A cross sectional study on awareness about the antibiotic resistance and antimicrobial stewardship program among the undergraduate medical, dental and pharmacy students of Dharmsinh Desai University, Gujarat

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ABSTRACT

Background: "A cross sectional study on awareness about the antibiotic resistance and antimicrobial stewardship program among the undergraduate medical, dental and pharmacy students of Dharmsinh Desai University, Gujarat". **Aim:** This study aims to determine the awareness about the current global health problem of Antimicrobial resistance (AMR) and the need for the development of Antimicrobial Stewardship Program (AMSP), and further to the improve the knowledge of these topics by education intervention among the undergraduate students of medical, dental and pharmacy of DDU, Gujarat. **Objectives:** (1)To assess the level of awareness about the antibiotic resistance & antimicrobial stewardship program among the undergraduate medical, dental and pharmacy students of Dharmsinh Desai University, Gujarat. (2)To compare the awareness level about the antibiotic resistance and antimicrobial stewardship program among the undergraduate medical, dental and pharmacy students of Dharmsinh Desai University, Gujarat. **Background:** Antimicrobial resistance (AMR), a global health threat requires urgent action plan to combat it. Rampant use of antimicrobials in healthcare, animal and food husbandry are the main cause of development of drug-resistant pathogens. Knowledge about these multidrug resistant organisms and stewardship practices among undergraduate students are likely to influence their practices in future. Assessing their awareness level about these problems helps to develop and modify academic strategies in order to bring about the deeper understanding of the magnitude of this threat. Further it identifies the gap in the training curriculum that can be addressed more effectively. **Methods:** This cross sectional study was conducted at the DDU campus. A structured questionnaire prepared using google form was circulated among the participants and responses were collected from them. Informed consent of the participants was taken in the google form. Questionnaire with three different set of questions including their demographic details, yes or no response questions, and MCQ based questions on AMR and AMSP were used for data collection. Students responses were analysed using the Microsoft Xcel analysis tool for descriptive data analysis. **Results:** Total of 302 students from medical, pharmacy and dental colleges participated in this study. All the students were of age group 18-27. Total mean % score for the questions related to general awareness about the AMR, its mechanism of action, spread among the patients were found to be good (above 60%) among all the three group of students. (medical-79.2%, pharmacy-72.83%, and dental- 69.68%). Where as in regard to the questions on AMR in specific pathogens and on AMSP it was below 60% among medical students (57.61%) and average below 50% among pharmacy students (41.78%) and poor among dental students (39.78%). **Conclusion:** Our finding showed correlating trends as observed in previous studies, with significant gap in the knowledge and level of awareness among the of students of medical, pharmacy and dental colleges, it highlights the importance of focusing on integration of AMR and AMSP related innovative activities in their curriculum. Academic level intervention measures need to be taken in order to improve their knowledge and understanding of AMR and AMSP.

Keywords: Antimicrobial resistance, Antimicrobial stewardship, Medical, dental and pharmacy student, questionnaire

INTRODUCTION

It is well established fact from the previous researches that antimicrobial resistance (AMR) is a global threat and its data are suggestive of rising incidence, deaths, longer hospital stay, and health-care cost associated with AMR.

As per the recent report in the lancet journal, about 1.27 million deaths were attributed to bacterial AMR where as 4.95 million deaths were associated with bacterial AMR. And the global burden of disease study identified *E.coli, S.aureus, K.pneumoniae, S.pneumoniae, a.baumannii and P.aeruginosa* were listed as six leading causes of AMR-associated deaths (73%) in year 2019.[(1)] AMR is natural process that occurs in bacteria over the time due to changes in the genetic makeup. As a result of AMR antimicrobials become ineffective and infections become difficult to treat. The 2022 global antimicrobial resistance and use surveillance system (GLASS) report showed alarming resistance rates among the most common bacterial pathogens.[(2)] Awareness among the prescribers as well as among the public is the key to tackle the global issue of bacterial AMR. Researches done in northeast Ethiopia on the public about the problems of AMR indicated poor awareness & knowledge of AMR.[(3)] Likewise, a systemic review study done among the healthcare workers in India on the knowledge, awareness and practices of antimicrobial resistance highlighted the need for targeted training and policy interventions to spread the awareness on AMR. Healthcare professionals can significantly contribute to mitigating the AMR threat by providing knowledge on AMR and antimicrobial stewardship.[(4)]

Undergraduate healthcare students being the frontliner to fight threat on AMR, number of studies have shown the need to integrate the educational initiatives and raise the awareness among them. It is crucial to form and implement comprehensive educational policy regarding the appropriate utilization and adverse outcomes associated with excessive antimicrobial usage and importance of adherence to antimicrobial stewardship practices (AMSP) for the undergraduate students. Antimicrobial stewardship is an approach for mitigating the global antimicrobial resistance. AMSP focuses on rational usage of antibiotics, preserves the antibiotic effectiveness and reduces resistance emergence among the bacteria.[(5)]

Having assessed the baseline knowledge and awareness among the medical, pharmacy and dental students will help us to create robust curriculum based activities to inculcate the best antimicrobial stewardship practices at an early stage of their profession.

MATERIAL AND METHODS

Study design & Participants: We conducted a cross sectional google form questionnaire based study on AMR and AMSP awareness among the Medical, Pharmacy and Dental undergraduate students studying at the DDU university, Gujarat. Study was conducted in December 2023. Our inclusion criteria was to consider students studying from 2nd year and above in all the three faculties as they do have fair exposure to these topics in their academic curriculum. Total of 302 students participated in the study. Informed consent of the participants were taken while collecting the data for this study. 1st year students were excluded from the study as their curriculum did not have these topics covered.

Data collection: Data collection was done using the google form based structured questionnaire that was distributed among the students in their batch group contacts by the

representative student from medical, pharmacy and dental college who were involved in the study design, data collection and did not take part as participants of the survey. All the responses were collected in the Microsoft Excel format and then descriptive analysis of the data was done.

Statistical analysis: Data was collected from the google form based questionnaire and entered into Microsoft Excel sheet. Descriptive analysis of the data was done using Microsoft excel tool. Comparative analysis of the finding was done with previous similar studies and the conclusion was summarised based on all the findings.

Ethical consideration: Ethical approval was obtained from the institutional ethical committee of DDU, Nadiad.

RESULTS

Total of 302 students participated in this study, of which 106 students from the pharmacy, 101students from the medical and 95 students were from the dental faculty. A total of 210 female students and 92 were male student participated. All were of age group between 18 to 27 years. Among the medical and pharmacy majority of the participants were 2nd & 3rd year students where as in dental 2nd and 4th year students participated in maximum numbers. As per the study data analysis AMR and AMSP awareness was comparatively higher among the medical student followed by pharmacy and dental students. In response to the question on basic knowledge about the AMR, its mode of transmission, mechanism of action and spread among the patients it was seen that majority of the students had fairly good knowledge on these topics with all the groups having score above 60%.

In respect to specific questions on most common pathogens their resistance mechanisms and questions on AMSP there was wide gap in the knowledge among the student from the various faculties with highest score for medical students (57.61%), followed by pharmacy students (41.78%) and dental students (39,78%).

DISCUSSION

This study was conducted among the undergraduate students of medical, pharmacy & dental faculties at Dharamsinh Desai university, Gujarat. Total of 302 students including 101 from medical college, 106 from pharmacy college and 95 from dental college participated in this study. Our study included student from 2nd year and above from each faculties. 1st year students were excluded as these topics are not covered in their curriculum.

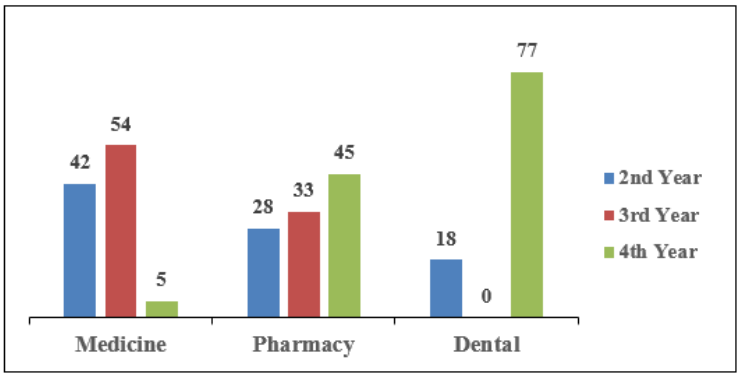

Figure 1: Academic Year Distribution

As shown in the **Figure-1**, a total of 302 students participated in this study. Maximum participation was by 2nd year undergraduate students from all the three disciplines. In dental however 4th year students responded in maximum numbers as compare to 2nd year students.

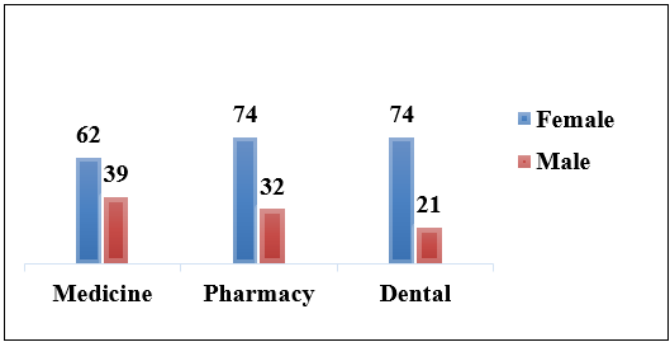

Figure 2: Gender Distribution

Figure 2 shows the gender distribution of participants in this study. Female students participation was higher side as compare to male students. Similar female gender predominance is observed in many other studies done for the medical undergraduate students with 63%, 64% and 71% reported in a multi centre cross sectional study China by Hu Y *et al.*, among university students in Nepal by Shah P *et al.*, and a Study done among medical students in Malaysia by Haque M *et al.*, respectively.[6-8] And as shown in **Figure-3** all the student participants from the different faculties were in the age groups of 18 to 27 years.

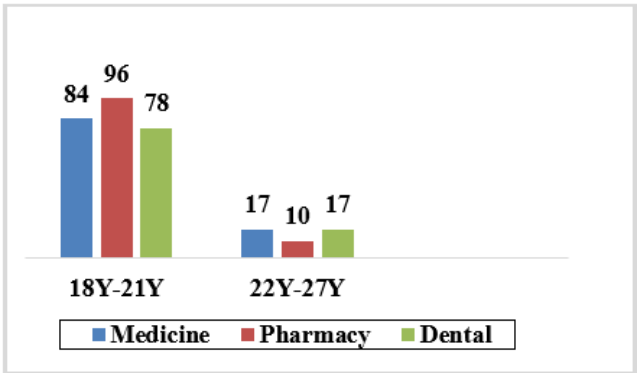

Figure 3: Age Distribution

A recent Study done in India in state of Kerala by Reena AP, Ittyachen AM, among Medical students showed the similar descriptive analytical data in terms of age, gender and academic year distribution of the student participants.[9]

Table 1

Table-1	Medical (n=101)		Pharmacy (n= 106)		Dental (n=95)	

Questions on general awareness on antimicrobial resistance -	Correct Answers (Except question 1)	Incorrect Answers (Except question 1)	Correct Answers (Except question 1)	Incorrect Answers (Except question 1)	Correct Answers (Except question 1)	Incorrect Answers (Except question 1)
Have you heard about the antimicrobial resistance & Antimicrobial stewardship program?	90 (89.10%)	11 (10.9%)	90 (84.90%)	16 (15.1%)	68 (71.57%)	27 (28.43%)
The most common type of antimicrobial resistant seen among the bacteria is due to ACQUIRED MECHANISMS (Extrachromosomal). (Correct answer-YES)	90 (89.10%)	11 (10.9%)	95 (89.62%)	11 (10.38%0	87 (91.57%)	8 (8.43%)
Long term use of broad spectrum antimicrobials can lead to disruption of patients normal flora also. (Correct answer-YES)	95 (94.05%)	6 (5.95%)	91(85.84%0	15 (14.16%)	89 (93.68%)	6 (6.32%)
Hospital acquired infections are NOT LIKELY due to multidrug resistant organisms. (Correct Answer-NO)	64 (63.36%)	37 (63.63%)	48 (45.29%)	58 (54.71%)	52 (54.73%)	43 (45.27%)
Resistant mechanisms are NOT SEEN in the bacterial infections but ONLY in viral/fungal infections. (Correct answer-NO)	61 (60.4%)	40 (39.60%)	62 (58.5%)	44 (41.50%)	51 (53.68%)	44 (46.32%)
Mean % score	79.20%	26.19%	72.83%	27.17%	69.68%	26.954%

When we look at the generalised awareness on the topics such as AMR and AMSP among the healthcare students or healthcare workers in Indian states few studies are suggestive of average level of knowledge ≈50-60%.[9-11]

There are number of studies done to assess the level of awareness on AMR and AMSP among the public as well as among the healthcare workers across the world. Our study findings showed that students from al the three healthcare facilities have heard about both antimicrobial resistance and antimicrobial stewardship practices with 89%, 84% and 71% of them responding "YES" to the question, from Medical, pharmacy and dental respectively. As they had received basic knowledge during their curriculum they were consider appropriate groups to assess their awareness level related to AMR and AMSP.

A study done by Ortega-paredes, D. *et al.*, in Quito, Ecuador included university students from applied sciences and social sciences with higher number of participants (n=733). Their findings were suggestive that there is moderate level of knowledge in regard to AMR and multidrug resistant infections, where 50% of the participants agree that multidrug resistant bacteria can spread from person to person.[12] In Our study we found that the basic knowledge about the mechanism of resistant gene transmission, their effect on disruption of normal flora were good with mean score of above 80% among all the students group. In regard to their understanding of role of resistant pathogen in healthcare associated infection and it spread it was found that 63.3% medical student, 45.29% of pharmacy student and 54.73% dental students were aware about it. On an average more 50 % students from all group agreed that resistance mechanisms are not only limited to viral or fungal infections but in common bacterial infections also. **(As per Table 1**)

Table 2

Table-2	**Medical (n=101)**		**Pharmacy (n=106)**		**Dental (n=95)**	
Questions on resistance in common pathogens & on AMSP	Correct Answers %	Incorrect Answers %	Correct Answers %	Incorrect Answers %	Correct Answers %	Incorrect Answers %
1. Today approximately what percentage of community and hospital acquired *Staphylococcus aureus* isolates are found to be penicillin-resistant ?	41(40.59 %)	60(59.40 %)	35(33.01)	71(66.98 %)	26(27.36 %)	69(72.63 %)
a. 10%						

b. 50%						
c. 75%						
d. 90% (Correct answer)						
2. One of the most important risk factor for acquiring *Methicillin Resistant Staphylococcus Aureus* (MRSA) infection in hospitals is,	77(76.23 %)	24(23.73 %)	70(66.03 %)	36(33.96 %)	53(55.78 %)	42(44.21 %)
a. Admission in the in patient units						
b. No prior antibiotic therapy						
c. Exposure to colonised or infected person with MRSA (Correct answer)						
d. Short duration of hospital stay						
3. Increased rate of vancomycin resistant is seen in infections due to,	35(34.65 %)	66(65.34 %)	35(33.01 %)	71(66.98 %)	23(24.21 %)	72(75.78 %)
a. Pseudomonas aeruginosa						
b. Klebsiella pneumoniae						
c. Enterococcus faecalis (Correct answer)						
d. Staphylococcus aureus						
4. Multidrug resistant tuberculosis (MDR-TB) is caused by the	59(58.41 %)	42(41.58 %)	41(38.67 %)	65(61.32 %)	27(28.42 %)	68(71.57 %)

tuberculosis bacilli that are,						
a. Only Isoniazid resistant						
b. Isoniazid and Rifampicin resistant (Correct answer)						
c. Isoniazid, Rifampicin and Fluroquinolones resistant						
d. Isoniazid, Rifampicin, Fluroquinolones and at least one second line of drug resistant						
5. Following is NOT TRUE about the infections by *Klebsiella pneumoniae* is,	54 (53.46%)	47(46.53 %)	44 (41.50%)	62(58.49 %)	35 (36.84%)	60(63.15 %)
a. Its global resistant rate has reached as high as 70%						
b. Carbapenem resistant mechanism is not seen in this bacteria (CRKP) (Correct answer)						
c. It is associated with HAI (Hospital acquired infections)						
d. Hypervirulent strains are common among this group of bacteria						

6. NOT TRUE about the Extended Spectrum B-lactamases (ESBL) is,	54(53.46 %)	47(46.53 %)	32(30.18 %)	74(69.81 %)	26(27.36 %)	69(72.63 %)
a. They are resistant to commonly prescribed antibiotics						
b. They are seen in both hospital and community acquired infections						
c. Infections with ESBL have been associated with poor clinical outcome						
d. They are limited to infection by gram positive organisms only (Correct answer)						
7. Treatment of Chloroquine phosphate resistant malaria (a drug of choice for treating Malaria infection) is major problem in case of,	77(76.23 %)	24(23.76 %)	43(40.56 %)	63(59.43 %)	47(49.47 %)	48(50.52)
a. Plasmodium falciparum infection (Correct answer)						
b. Plasmodium vivax infection						
c. Plasmodium malariae infection						
d. None of the above						

8. Which of the following is Reserved (Restricted) Group of antibiotic as per the WHO AWaRe classification?	49(48.51 %)	52(51.48 %)	29(27.35 %)	77(72.64 %)	27(28.42 %)	68(71.57 %)
a. Amoxicillin/clavulanic acid						
b. Cefuroxime						
c. Colistin (Correct answer)						
d. Levofloxacin						
9. Antimicrobial stewardship program should include,	67(66.33 %)	34(33.66 %)	61(57.54 %)	45(42.45 %)	58(61.05 %)	37(38.94 %)
a. Education of clinicians, students, patients & public						
b. Duration & dose optimization of antimicrobials						
c. Prior authorization of restricted drugs						
d. a. b and c (Correct answer)						
e. Only a and b						
10. Antimicrobial stewardship program should include,	69(68.31 %)	32(31.68 %)	53(50%)	53(50%)	56(58.94 %)	39(41.05 %)
a. Education of clinicians, students, patients & public						
b. Duration & dose optimization of antimicrobials						

c. Prior authorization of restricted drugs						
d. a. b and c (Correct answer)						
e. Only a and b						
Mean % Score	57.61%	42.36%	41.78%	58.20%	39.78%	60.20%

As shown in the **Table-2** data students were assesses based on their knowledge on most common resistant pathogens encounter in the healthcare settings and in the communities, role of antimicrobial resistant in infections such as tuberculosis and malaria and on the antimicrobial stewardship programs. The mean % score of questions on specific pathogens and related resistance showed that medical students awareness was at higher side, around 57.61% as compare to pharmacy students (41.78%) and dental students (39.78%). Though higher in comparison to pharmacy and dental students, medical students awareness level was below 60%. However awareness in regard to antimicrobial stewardship practices or program all the group students had moderate awareness level around 60%. It was also observed that there was poor knowledge on WHO AWaRe group of antimicrobial classification where antibiotics such as Colistin are grouped under reserved category. Only 49 (48.51%) students of medical, 29 (27.35%) of pharmacy and 27 (28.42%) of dental students seem to have knowledge about it. Where as only 35(34.65%), 35(33.01%) and 23(24.21%) students from medical, pharmacy and dental knew about increased resistant to Vancomycin seen in *Enterococcus spp.* In response to the questions such as rate of penicillin resistant S.aureus infections in the community & hospital it was seen that only 41(40.59%) of medical, 35(33.01) Of pharmacy and 26(27.36%) of dental students were aware about it, however more than 55% student from all three groups were aware about the mode of transmission of these MRSA pathogen in hospitals. When asked questions related to some of the most resistant mechanisms such as Extended spectrum beta lactamases (ESBL) only 54(53.46%), 32(30.18%) & 26(27.36%) and about Carbapenem resistant enterobacteria (CRE) only 54(53.46%), 44(41.5%) and 35(36.84%) students were aware about it in the medical, pharmacy and dental category respectively.

A report from world health organisation in 2022, India was one of the top country ranked at first spot in terms of number of cases of TB accounting for two thirds of global cases.[13] Yet very poor response was seen in regard to definition of multidrug resistant tuberculosis (MDR-TB) among all the three groups of students with only 59(58.41%) of medical, 41(38.67%) of pharmacy and 27(28.42%) of dental student being aware about it. Similarly except medical (76.23%) both pharmacy (40.56%) and dental (49.47%) students had knowledge of chloroquine resistance becoming common in *P.falciparum* malaria. Lastly, to the question on the basic components of antimicrobial stewardship program moderate response rate was seen with s69(68.31%), 53(50%) and 56(58.94%) among medical, pharmacy and dental students respectively.

One of the study done as pre and post intervention, on knowledge, attitude and practices among medical undergraduate students in tertiary care hospital in Rajasthan by Rajini E *et al.*, showed statistically significant increase in the awareness score from 20.9% (in pre-intervention) to 90.7% (in post-intervention) study.[14] Considering our findings as pre-interventional it showed

higher level of awareness among the all the three groups of students. In response to a question on risk factors related to common resistance infection such as MRSA it was observed that more than 50% students were aware about it. One such study done among the medical students in Zambia by Zulu A *et al.*, showed 97% of medical students had awareness about the antimicrobial resistance and 87.3% had good knowledge regarding its usage and outcomes.[15] In contrast our study showed 79.20% for general knowledge on AMR and only 57.6% of awareness among the medical students. Another studies done among the medical students in Saudi Arabia by Nukaly HY *et al.*, and in East China by Min S, *et al.*, showed higher level of mean % awareness in regard to antimicrobial resistance among medical students ranging from 70 to 90% in various types of AMR based questionnaires.[16,17] These findings were significantly higher than the result of our study.

Our study shows that knowledge on AMR in common pathogen and AMSP is inadequate among the dental student (39.78%). This is in agreement with the similar findings in a study done among dental students in Tamil Nadu by Indrapriyadharshini K *et al.*, in a cross-continental student study done by Bajalan A *et al.*, and study done in Asia-Pacific region among dental student by Ghafoor S *et al.*, to assess the confidence to antibiotic prescriptions and knowledge on AMR where they found it to be unsatisfactory and emphasize the need of educational interventions to improve the awareness.[18-20]

In our study we found higher level awareness on general knowledge about the AMR (72.83%) but moderate level awareness about the AMSP (41.78%) among the pharmacy students. Where in a study on AMR & AMSP done in Ghana by Sefah, I.A *et al.*, they found higher level of awareness among the pharmacy students (94%) in regard to antibiotic use, antibiotic resistance and AMSP.[21] Another study done in Pakistan universities by Khan FU *et al.*, showed good knowledge (54%) about antibiotic use, antimicrobial resistance and antimicrobial stewardship initiative.[22] A cross sectional survey carried out in universities in East Africa by Lubwama M *et al.*, among medical and pharmacy students showed that pharmacy students were better knowledgeable than medical students in regard to antimicrobial resistance and use of antibiotics in clinical scenarios, however in contrast to this our study findings showed that medical student had higher knowledge about these topics.[23]

A study done by Higuita-Gutiérrez, L.F., *et al.* among medical student sin Columbia found that only 18.2% of the participants had heard of the term “antimicrobial stewardship” and 69.3% were aware that empiric antibiotic therapy contributes to antibiotic resistance, in contrast to these our study showed higher awareness among the students (more than 70%).[24] A study among the healthcare students by Nisabwe, L *et al.* at university of Rwanda found that that had good knowledge of antibiotics and AMR but 83% students were unaware about the concept of AMSP.[25] Also in a study done among medical students by Alfaifi MS among medical students found the knowledge and practice dimensions had slightly higher mean than the attitude.[26] Majority of these studies showed moderate level of awareness among students from medical, pharmacy and dental faculties.

In addition to AMR many studies have highlighted the gap in knowledge and awareness about the concepts of AMSP. A study by Alsaleh N, *et al.* found that 87% of students were not familiar with and unaware of the term antimicrobial stewardship, 6% students had good knowledge while 80% students have fair knowledge about antibiotics.[27] Similarly a study by Singh Santosh Kumar *et al.* done in medical college in Maharashtra among the various

categories of healthcare workers found that only 13% of the participants including doctors were aware about the WHO courses on antimicrobial stewardship and a definite knowledge gap existed in appropriate usage of antimicrobials.[28] Our findings also agree with this fact about lack of enough knowledge and awareness about the antimicrobial stewardship practices among the healthcare students.

STUDY LIMITATIONS

Since it was online structured questionnaire based study it was restricted to the less number of questions due to the general understanding that very long descriptive questions and more number of questions may not be convenient for most of the students to complete the questionnaire and submit it. In addition to this our study did not include any assessment of behaviour or practices regarding the antimicrobial usage. Participants were only representative groups of the respective faculties, and being online survey study it may have bias to transparency.

CONCLUSIONS

Assessment of the awareness about the AMR & AMSP among the undergraduate student not only aids to create stewards to combat the threat of AMR but also helps in spreading the knowledge about AMR among the public through them. They are the future prescribes of the antibiotics, so the practices they may follow will be having huge impact in this battle against AMR. In accordance with many other previous similar studies, our study findings are also suggestive that more & more efforts including training, workshops, conferences, symposiums and seminar based initiatives needs to be organized in addition to teaching about these crucial topics to emphasize the importance of understanding the concepts of AMR and teaching of evidence based AMSP in the early curriculum of the undergraduate students, who are the prime force of tomorrows healthcare system. The academic curriculum should not only focus on knowledge acquisition but also promote attitude changes & practical applications of the same as well.

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Conflict of Interest: NONE

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