). The survey questionnaire consisted of 17 questions including the responder's demographics, knowledge, awareness, and attitude questionnaires toward AMS. Demographic questions included name, age, gender, and year of study. The responses were compared with the predetermined answers and only valid responses were considered in calculating the percentage of total correct answers and assessing the level of knowledge, awareness, and attitude.

We included questions related to the choice and duration of surgical prophylaxis, common resistance in hospitals, antibiotic allergy testing, its significance in patient care, and the available testing methods. The purpose was to gauge their understanding and familiarity with these topics. Additionally, we sought to understand the students' attitudes toward AMS programs. This was accomplished by asking questions regarding their interest in participating in such future programs and their perception of the importance of AMS in healthcare.

The collected data were entered in Microsoft Excel sheets and analysed descriptively using Statistical Package for Social Science (SPSS) version 23. A two-sample independent t-test and chi-square test was used to compare the levels of knowledge, awareness and attitude among different academic years and graduates. The p-value < 0.05 was considered as a significant association.

RESULTS

This study included a total of 190 respondents. Gender, academic year of study and age distribution of our study population were depicted in table-1. By examining the responses, this study provides insights into the level of knowledge, awareness and attitudes toward responsible antimicrobial use and their preparedness to contribute to AMS initiatives.

Table 1. Descriptive Statistics Demographics

Variables	Percentage(N)
Gender	
Male	43.68% (83)
Female	55.79% (106)
Prefer Not to Say	0.53% (1)
Year of Study	
I	7.89% (15)
II	7.89% (15)
III	13.68 (26)
IV	22.11% (42)
V	20.00% (38)
Intern	16.84% (32)

Graduates	11.59% (22)
Age	
17-20	25.26% (48)
21-24	65.79% (125)
>=25	8.95% (17)

Out of 190 respondents, only 32.11% (61) Pharm.D. students reported having participated in any AMS programs and activities during their period of pharmacy education but 72.6% (138) preferred to attend AMS training in the future as shown in Figure 1. More than 80% of the respondents marked wrong options for the question based on antibiotic allergy testing. Nearly 38% opted for the right antibiotic as surgical prophylaxis. However, about 71.05% were not sure about the required standard dose of Antibiotics for surgical prophylaxis.

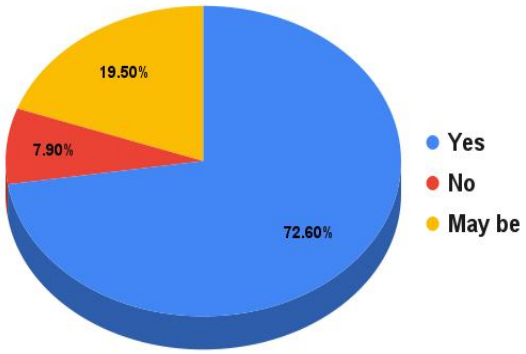


Fig. 1 Percentage of students preferring to attend AMS training

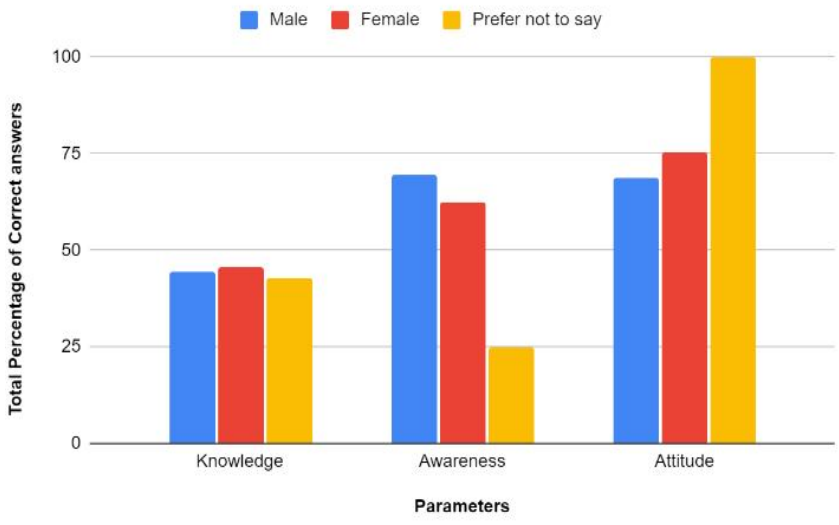


Fig. 2 Knowledge, Awareness and Attitude among males and females

Figure 2 shows that females are less aware but have more positive attitudes compared to males. This study also highlighted that there is no gender disparity in knowledge with only a slightly higher percentageof correct answers by females than males and others.

Table 2. Percentage Mean Score of correct answers

Parameters	Survey questionnaires	Total no. of correct answers	% Mean Score
Knowledge	Based on Antibiotic Resistance	438	45.19%
	Based on Surgical Prophylaxis	127	
	Based on antibiotic allergy testing	36	
Awareness	About antibiotic susceptibility testing	147	65.13%
	About basics of AMS	287	
	Actively participated in AMS program	61	
Attitude	Interest in attending future AMS programs	138	72.48%

Knowledge, awareness, and attitude scores of Pharm.D. students and interns were described in Table 2. This depicts the lack of sufficient knowledge among Pharm.D. students. But it also showed good awareness and a positive attitude of them toward AMS. Therefore, integrating AMS classes into the curriculum can significantly enhance the knowledge of future clinical pharmacists, empowering them to play a pivotal role in combating AMR.Theoretically, it can help students develop a deeper understanding of the mechanisms of AMR and the importance of prudent antibiotic use. Clinically, by emphasizing the role of clinical pharmacists in antimicrobial stewardship programs (ASPs), the curriculum can instill a sense of responsibility and commitment among students toward promoting appropriate antibiotic prescribing practices.Furthermore, AMS classes can equip students with practical skills in antimicrobial prescribing, monitoring, and patient education, thereby preparing them to effectively contribute to multidisciplinary AMS teams in healthcare settings.

Table 3 not only demonstrates a rise in the percentage of correct answers with advancing academic years but also indicates that the increase in percentage of correct answers outpaces that of wrong answers as the academic year progresses.

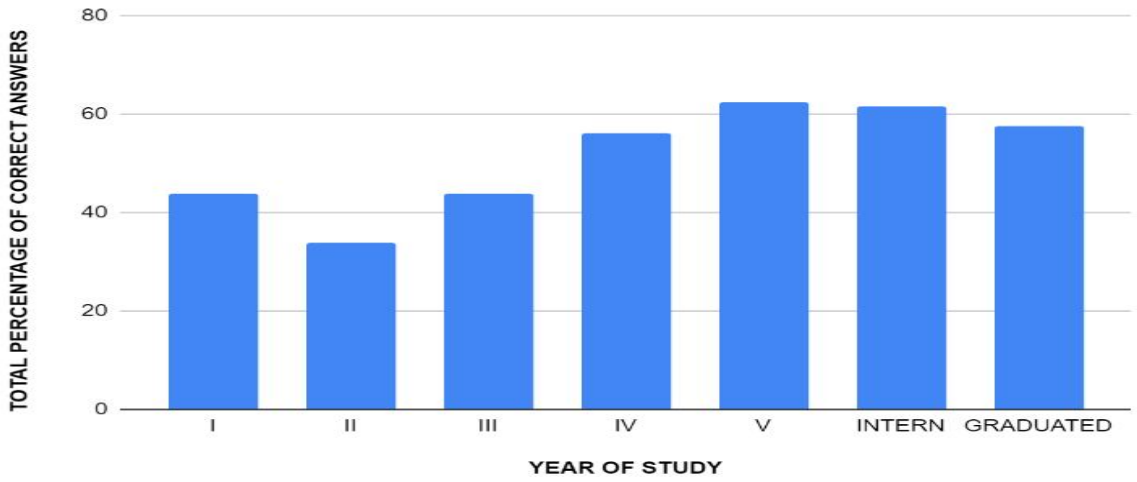
Table 3. Distribution of correct answers among different academic years and genders

	KNOWLEDGE		AWARENESS		ATTITUDE	
	Correct answer %	Wrong answer %	Correct answer %	Wrong answer %	Correct answer %	Wrong answer %
Gender						
Male	44.58	55.42	69.28	30.72	68.67	31.33
Female	45.69	54.31	62.26	37.74	75.47	24.53
Prefer not to say	42.86	57.14	25.00	75.00	100.00	0.00
Year Of Study						
I	39.05	60.95	48.30	51.67	60.00	40.00
II	30.48	69.52	33.30	66.67	60.00	40.00
III	37.36	62.64	52.88	47.12	53.85	46.15
IV	48.30	51.70	64.29	35.71	78.57	21.43

V	51.13	48.87	79.61	20.39	73.68	26.32
Interns	50.45	49.55	75.00	25.00	87.50	12.50
Graduates	44.81	55.19	75.00	25.00	77.27	22.73

Fig. 3. Percentage of correct answers among different years of study

Figure-3 evidences an increase in the percentage of correct answers as the academic year increases. Detailed microbiology syllabus and clinical exposure through ward rounds typically commences in the second year, which



might have potentially contributed to an incremental improvement in the percentage of correct answers across subsequent academic years. However, there is a noticeable decrease in percentage in the second year, among interns and graduates which could be attributed to several reasons which remain exceptional. Further studies may need to identify the reasons behind this observed fluctuation.

Figure. 4 depicts the percentage of correct answers that each academic year contributes to the total for each questionnaire. Fifth-year Pharm.D. was found to have a higher percentage of correct answers for every question while second year had the least. The fifth year of the Pharm.D. journey is found as a notably beneficial period, characterized by project work and clerkship activities, offering students a greater exposure to diseases and drug information. This likely contributes to an overall elevation in correct answer rates compared to other years.

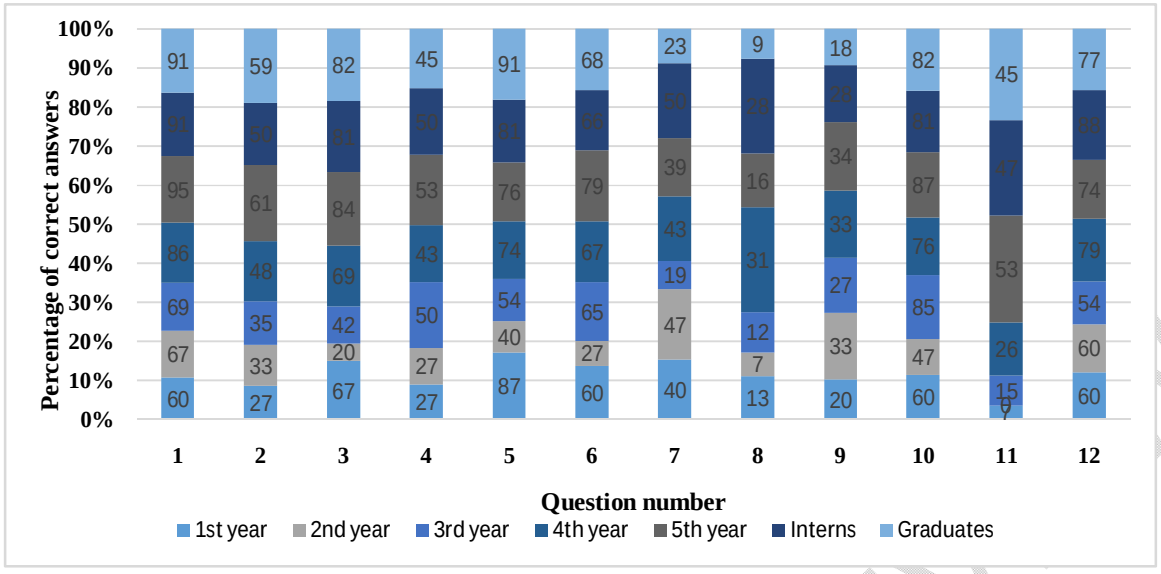


Fig. 4. Percentage of correct answers for each questionnaire over academic years

A Chi-Square test was conducted for each question to assess significant differences in responses across academic years, adjusting for gender as a potential confounder. The p-values were calculated for the overall population and separately for males and females to evaluate whether the association between academic year and responses varied by gender.

Table.4 Chi-square statistics

Question number	Total p-value	Male	Female
1	**0.006**	**0.043**	0.183
2	0.152	0.562	0.365
3	**<0.001**	**0.002**	**0.007**
4	0.465	0.121	0.674
5	**0.003**	**0.014**	0.081
6	**0.039**	0.111	0.100
7	0.174	0.252	0.486
8	0.123	0.407	0.122
9	0.817	0.920	0.649
10	**0.030**	**0.014**	0.800
11	**<0.001**	**0.002**	**0.023**
12	0.072	**0.032**	0.883

The results indicate that for several questions, there were statistically significant differences in responses based on academic year in the male population (e.g., Question 1: p = 0.043, Question 3: p = 0.002), while no significant differences were observed for most questions in the female population, except for one (Question 3: p = 0.007). The total

population p-values, adjusted for gender, show significant associations for some questions (e.g., Question 1: $p = 0.006$, Question 3: $p < 0.001$). These results suggest that while gender did not significantly influence responses in most cases, differences between academic years were more pronounced in the male population for certain questions.

A two-sample independent t-test was performed which showed statistically insignificant difference in the percentage of correct answers between the first-year participants and graduates, with a p-value of 0.236. Consequently, this underscores the necessity for educators and stakeholders engaged in crafting Pharm.D. curricula to reformulate them, integrating antimicrobial stewardship (AMS) practices and strategies to address antimicrobial resistance (AMR).

Table 5. Two-sided t-test

Year of study	P value (two tailed)
1st vs 2nd	0.2904
1st vs 3rd	0.9933
1st vs 4th	0.2089
1st vs 5th	0.0777
1st vs interns	0.0817
1st vs graduates	0.2369
2nd vs 3rd	0.2709
2nd vs 4th	**0.0142**
2nd vs 5th	**0.0045**
2nd vs interns	**0.0041**
2nd vs graduates	**0.0321**
3rd vs 4th	0.1855
3rd vs 5th	0.0657
3rd vs interns	0.0684
3rd vs graduates	0.2195
4th vs 5th	0.5011
4th vs interns	0.5434
4th vs graduates	0.9054
5th vs interns	0.9311
5th vs graduates	0.6465
interns vs graduates	0.6936

However, there observed a statistically significant increase in the percentage of correct answers in fifth year participants compared to second year with a p-value of 0.002.

DISCUSSION

The findings of this report have implications for the design and enhancement of AMS curricula within Pharm.D. programs. By identifying areas of improvement, educational institutions can refine their teaching methods and ensure that future pharmacists are adequately equipped to address the challenges of AMR and contribute to global efforts towards stewardship(8).

A significant majority of the survey respondents, accounting for more than half, agreed with the notion that healthcare workers could serve as vectors for the transmission of antibiotic-resistant pathogens within a hospital setting(9). This aligns with the findings of several studies that support this concern. For instance, a study conducted in Tanzania demonstrated a high prevalence of MRSA carriage among healthcare workers, including nurses(10,11).

Similar to a previous study, a substantial number of respondents believed that transitioning from empiric therapy to definitive therapy based on culture and sensitivity tests could help reduce antibiotic resistance(12). This understanding reflects the importance of targeted antibiotic treatment guided by accurate diagnostic information(13). Furthermore, nearly two-thirds of the respondents recognized that inadequate duration of antibiotic therapy could contribute to the development of antibiotic resistance. This finding aligns with a study conducted among Malaysian pharmacy students(14).

To mitigate the risk of antibiotic resistance, it is crucial to ensure that antibiotics are used for an optimal duration as recommended by healthcare professionals. Inappropriate or premature discontinuation of antibiotic therapy can potentiate the development of antibiotic resistance. Therefore, adherence to recommended treatment durations is essential in order to minimize the risk of resistance and preserve the effectiveness of antibiotics.

Based on these findings, it is recommended that healthcare professionals emphasize the role of healthcare workers as potential vectors for transmitting resistant strains, promote the importance of switching to definitive therapy based on culture and sensitivity results and educate patients and colleagues about the significance of appropriate duration of antibiotic therapy. By adhering to these principles, the risk of antibiotic resistance can be minimized, contributing to effective infection management and the preservation of available treatment options.

While the significance of ASPs is being highlighted in numerous countries, there is a lack of extensive research on such programs in India. Therefore, we conducted a nationwide survey to assess the presence and effectiveness of ASPs among Pharm.D. students in India. This comprehensive survey provided valuable insights into the state of ASPs among Pharm.D. students and interns in the country.

Through the survey, we aimed to evaluate any changes in the implementation and impact of ASPs among Pharm.D. students and interns. We examined various aspects of ASPs, including their establishment, functioning and adherence to guidelines. Additionally, we assessed the involvement of infectious disease (ID) specialists in ASPs and the extent to which hospitals had embraced these programs.

The findings of the survey revealed that despite an increase in the number of ID specialists, a considerable number of hospitals in India still did not have operational ASPs. Moreover, there was no significant change in this proportion compared to previous assessments. These results highlight the existing gaps and challenges in implementing effective ASPs across healthcare facilities in India.

The nationwide survey provided important baseline data, shedding light on the current status of ASPs among Pharm.D. students and interns. It underscores the need for further research, policy development and targeted interventions to enhance the understanding, implementation and impact of AMS in the Indian healthcare system. By addressing these gaps, we can work towards optimizing antibiotic use, combating AMR and improving patient outcomes in India.

The Infectious Disease Society of America (IDSA) guidelines emphasize the importance of including specific professionals in the AMS team. It is recommended that the team comprises an infectious disease (ID) physician and a clinical pharmacist with ID training. Furthermore, it is crucial to provide appropriate compensation to both individuals for their dedicated time and contributions. In addition to an ID physician, the IDSA guidelines stress the importance of having a clinical pharmacist with ID training as part of the AMS team. These pharmacists possess in-depth understanding of infectious diseases and antimicrobial agents, enabling them to contribute significantly to optimizing antimicrobial therapy. Their roles may include medication order review, drug information provision, therapy monitoring and implementation of interventions to promote appropriate antibiotic utilization.

Recognizing the expertise and time commitment of both the ID physician and the clinical pharmacist, it is essential to provide them with appropriate compensation. Adequate compensation acknowledges their dedicated efforts in reviewing cases, developing guidelines, educating healthcare professionals and implementing strategies to improve antibiotic use and combat AMR.

The limitation of this study is that relies on data collected from online survey which may be susceptible to violations.

CONCLUSION

This study conducted among Pharm.D. students and interns from three colleges in India, provides the first comprehensive insights into their understanding of antibiotic use, AMR and ASPs. The findings of this study indicate that students possess a moderate level of understanding (45.19) regarding certain aspects of antibiotic use and AMR. Furthermore, their attitude towards the approaches employed to mitigate the progression of AMR is positive (72.48%) with an optimal awareness (65.13%). About 92.11% of the respondents prefer to attend future AMS training but 7.89% showed no interest in AMS training and programs. This study highlights their awareness and comprehension of key concepts and principles, allowing for a better understanding of their educational needs and areas that require further emphasis. In future, AMS education programs should target not only clinicians but also Pharm.D. students and interns.

Overall, the study suggests that while there is room for improvement in certain areas such as a deeper understanding of AMR mechanisms or specific stewardship strategies, the student's attitude towards combating AMR is encouraging. Their positive attitude towards the approaches used to limit the progression of AMR indicates a willingness to actively participate in addressing this global challenge. These findings provide valuable insights for educators and policymakers, emphasizing the importance of integrating comprehensive education on antibiotic use, AMR and ASP into the curriculum for Pharm D students. By enhancing their understanding and fostering a proactive attitude, these future healthcare professionals can contribute significantly to the effective management of AMR and the promotion of responsible antibiotic use.

In conclusion, this report sheds light on the knowledge, awareness and attitude of Pharm.D. students regarding AMS. It serves as a valuable resource for educators, policymakers and stakeholders involved in shaping the curricula of Pharm.D. programs to enhance the training and preparedness of students in AMS practices. This information can be used to identify gaps in their understanding and develop targeted educational interventions to enhance their knowledge and promote their active participation in AMS programs in the future.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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