Knowledge, Attitude and Practices of University students towards Antibiotic Use and Resistance: Questionnaire Based Assessment

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Abstract

Antibiotic resistance is a serious health crisis all over the world and students of biological sciences should have proper awareness to combat the problem. This study aims to assess the knowledge, attitude and practices (KAP) towards antibiotic use and resistance among university students of biological sciences in Pakistan. A descriptive cross-sectional study was conducted amongst 826 students of biological sciences programs from eight major Pakistani universities during September-November 2020. A self-administered online questionnaire was developed which consisted of four dimensions: sociodemographic characteristics (3

questions) and assessment of the knowledge, attitude and practices with 13, 6 and 11 questions, respectively. Association of KAP scores with sociodemographic characteristics was analyzed by nonparametric analysis *i.e.*, Mann-Whitney U and Kruskal-Wallis H test (*p*-value < 0.05). The sample comprised more females (82.9%) than males while most of the respondents belonged to 21-23 years and enrolled in the master's degree. The overall knowledge score (correct answer) was 74.7% which was significantly associated with gender, age and degree. The positive attitude score (87.9%) was significantly higher in >23 years age group. Around 75% of the surveyed students had positive practices. The scores were observed significantly higher in females, 21-23 years age group and doctoral students. The study provides baseline evidence about the knowledge, attitudes and practices regarding antibiotic use and resistance among biology students. Overall, good positive attitude was depicted by participants however level of knowledge and positive practices was found lower and declared as moderate. Academic interventions such as lectures, courses, seminars and workshops on antibiotic use, along with establishing open-access antibiotic-resistance learning sites and use of mainstream and social media platforms, etc., are needed to improve the awareness and practices of university students of biological sciences with regards to the rational use of antibiotics.

Keywords: Antibiotics; cross-sectional study; KAP; Pakistan; university students

1 Introduction

Antibiotics have been used as pivotal weapon in the prevention and cure of various pathogenic infections for the last few decades [1]. In the developing countries, increased population and emerging resistance in microorganisms have become a danger in the antibiotics efficacy [2]. Antibiotic or antimicrobial resistance is caused when pathogens develop the ability to conquer the antibiotics being used to kill them. This is one of the serious concerns for public health care across the globe, [3,4] usually caused by improper use of antibiotics [5] which could be influenced by self-medication or improper antibiotic consumption due to lack of knowledge, easy access, unavailability of any check on the antibiotics sale without prescription and lack of public awareness towards antibiotics use [6–

11]. These practices are not only responsible for the gradual decline in antibiotic efficacy but also increase the chances of failure of a disease treatment leading to severe health outcomes and eventually mortality [6]. Approximately 700,000 deaths occur each year due to antibiotic resistance and 10 million deaths/year are estimated after 2050, which would be equal to the number of deaths/year due to the cancer at present [12]. Therefore, appropriate means of intervention are required to control the improper use of antibiotics. For this purpose, several approaches have been proposed such as a formulary replacement or restriction, education of health care providers, feedback activities, and strict requirement of drug prescription from a specialist physician or other disease specialist and enhanced antibiotic rational use [13, 14].

The assessment of knowledge, attitude and practice (KAP) on a large scale at university level could be an effective way to make improvements in the usage of antibiotics [15], therefore, several such investigations have been performed in the previous literature. These studies showed that despite being students of higher education, university students lack in proper KAP towards antibiotic use. Excessive use of antibiotics without prescription for self-treatment has been observed in students [3,16–19]. In developing countries like Pakistan, antibiotics resistance has become a serious issue for healthcare facilities these days which is mainly due to self-medication and the problem is only expected to be worse with time. To our best knowledge, very few studies [20–23] have been carried out in Pakistani universities related to antibiotic use and resistance, specially focusing on KAP assessment among university students. Hence, there is a dire need to design a comprehensive study to report the KAP data of students from different major universities of Pakistan. With a background in biology, students of biological sciences are expected to have an adequate knowledge and can depict more positive practice towards antibiotic use that would be supporting in combating the concerning issue of antibiotic resistance. So, the current cross-sectional study aimed to

assess the level of KAP among students enrolled in different programs of biological sciences in eight (8) major universities of Pakistan.

2. Methodology

The overall flowchart of pipeline of current cross-sectional study has been explained in Figure 1.

1.1 Survey design

The current study was designed as a descriptive questionnaire-based cross-sectional survey which was conducted among random sample of students from eight (8) major universities of Pakistan (Quaid-i-Azam University, Islamabad; University of the Punjab, Lahore; Government College University, Lahore; University of Education, Lahore; Lahore College for Women University, Lahore; University of Peshawar, Peshawar; Bahauddin Zakariya University, Multan; The Islamia University of Bahawalpur, Bahawalpur). Target population was the students of biological sciences programs such as agriculture, biochemistry, biology, biotechnology, botany, environmental biology, microbiology, molecular biology, psychology and zoology.

1.2 Data collection

The survey was conducted during September to November, 2020. A questionnaire was developed and designed by the research team after doing a thorough review of available recent literature related to the antibiotic use and resistance. After formulation, the questionnaire was further reviewed by two experts before the survey. Three irrelevant questions were removed while five questions were modified to increase their validity and relevancy. After modifications, the questionnaire was subjected to a pilot study conducted among 30 students followed by the reliability test. Cronbach's alpha coefficient (0.72) was found satisfactory within an acceptable range indicating the data reliability and validity. The

pilot study data was not included in the final analysis. The present investigation followed the ethical principles for research involving human subjects outlined in the Declaration of Helsinki. The Bioethics Committee of University of the Punjab, Quaid-i-Azam Campus, and Lahore 54590, Pakistan approved the study under the reference No. 1580-42. All participants completed the anonymous survey voluntarily and gave their informed consent before completing the survey questionnaire. Procedure was explained very clearly and respondents could quit or interrupt the survey at any point without mentioning the reason.

Online questionnaire was generated using Google Forms (https://docs.google.com/forms/) in English language. The electronic link to questionnaire was shared to approximately thirteen hundred (1300) students of eight universities using email and other frequently used social media platforms such as WhatsApp and Facebook especially in class groups on these platforms. A brief message including introduction, objectives, information of confidentiality and anonymity, procedure description and statement of the voluntary nature of survey was also mentioned along with the electronic link.

1.3 Measures

The questionnaire was consisted of four sets. First set comprised of sociodemographic characteristics *i.e.*, gender, age and degree/course of enrollment in university. The second set consisted of 13 questions and assessed the students' knowledge while third set (6 questions) dealt with the attitude of respondents and fourth set (11 questions) was related to the practices regarding antibiotic use and resistance. The KAP related questions were answered by choosing 'yes/no/maybe' responses. Along with these sections, the information related to the health facilities from where the respondents get medical care, was also obtained.

1.4 Statistical analysis

The descriptive statistical analysis was used to calculate the frequency (n) and the percentage (%) of sociodemographic characteristics and KAP data. In the knowledge section, each correct answer obtained '1' score while incorrect or 'maybe' response got '0'. Similarly, a score of '1' was allotted to each positive attitude and practice while negative or 'maybe' answer was given '0' score [24]. During descriptive analysis, a score higher than 80% was considered as good, between 60-80% as moderate and less than 60% as poor [25].

Shapiro–Wilk test on KAP scores displayed the non-normal distribution of data, therefore, non-parametric analyses *i.e.,* Mann–Whitney U and Kruskal–Wallis H tests with $p < 0.05$ were performed to analyze the association of KAP data with sociodemographic characteristics. Results were presented in the form of mean and standard deviation (SD) as well as median and interquartile range (IQR). All statistical tests were applied using IBM SPSS Statistics (SPSS Inc, version 20.0, IBM, Chicago, IL, USA) software.

1.5 Strengths and Limitations

This study has a large sample size and covers eight major universities of Pakistan to evaluate the KAP data, thus it is more feasible to generalize the results for biology students from all Pakistani universities. However, the present study has a few limitations. This study only presented the students of biological sciences, so the results cannot be generalized for all students. Further studies are required in university students of non-biological programs as well as non-university students to better understand and improve the level of knowledge, behavior and practices among young adults and adolescents towards the antibiotic use and resistance in Pakistan.

2 Results

Online questionnaire was circulated among approximately 1300 university students enrolled in different programs of biological sciences. However, 351 participants did not respond whereas 123 forms were incomplete which were not included in the final analysis. Total eight hundred and twenty-six (826) participants (63.5% of total) responded by filling the complete questionnaire forms and data were subjected to further statistical analysis.

2.1 Sociodemographic characteristics of study population

Results in Table 1 demonstrated the sociodemographic characteristic of participants (N = 826). Most of participants (n = 685, 82.9%) were females while 141 (17.1%) were males. Majority (n = 635, 76.9%) belonged to the 21-23 years age group, 135 (16.3%) were aged > 23 years and 56 (6.8%) were aged 18-20 years. About three-quarter of the participants (n = 626, 75.8%) were enrolled in master's degree whereas 125 (15.1%) and 75 (9.1%) were enrolled in bachelor's and doctoral degrees respectively.

Among respondents, most of participants (n = 491, 59.4%) reported that they mostly got medical facilities form hospital whereas 285 (34.5%) from clinics, 30 (3.6%) from medicine shops and 20 (2.4%) from other sources (Figure 2).

2.2 Knowledge of antibiotics use and resistance among participants

Table 2 depicted the frequency (n) and percentage (%) of participants answering 'yes/no/may' for KAP questions regarding antibiotic use and resistance. The overall knowledge score (correct answers) of participants was found as 74.7% indicating the moderate level of knowledge, with the mean of 9.7 ± 1.9 and score range of 2-13. Out of 826 participants, 711 (86.1%) possessed the knowledge about the presence of useful bacteria in human body and 776 (92.7%) about the difference of antibiotics and antivirals. Almost all respondents (n = 801, 97.0%) reported that antibiotics were useful against harmful bacteria

but could not be used to cure antiviral infections (n = 616, 74.6%). However, few students knew about the ineffectiveness of antibiotics for speedy recovery from coughs, colds and other diseases (n = 140, 16.9%) and requirement of doctor's prescription to obtain antibiotics from pharmacies (n = 121, 14.6%). Most of students (n = 706, 85.5%) had an idea of antibiotic resistance and 756 (91.5%) respondents were aware of the fact that antibiotic resistance lowers the antibiotic efficacy. Frequent use of antibiotics would not lower the infection chances (n = 515, 62.3%). Most of students (n = 706, 85.5%) reported that antibiotics could have side effects and majority knew that tetracycline (n = 751, 90.9%), penicillin (n = 750, 90.8%) and amoxicillin (n = 686, 83.1%) were antibiotics. The overall knowledge scores have been displayed in Figure 3.

2.3 Attitude towards antibiotics use and resistance among participants

Based on six questions, the overall positive attitude score (positive answers) was calculated as 87.9% depicting the good level of attitude among university students of biological sciences. The mean score was found as 5.3 ± 1.1 and range as 1-6. Table 2 demonstrated that most of respondents reported the existence of antibiotic misuse (n = 725, 87.8%) and resistance (n = 676, 81.8%) in Pakistan. Most of participants (n = 701, 84.9%) reported the negative effect of antibiotic resistance on health and almost all (n = 816, 98.8%) agreed to the importance of its awareness for everyone. According to most students (n = 736, 89.1%), there should be a proper coursework related to the rational use of antibiotics in the university course. Overall positive attitude scores have been depicted in Figure 4.

2.4 Practices towards antibiotics use and resistance among participants

Overall score of practices of participants was found as 75.5% (moderate level) with a mean of 8.3 ± 2.1 and a range of 3 to 11. As described in Table 2, majority of participants (n = 615, 74.5%) always consulted the doctor before using the antibiotics and 591 (71.5%) never used

antibiotics on the suggestion of any neighbor or friend. About half of respondents (n = 411, 49.8%) reported that they did not have a stock of different antibiotics at their home, however 320 (38.7%) had a stock of common antibiotics at their home while rest 95 (11.5%) were not sure about this. Two hundred and thirty-five participants (28.5%) had practiced either self-administration of antibiotics or giving them to their sick family members, however 65.5% did not practice this. More than three-quarter participants (n = 630, 76.3%) always read the antibiotics instructions label. About half of the participants (49.6%) always completed the course duration of antibiotics as recommended by doctor; however, 37.0% did not follow the doctor's instructions related to it while 13.3% did not have clear response related to it. Majority (n = 781, 94.6%) always checked the expiry date of an antibiotic before using it. Five hundred and fifty (66.6%) students did not practice using leftovers antibiotics without consulting the doctor, however 185 (22.4%) practiced this activity while 91 (11.0%) were not sure about this. A majority of respondents 781 (94.6%) did not demand antibiotics themselves from a doctor. Similarly, 779 (94.3%) would believe doctor if he did not prescribe antibiotics and 766 (92.7%) would trust doctor if he prescribed antibiotics. Overall positive practices score related to antibiotic use and resistance have been shown in Figure 5.

2.5 Association of sociodemographic characteristics with KAP scores

Table 3, 4 and 5 explained the association of sociodemographic characteristics with KAP scores. Knowledge scores were associated significantly with gender, age and degree ($P < 0.05$) as displayed in Table 3. Female students scored significantly higher (75.4%) than males. Lowest scores were achieved by 18-20 years age group (75.4%) while other two age groups (21-23 years; > 23-year) had given similar scores (76.9%). Similarly, higher score (76.2%) was achieved by master's and doctoral students, while bachelors obtained the lowest score (67.7%).

Significant association ($p < 0.05$) was observed between positive attitude and age group where highest scores were achieved by age group of more than 23 years (90.0%) while non-significant association ($p > 0.05$) was obtained for gender and degree with higher scores in males (91.7%) and doctoral degree participants (86.7%). The details have been explained in Table 4.

Table 5 demonstrated that positive practices were associated significantly ($p < 0.05$) with all sociodemographic characteristics *i.e.,* gender, age and degree. Maximal scores were earned with the females (76.4%), 21-23 years age group (76.4%) and doctoral degree holders (80.0%).

3 Discussion

Antibiotic resistance is one of the deadliest issues in the public health sector. Evaluation of KAP among university students related to the problem could be of great importance in tackling the antibiotics related growing threats [26,27] and for the guide development of optimal training related to antibiotic practices [11].

Given to the worldwide importance of antibiotic resistance and irrational antibiotics use, the present study assessed the self-medication and KAP among university students for the development antibiotic related optimal training programs. In the current study, the overall observed veracious knowledge score was found as 74.7% indicating its moderate level in the university students enrolled in different programs of biological sciences. In comparison, about 78% of university students of biology/health related majors depicted high knowledge scores in Lebanon [5]. While health related students of UAE showed comparatively lower knowledge scores (65%) as reported by Jairoun et al [3]. Concerning the efficacy of antibiotics against antiviral infections, most of the respondents of current study knew that antibiotics are effective only against bacterial infections. However, only few of the students (16.9%) knew that antibiotics are not effective against colds, cough and other common seasonal viral diseases. This could be due to the lack of knowledge that the above-mentioned diseases are viral infections. Misuse of antibiotics for the treatment of viral infections is a common practice and prevalence of self-medication is highly alarming in the developing countries [28,29]. In a study conducted on antibiotic use in the Ethiopian population, 83% of the participants believed that antibiotics are useful against common cough and flu symptoms [30]. In another study conducted on the Lebanese population, only 26.5% study population knew that antibiotics are not anti-viral [31]. Similarly, a study done by Arshad et al [22] involving students of Bahauddin Zakariya University Multan, Pakistan revealed that 59% of the studied population believed that symptoms of cold and flu can be managed by antibiotics

use. In the general Pakistani population, 47.5% believed that antibiotics could treat cold and flu [32]. This poor awareness about the difference between viral and bacterial infections is consistent with multiple studies carried out in developing countries. It was alarming to know that only 14.6% participants knew that antibiotics are not obtainable from pharmacies without doctor's prescription which indicated that getting antibiotics without prescription from pharmacies is a common practice in Pakistan which is also indicated by other investigations of the country. In a study conducted on antibiotic use in Swat, Khyber Pakhtunkhwa Pakistan, the majority of the respondents (57.6%) consulted pharmacies directly without getting any prescription for antibiotics [33]. In a study on less-educated communities of Punjab Pakistan, 60% of the study population gave an affirmative answer to self-medication using antibiotics [32]. Much of the participants (85.5%) has an idea of antibiotic resistance as well as their side effects and 91.5% lowering of antibiotic efficacy on their frequent use. In comparison with this study, an investigation on antibiotic self-medication in non-medical university students of Pakistan showed that only 43% of students had an idea of antibiotic resistance and only 30% knew that misuse will eventually result in antibiotic resistance [34]. This massive difference in numbers furthers strengthens the conclusion that medical and biosciences students have a greater degree of awareness as compared to non-medical students. In the current survey, 85.5% of students were aware of the side effects of the antibiotics, in similar study on non-medical university students, 73% of students were aware of the misuse of antibiotics and its side effects [34]. Moreover, Gillani et al [32] reported that only 53.5% of the general population of Punjab was aware of the side effects of antibiotics use. Overall, the comparison of these different data sets from multiple studies reveals how education especially in medical fields can greatly enhance awareness of a student about antibiotic use and misuse. In the questionnaire-based survey, Sakr et al [5] found that the knowledge scores of students with health related majors (biology, biochemistry, nutrition,

food sciences, biomedical sciences and pharmacy) was significantly higher compared to the non-health related majors. Similar pattern was also observed by other several studies including the reports of Jairoun et al [3], Jairoun et al [11], Huang et al [18] and Iqbal et al [19]. Moreover, most of biosciences students were aware of some famous antibiotics such as tetracycline, penicillin and amoxicillin. In another cross-sectional survey conducted by Shah et al [22], most of the students recognized the penicillin and amoxicillin as antibiotics.

A severe increase in antibiotic resistance, disease severity, duration of disease, complication risk, health care cost and mortality has been observed because of unorthodox use of antibiotics [34]. Several mutated and antibiotic-resistant pathogens are creating threat throughout the world and developing countries are contributing to the strength of resistance [35,36]. In Pakistan, there is emergency of a bacterial strain “super-bug” which is resistant to all available antibiotics and this is definitely result of unregulated use of antibiotics [37]. There is dire need of strong law enforcement and public eradication to eradicate the practices of self-medication. This practice was adopted in several developed countries and has been found very effective [38,39]. Antibiotics are the prescription-only drugs and should be sold on prescription only and it should really be implemented.

This current study revealed a good positive attitude score (88%) towards antibiotic use and showed a consensus among the students on the importance of awareness on antibiotics use and misuse. Sakr et al [5] found 93.4% attitude scores in biology/health related majors’ university students in Lebanon while Jairoun et al [3] discovered 80% attitude scores in UAE health related university students. Most of the participants agreed the existence of antibiotic abuse in the society of Pakistan causing the resistance in harmful bacteria affecting the human health. Similarly, most of the Lebanon’s university students related to health major thought that high antibiotic use caused the resistance as reported by Sakr et al [5]. In support to present study, three fourth Chinese students recognized the antibiotic as health problem in

the country [18]. According to almost all respondents, information to antibiotic resistance is necessary for everyone and 89.1% agreed about the inclusion of the subject related to rational use of antibiotics in the university course to boost the level of knowledge. In a report of Huang et al [18], 74% of Chinese medical students favored the antibiotic related course in university while 88.4% UAE university students agreed with the establishment of course on the rational use of antibiotics. Similarly, Minen et al [40], reported that more than 75% medical students supported the antibiotics education in America.

A moderate level of positive practice (75.5%) was observed towards the antibiotic use among the participants of study. Biology/health related university students' depicted 84.4% practices scores in Lebanon [5], however UAE health related students showed 47% practice scores [3]. Lower scores in UAE indicate that the students did not practice what they knew. About 74.5% reported to consult a doctor before antibiotic use while 21.8% took without doctor's instructions indicating the self-medication. During another investigation [40], in universities students of Pakistan, 65.7% students were reported to take antibiotic on prescription by doctor whereas high number of participants (54%) took without prescription. While 55.6% UAE students took antibiotics without consulting doctor [3]. Most of participants (71.5%) did not use the antibiotics suggested by neighbor or friends. However, 28.5% had a habit of prescribing antibiotics to their family members without consulting any health care professional. A significant part of the studied population (38.7%) had a stock of antibiotics at their homes and 66.6% also sometimes used leftovers antibiotics without consulting doctor. This indicated that students of biological sciences from Pakistani universities were not well aware of antibiotics irrational use, although university showed better attitude and practices. The contrasting fact that 74.5% consulted doctor before using the antibiotics but 38.7% had antibiotic stock at home while 66.6% used leftovers, could be because of that most of the students took antibiotics on doctor's consult but store at home and used leftovers in future.

Comparable with present results, a study on self-medication by university students of Islamabad, Pakistan depicted that nearly 77% of students self-medicated using antibiotics [41]. Another report on self-medication using antibiotics by non-medical university students of Karachi, Pakistan showed 50.1% of students used antibiotics without proper prescription [21]. In the case of antibiotics stock, a study reported that 17% of respondents kept antibiotics at homes for future use [42]. Pavydė et al [43] reported that 28.5% of participants stored antibiotics for future use. In India, 76% users obtained antibiotics without prescription [44], 32.7% in study of Italy [45], 28.8% from Saudi Arabia [46] and 9% from Hong Kong [47]. Such differences could be due to country to country variability in regulations and their applications beside the differences of sociodemographic conditions.

Three-fourth of total participants (76.3%) always read instructions label of antibiotics while 94.6% checked the expiry date before use. In an investigation carried out by Mouhieddine et al [31] mentioned that 69.7% usually read the label instruction and 83.2% read the date of expiration. In accordance with current study, during a survey carried out by Nepal et al [48], 94.5% participants checked the expiry date before use. About half of the respondents completed the full course of antibiotics as recommended by doctor in the case of any disease while 37% stopped taking antibiotics before the completion of antibiotics and rest were not sure about this. Similar results were obtained from the people of Kuwait more than one-third (36%) didn't complete the prescribed antibiotics course [26]. Almost all participant students (more than 90%) did not demand antibiotics and trusted the doctor's decision if he prescribes or not.

Statistical analysis showed the interesting findings in terms of identifying the sociodemographic characteristics influencing the knowledge, attitude and practices of students. Antibiotic related knowledge was significantly different in different gender, age and degree groups of students while positive attitude was depicted significantly different in

different age groups. Students of different gender, age and degree programs showed significantly different practices. These findings clearly indicated that sociodemographic features of students strongly determine the KAP regarding antibiotic use and resistance. A report of Jairoun et al [11] showed that major, study level, sex and age were jointly highly associated with KAP regarding antibiotic use among university students of UAE. However, Jairoun et al [11] determined the association of demographics with joint data of KAP while in the present study, the association was found separately with each parameter KAP.

The current finding clearly indicated that there is urgent need to limit the granted access for antibiotics in developing countries such as Pakistan. World Health Organization (WHO) is actively taking stance on the increasing levels of antibiotic resistance. WHO has issued "Global Strategy for Containment of Antimicrobial Resistance" for the governments and policy makers to implement and take actions on this subject. In this concern, South Korea launched numerous educational campaigns to implement for antibiotic use in several ways targeting the general population [49]. This nationwide study for the assessment of KAP towards antibiotic use and resistance among Pakistani university students depicted that although biological sciences' students have shown a good level of positive attitude (87.9%) towards antibiotics use and resistance, but results of knowledge (74.7%) and positive practices (75.5%) are not much satisfactory (moderate level). So, the findings call for tailored interventions to improve the students' knowledge and positive practices. For that purpose, antibiotics related educational programs such as workshops, seminars and symposiums are required at university level. In university, a multidisciplinary group consisting of expert microbiologists, infectious-disease's specialists and pharmacists should be involved in developing the curriculum of educational programs on antibiotics. University teachers delivering the sessions or lectures on irrational use of antibiotics must be trained also. Public

Health England introduced the “train the trainer” workshop for teachers to train them on how to educate students about spread of infection, hygiene, and antibiotic use [50].

Interactive learning in the form of problem-based learning with case vignettes could be an appropriate approach. For example, a program-based module was offered to undergraduate students in the University of Nijmegen, Netherlands on antibiotic policy treating the infectious diseases history, principles of prophylaxis and antibiotic guidelines [51]. Additionally, establishing the standardized electronic tools providing easy access to the correct information can be proved very beneficial for the improvement of knowledge related to antibiotics. In US, an open-access antimicrobial-resistance learning site was developed by CDC, University of Minnesota and Michigan State University for veterinary medical students [52]. Mainstream and social media platforms can also play a vital role in this concern.

Science has made progress to resolve inexplicable matters in the medical field. To date, innumerable drugs have been discovered for different ailments from mildest pain to excruciating conditions, such as cancer. What, if all the efforts of the great scientists go for naught? Antibiotic resistance is prevailing among literate and illiterate communities equally.

To cope with antibiotic resistance, substantial efforts should be made to aware people especially the layperson about the prudent use of antibiotics. In the current study, the targeted group belonged to the biological sciences that were expected to be well aware of the judicious use of antibiotics but the gap found in KAP perturbs about the gravity of the situation. Several problems that need to be addressed imperatively include restricting the widespread availability of antibiotics from unofficial distributors, irrational prescription of antibiotics by healthcare personnel, misconceptions regarding excessive use of antibiotics, self-medication, and deleterious effects of the irrational use of antibiotics. Educating the ‘educated’ health workers along with the general population is indispensable now to limit the

extravagant prescription of antibiotics. Campaigns at the grassroots level should be initiated to inform and educate the people about the correct use of drugs. Moreover, educating the university/college students irrespective of their field can give promising results over this very serious matter. A person being instructed at the university/college/school about the pros and cons of antibiotic use can disseminate the information very effectively to their family members. This systematic and structured approach to deal with this concern can have a remarkable effect on the community in the future. Besides this, a bold note should be added to the leaflet of every drug being distributed/administered for any disease condition. Though new drugs are being developed, without changing the attitudes and behavior towards the use and prescription of antibiotics, no amelioration can be expected.

4 Conclusion

The evaluation of knowledge, attitude and practices towards antibiotic use and resistance among university students is a helpful tool to help improve the use of antibiotics. The present investigation addressed the KAP about antibiotics enrolled in the biological sciences programs of eight major universities of Pakistan. Findings revealed that students showed moderate level of knowledge (74.4%), good attitude scores (87.9%) and moderate practices (75.5%). With the relevant background, biology students depicted satisfactory KAP scores however there is still need to improve the students' knowledge. Improving the students' level of knowledge about the antibiotic use and resistance would remediate and rationalize their attitude and practices toward antimicrobial use. This could be achieved by educating the students through nationwide awareness programs, academic interventions including seminars, workshops, and/or courses related to public health concerns and interactive learning. Awareness campaigns through media considering public health is also recommended.

Involving the civil society organization and the media intervention would greatly serve this aim.

Conflict of Interest

The authors declare no conflict of interest

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Table 1. Sociodemographic characteristics of participants (N = 826).

No.	Sociodemographic characteristics		N	%
	Gender	Male	141	17.1
		Female	685	82.9
	Age (years)	18-20	56	6.8
		21-23	635	76.9
		> 23	135	16.3
	Degree	Bachelors	125	15.1
		Masters	626	75.8
		Doctoral	75	9.1

Table 2. Frequency (n) and percentage (%) of participants answering the KAP questions on antibiotic use and resistance (N = 826).

		Yes		No		Maybe	
No.	Questions	n	%	n	%	n	%
	Knowledge	([a] Correct answer)					
1.	There are bacteria found in the human body which are useful for us	711[a]	86.1	20	2.4	95	11.5
2.	Antibiotics and Antivirals are the same things	40	4.8	776[a]	92.7	20	2.4
3.	Antibiotics are used to cure bacterial infections	801[a]	97.0	15	1.8	10	1.2
4.	Antibiotics are also used to cure viral infections	140	16.9	616[a]	74.6	70	8.5
5.	Antibiotics can be used for the speedy recovery from coughs, colds, and other diseases	570	69.0	140[a]	16.9	116	14.0
6.	Antibiotics are obtainable at pharmacies without prescription of a doctor	595	72.0	121[a]	14.6	110	13.3
7.	I have an idea of 'antibiotic resistance'?	706[a]	85.5	105	12.7	15	1.8
8.	Frequent use of antibiotics could reduce their efficacy	756[a]	91.5	35	4.2	35	4.2
9.	Frequent use of antibiotics lowers the chances of infection	175	21.2	515[a]	62.3	136	16.5
10.	Antibiotics can have side effects	706[a]	85.5	15	1.8	105	12.7
11.	Tetracycline is an antibiotic	751[a]	90.9	20	2.4	55	6.7
12.	Penicillin is an antibiotic	750 [a]	90.8	35	4.2	41	5.0
13.	Amoxicillin is an antibiotic	686 [a]	83.1	35	4.2	105	12.7
	Attitude	([a] Positive attitude)					
1.	Misuse of antibiotics exists in the society	725[a]	87.8	15	1.8	86	10.4
2.	Antibiotic resistance is an issue in Pakistan	676[a]	81.8	40	4.8	110	13.3
3.	Frequent use of antibiotics results in resistance in harmful bacteria	706[a]	85.5	50	6.1	70	8.5
4.	Antibiotic resistance affects the health	701[a]	84.9	40	4.8	85	10.3
5.	Information related to antibiotic resistance is necessary for everyone	816[a]	98.8	10	1.2	0	0.0

6.	There should be a subject related to the rational use of antibiotics in the university course	736[a]	89.1	25	3.0	65	7.9
	Practices	([a] Positive practices)					
1.	I always consult a doctor before using an antibiotic	615[a]	74.5	180	21.8	31	3.8
2.	I sometimes use antibiotics on the suggestion of any neighbor or friend	150	18.2	591[a]	71.5	85	10.3
3.	I always keep a stock of different antibiotics at my home	320	38.7	411[a]	49.8	95	11.5
4.	I myself give antibiotics to other family members if someone gets sick	235	28.5	541[a]	65.5	50	6.1
5.	I always read the antibiotics instructions label	630[a]	76.3	96	11.6	100	12.1
6.	I stop taking antibiotics before completing the full course recommended by doctor?	306	37.0	410[a]	49.6	110	13.3
7.	I always check the expiry date of an antibiotic before using it	781[a]	94.6	30	3.6	15	1.8
8.	I sometimes use leftovers antibiotics without consulting the doctor	185	22.4	550[a]	66.6	91	11.0
9.	I demand antibiotics from a doctor while he says you don't need it	25	3.0	781[a]	94.6	20	2.4
10.	I trust the doctor's decision if he/she doesn't prescribe me antibiotics	779[a]	94.3	45	5.4	2	0.2
11.	I trust the doctor's decision if he/she prescribes me antibiotics	766[a]	92.7	25	3.0	35	4.2

Table 3. Association of sociodemographic characteristics with knowledge score related to antibiotic use and resistance (N = 826).

No.	Sociodemographic characteristics		Positive knowledge score			Z/χ^2	*p*-value
			%	Mean ± SD	Median (IQR)		
1.	Gender[a]	Male	73.1	9.5±1.7	10(2)	−2.481	0.013
		Female	75.4	9.8±1.9	10(2)		
2.	Age (years)[b]	18-20	75.4	9.8±1.8	9(4)	32.382	< 0.001
		21-23	76.9	10.0±1.4	10(2)		
		> 23	76.9	10.0±1.6	10(2)		
3.	Degree[b]	Bachelors	67.7	8.8±2.6	10(4)	16.807	< 0.001
		Masters	76.2	9.9±1.7	10(2)		
		Doctoral	76.2	9.9±1.1	10(2)		

[a]Mann–Whitney U test, [b]Kruskal–Wallis H test

Table 4. Association of sociodemographic characteristics with attitude score related to antibiotic use and resistance (N = 826).

No.	Sociodemographic characteristics		Positive attitude score			Z/χ^2	*p*-value
			%	Mean ± SD	Median (IQR)		
1.	Gender[a]	Male	91.7	5.5±0.9	6(1)	−1.838	0.066
		Female	86.7	5.2±1.2	6(1)		
2.	Age (years)[b]	18-20	71.7	4.3±1.2	5(2)	53.639	< 0.001
		21-23	88.3	5.3±1.1	6(1)		
		> 23	90.0	5.4±0.9	6(1)		
3.	Degree[b]	Bachelors	85.0	5.1±1.3	6(1)	1.666	0.435
		Masters	88.3	5.3±1.1	6(1)		
		Doctoral	86.7	5.2±1.2	6(2)		

[a]Mann–Whitney U test, [b]Kruskal–Wallis H test

Table 5. Association of sociodemographic characteristics with practices score related to antibiotic use and resistance (N = 826).

No.	Sociodemographic characters		Positive practices score			Z/χ^2	*p*-value
			%	Mean ± SD	Median (IQR)		
1.	Gender[a]	Male	70.9	7.8±2.3	8(4)	−2.601	0.009
		Female	76.4	8.4±2.0	9(3)		
2.	Age (years)[b]	18-20	64.5	7.1±2.3	7(5)	16.872	< 0.001
		21-23	76.4	8.4±2.0	9(3)		
		> 23	75.5	8.3±1.9	9(3)		
3.	Degree[b]	Bachelors	70.9	7.8±2.3	8(3)	11.014	0.004
		Masters	75.5	8.3±1.9	8(3)		
		Doctoral	80.0	8.8±2.2	9(2)		

[a]Mann–Whitney U test, [b]Kruskal–Wallis H test

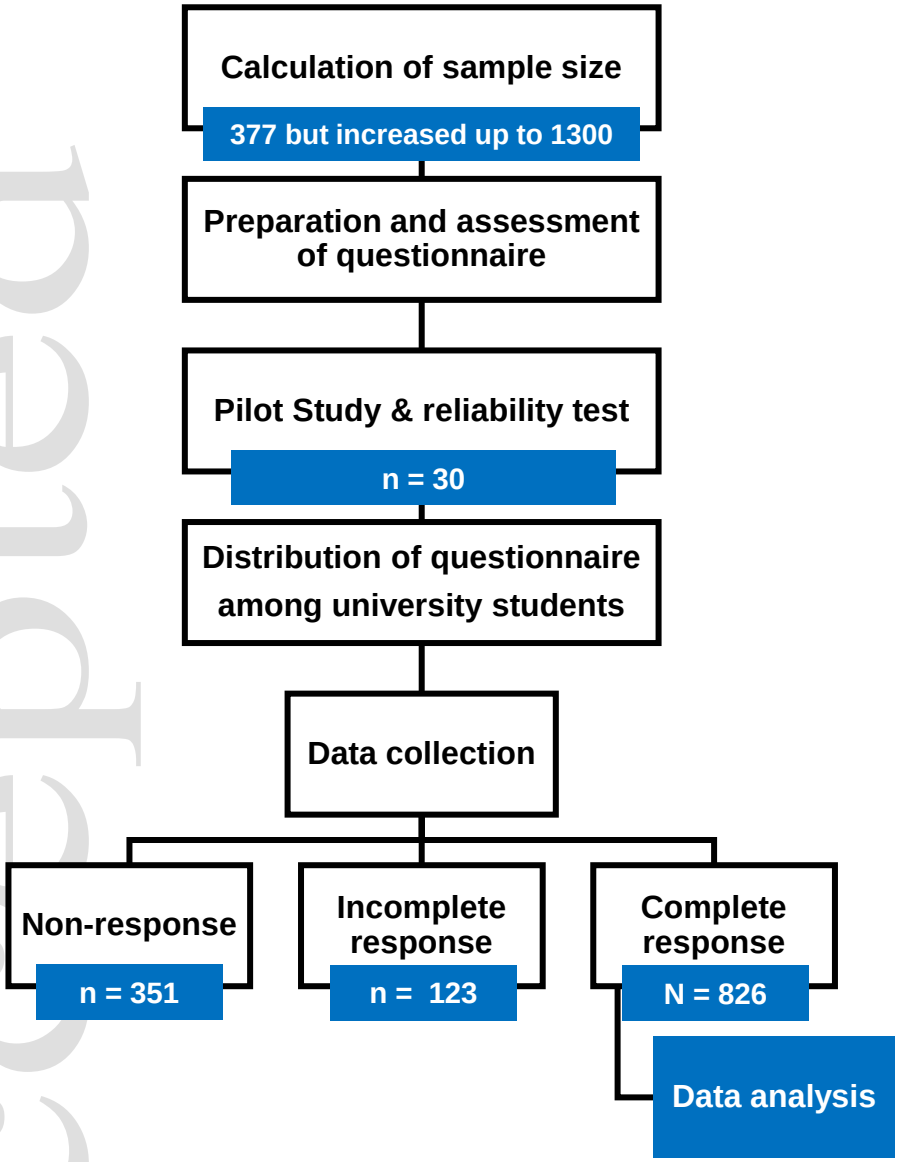

Figure 1. The flowchart of pipeline of this cross-sectional study related to antibiotics use and resistance among university biological science's students. Starting with the selection of required sample size for the designed study, the preliminary steps included preparation of the questionnaire and its assessment via reliability tests before its distribution among biological science's students for data collection. Further sorting of data was performed based on responses obtained and inclusion criteria included data from questionnaires having complete responses.

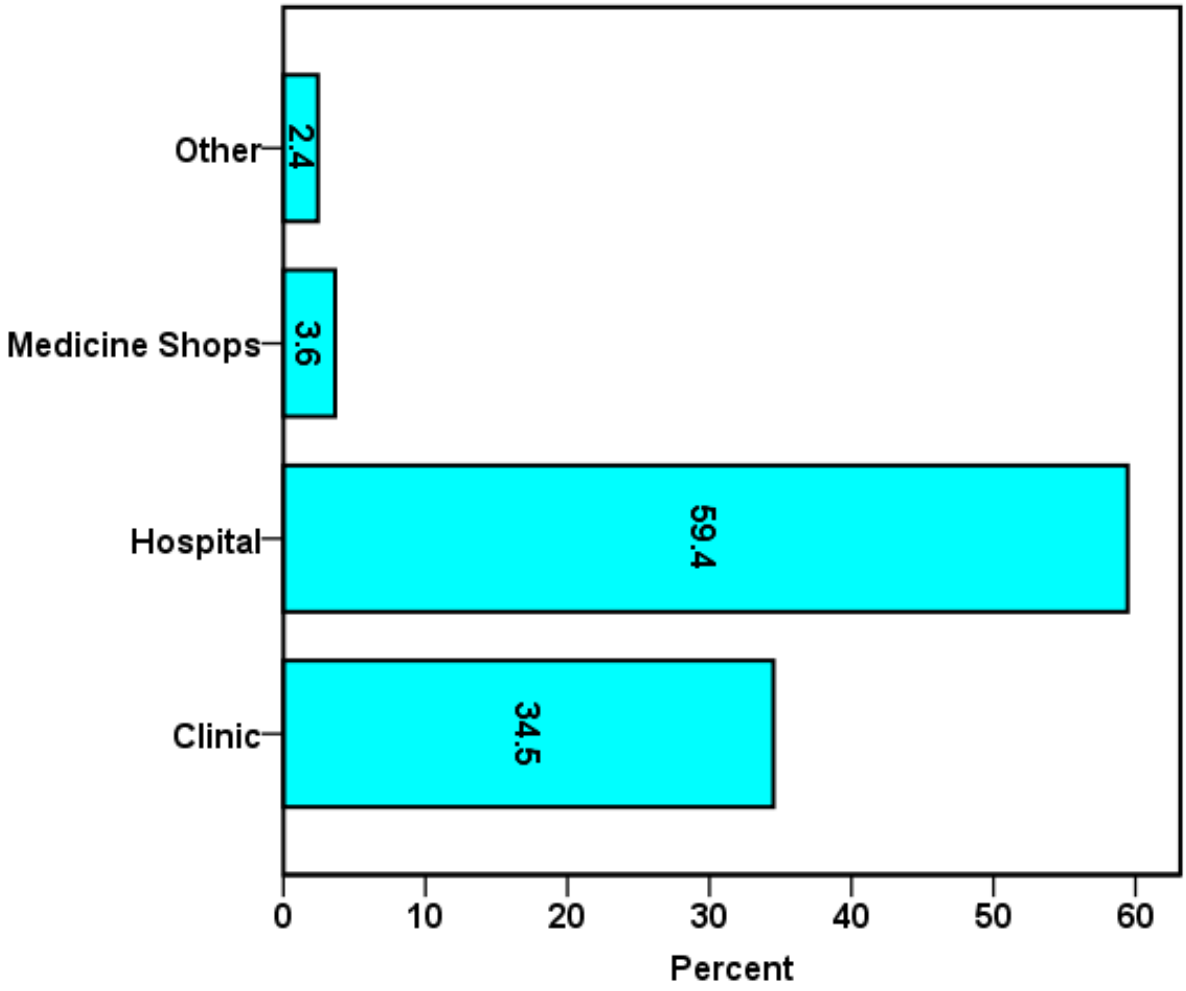

Figure 2. Bar chart representing the variations in health care facilities approached by participants in the case of illness. Four hundred and ninety-one (59.4%) participants visited hospital during illness followed by clinic (34.5%), medicine shops (3.6%) and other sources (2.4%).

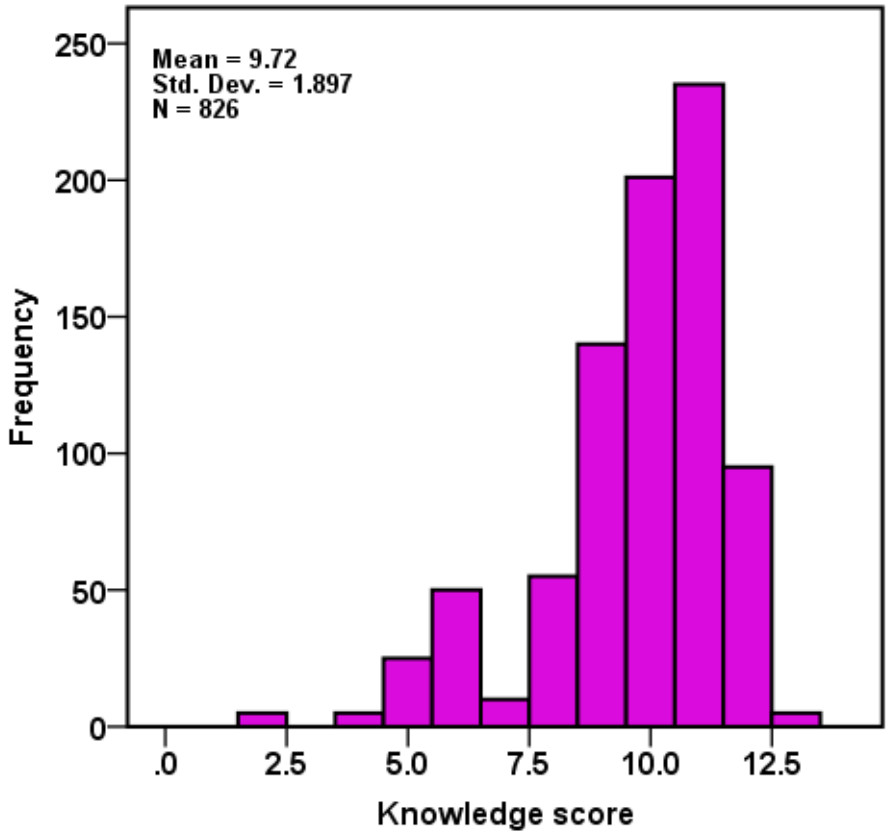

Figure 3. Histogram depicting the knowledge score of participants. The knowledge scores ranged from 2 to 13 with the mean of 9.7 ± 1.9 while most repetitive number (mode) was 11 which were scored by 235 participants (28.4%).

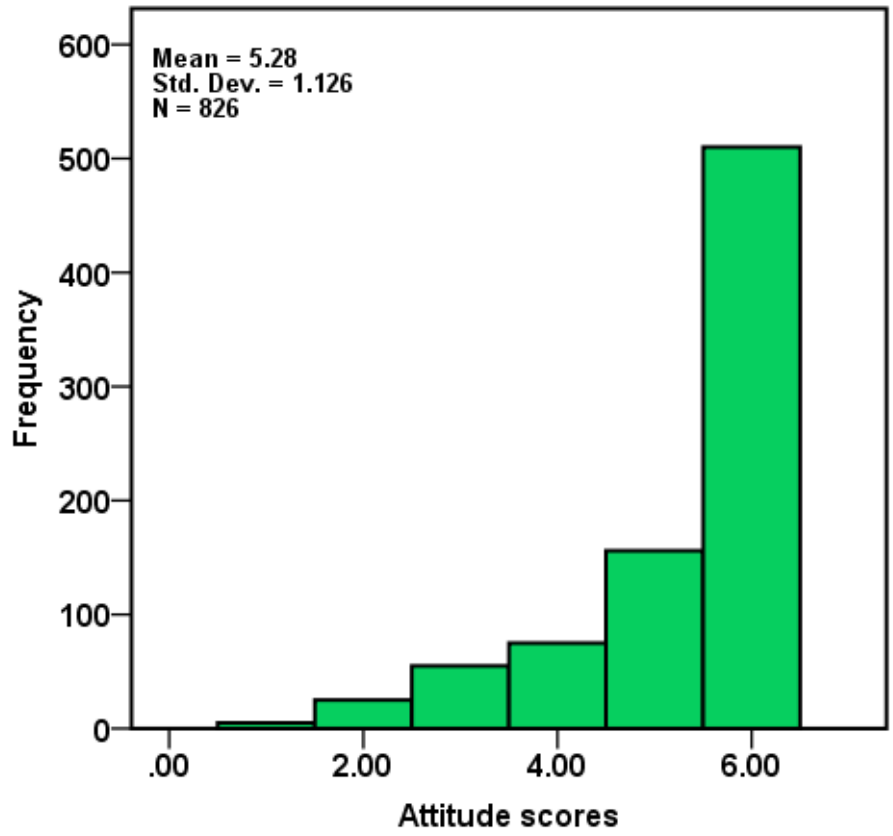

Figure 4. Histogram depicting the attitude score of participants. The scores ranged as 0-6 with the mean of 5.3 ± 1.1 whereas most participants (n = 510, 61.7%) obtained the score of 6.

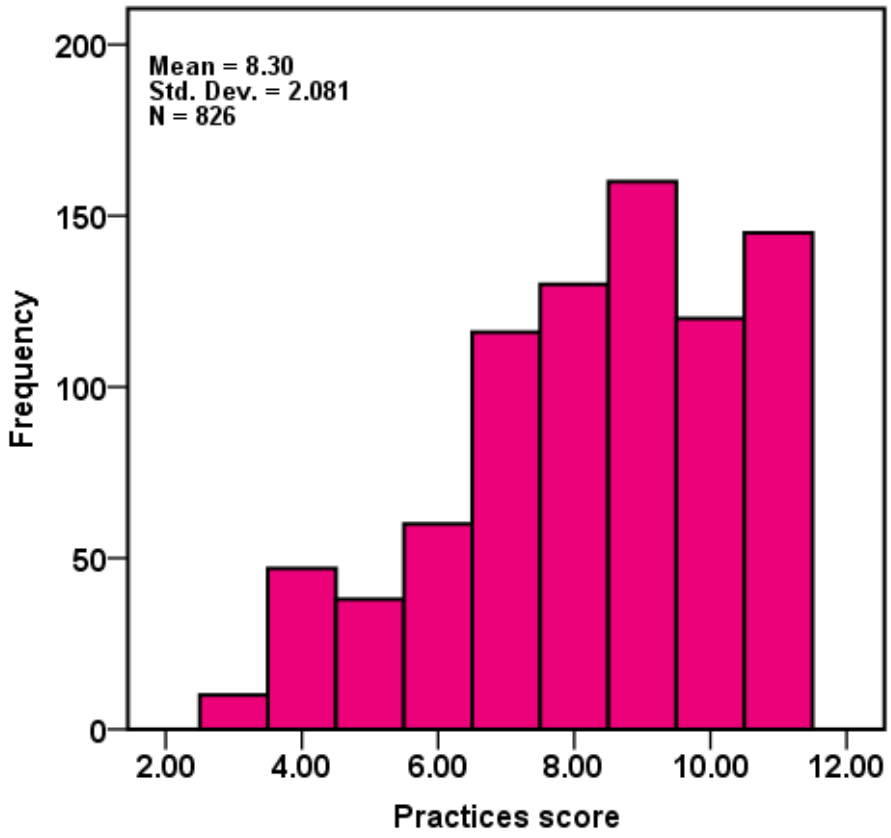

Figure 5. Histogram depicting the practices scores of participants. The scores varied from 3 to 11 with 8.3 ± 2.1 mean. The most achieved score was 9 which were obtained by 160 students.