

Knowledge, Attitudes and Practice Regarding Antimicrobial Resistance and Antimicrobial Use among Undergraduate Medical Students in Majmaah, Saudi Arabia

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ABSTRACT

Background: Antibiotics are the most frequently prescribed and misused drugs. One of the important pillars of the global action plan on antimicrobial resistance launched by the World Health Organization is to improve awareness.

Objective: To evaluate knowledge, attitudes, and practice regarding antimicrobial use and resistance among undergraduate medical students.

Methodology: A cross-sectional observational study was conducted by administering a 31-item pretested and prevalidated questionnaire. The questionnaire had five sections, relating to sociodemographic characteristics, antimicrobial consumption during the last year, knowledge about antibiotics, awareness of antibiotic resistance, and attitudes and behavior regarding antimicrobial use.

Results: A total of 190 students participated in the study; 126 were from the College of Medicine and 64 were from the College of Applied Medical Sciences. The College of Medicine students demonstrated good knowledge in comparison to the College of Applied Medical Sciences students. The overall knowledge and awareness of the College of Applied Medical Sciences students was poor. No significant differences were found in attitudes and practice between the two colleges.

Conclusion: The study showed a need for educating medical students regarding appropriate antibiotic use and resistance. Also, disparities were noticed between the knowledge and practice of the students at both colleges.

Key words: Medical students, Antimicrobial use, Antimicrobial resistance, Knowledge, Attitude, Practice

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INTRODUCTION

Antimicrobial resistance (AMR) is a serious global concern, as many people across the world use antibiotics inappropriately [1,2]. AMR occurs when bacteria, parasites, viruses, and fungi become resistant to antimicrobial agents that are used for treating the infections they cause [3]. Antimicrobial agents such as antibiotics are mainstays for the treatment of infections, and many life-saving interventions, such as cancer chemotherapy and major surgeries, depend on effective antimicrobial agents to succeed [4,5]. Unfortunately however, the current dependence on antibiotics, to treat

disease, prevent disease, and stimulate livestock growth, has increased AMR exponentially. When antibiotics are used, selection pressure is created, potentially forcing the exposed bacteria to mutate or acquire pieces of DNA to develop AMR [6]. The selection pressure resulting from the overwhelming use and misuse of antibiotics is exacerbating the AMR phenomenon [7].

Despite this known fact, approximately 10 million tons of antibiotics are used globally every 10 minutes, which is mostly not justified by medical use [8]. Multidrug-resistant (MDR) pathogens are spreading rapidly in many parts of the world, causing severe medical and economic consequences. It is estimated that at least every 10 minutes, a patient dies in the USA or Europe because of fatal infections caused by antibiotic resistant bacteria [9].

Antibiotics are the most frequently prescribed drugs, but they are often misused [10,11]. This contributes to the spread of resistant strains of bacteria [12]. One of the causes for antimicrobial misuse is incorrect prescribing by physicians [13-15]. There are many factors that can influence doctors' decisions, leading them to fail to uphold the principles of good clinical practice. Examples of these include the fear of possible future complications in their patients and the desire to fulfill patients' expectations [16]. Patients' incorrect habits and their lack of knowledge also represent another leading cause of AMR [17].

To limit the alarming threat of AMR, the World Health Organization launched the Global Action Plan on Antimicrobial Resistance [18]. This plan was signed off by most member states, including Saudi Arabia, during the World Health Assembly in 2015 [19]. One of the important pillars of this plan is to improve awareness of AMR.

Educational initiatives on the correct use and prescription of antimicrobial agents, addressing both the general population and health care professionals, should thus be promoted [20]. The future doctors and other health care professionals must be fully aware of the increasing problem of antibiotic resistance [21,22].

Therefore, this study was conducted to identify knowledge, attitudes, and practice regarding antimicrobial use and resistance among undergraduate medical students.

MATERIALS AND METHODS

A cross-sectional study to find out the knowledge, attitudes, and practice regarding antimicrobial use and resistance among undergraduate medical students was conducted at the College of Medicine and the College of Applied Medical Sciences at Majmaah University, Saudi Arabia. The study was conducted between January 2018 to June 2018 after obtaining the ethical approval from the ethics committee of the Deanship of Scientific Research at Majmaah University. This study included nursing, physiotherapy, and medical students at Majmaah University. Study participants who declined to participate in the study were excluded.

A 31-item pretested and prevalidated questionnaire, composed of five sections, was used [23]. The first part of the questionnaire collected data on the sociodemographic characteristics of the students surveyed. The second part evaluated the consumption of antimicrobial agents in the last year. In the third part, knowledge about antibiotics and related adverse reactions was assessed, while in the fourth part information about awareness of antibiotic resistance was collected. Finally, the last part focused on attitudes and behaviors toward antibiotic use [23]. Both a 4-point Likert scale (with responses ranging from "Strongly disagree" to "Strongly agree") and dichotomous answers (yes/no) were used for some questions.

The data was entered and analyzed using IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Pearson-Chi Square was applied to associate the responses of students of the two colleges in relation to knowledge, attitudes, and practice. Logistic regression analysis was conducted to test the relationships between dependent and independent categorical variables. A p-value of <0.05 was considered as statistically significant.

RESULTS

The questionnaire was distributed to more than 237 students; 150 students were from the College of Medicine, Majmaah University, and 87 students were from the College of Applied Medical Sciences, Majmaah University, which includes the College of Nursing, College of Physiotherapy, and College of Laboratory Medical Sciences. Only 126 (84%) of the students from the College of Medicine consented and returned completed questionnaires, and 64 (73.56%) of the students from the College of Applied Medical Sciences returned completed questionnaires.

Table 1 shows the characteristics of the sample. The total sample size was 190. All the participants in the study were male. No significant differences were found between the two groups of students regarding the percentage of students who had a family member who worked in a health-related field and the percentage of students who had used an antibiotic in the last year. The participation rate of first-year students was the lowest rate for both colleges.

Table 1: Description of the sample

Description	College of Medicine	College of Applied Medical Sciences
Number of participants	126	64
Age (years), mean ± SEM	22.15 ± 0.15	22.06 ± 0.22
Family member working in health-related field, N (%)	64 (50.8%)	34 (53.1%)
Year of study, N (%)	1 st year	0 (0%)
	2 nd year	30 (23.8%)
	3 rd year	19 (15.07%)
	4 th year	29 (23.01%)

	5 th year	23 (18.25%)	5 (7.81%)
	6 th year	25 (19.84)	1 (1.56%)
Antibiotic use in the last year		80 (63.5%)	37 (57.8%)

Table 2 shows the responses of the students to the knowledge-related questions about antibiotics. Correct answers (corresponding to either “strongly agree” or “strongly disagree,” depending on the statement) were

>70% for more than half of the questions in the Medicine group and <50% for all the questions in the College of Applied Medical Sciences group.

Table 2: Response of the students to knowledge-related questions about antibiotics on a 4-point Likert scale

Question	College of Medicine, N (%)				College of Applied Medical Sciences, N (%)			
	Strongly Disagree	Disagree	Agree	Strongly Agree	Strongly Disagree	Disagree	Agree	Strongly Agree
Penicillin or amoxicillin are antibiotics?	9 (7.1%)	5 (4%)	5 (4%)*	107 (84.9%)*	20 (31.3%)	22 (34.4%)	8 (12.5%)*	14 (21.9%)*
Aspirin is an antibiotic?	110 (87.3%)*	9 (7.1%)*	6 (4.80%)	1(0.80%)	26 (40.6%)*	19 (29.7%)*	9 (14.10%)	10 (15.60%)
Paracetamol is an antibiotic?	112 (88.9%)*	6 (4.8%)*	4 (3.20%)	4 (3.20%)	26 (40.6%)*	15 (23.4%)*	15 (23.40%)	8 (12.50%)
Antibiotics are useful in bacterial infection?	9 (7.10%)	4 (3.20%)	14 (11.1%)*	99 (78.6%)*	9 (14.10%)	22 (34.40%)	12 (18.8%)*	21 (32.8%)*
Antibiotics useful in viral infection?	101 (80.2%)*	9 (7.1%)*	9 (7.10%)	7 (5.60%)	20 (31.3%)*	19 (29.7%)*	9 (14.10%)	16 (25%)
Antibiotics are used for pain inflammation?	70 (55.6%)*	32 (25.4%)*	15 (11.90%)	9 (7.10%)	12 (18.8%)*	12 (18.8%)*	21 (32.80%)	19 (29.70%)
Antibiotics kill good bacteria?	7 (5.60%)	15 (11.90%)	26 (20.6%)*	78 (61.9%)*	16 (25%)	16 (25%)	13 (20.3%)*	19 (29.7%)*
Antibiotics cause secondary infection?	9 (7.10%)	24 (19%)	33 (26.2%)*	60 (47.6%)*	11 (17.20%)	18 (28.10%)	20 (31.3%)*	15 (23.4%)*
Antibiotics can cause allergic reactions?	5 (4%)	19 (15.1%)	24 (19%)*	78 (61.9%)*	16 (25%)	18 (28.1%)	16 (25%)*	14 (21.9%)*

*p<0.05 by chi square test

Table 3 represents the responses of the students to questions on knowledge of the term “antibiotic resistance” and if they responded ‘yes’ to the questions,

whether they were exposed to this term in a university course.

Table 3: Response of the students to knowledge-related questions (yes/no)

Question	College of Medicine, N (%)		College of Applied Medical Sciences, N (%)	
	Yes	No	Yes	No
Have you ever heard about antibiotics resistance?	117 (92.9%)*	9 (7.1%)	40 (62.5%)*	24 (37.5%)
Have you ever heard about antibiotic resistance in university courses?	101 (80.2%)*	25 (19.8%)	31 (48.4%)*	33 (51.6%)

*p<0.05 by chi square test

Table 4 shows awareness of AMR among the students. The awareness was low, at <70%, for all questions in both the groups, but the College of Medicine students

were more aware than the College of Applied Medical Sciences students.

Table 4: Awareness of antibiotic resistance

Question	College of Medicine, N (%)				College of Applied Medical Sciences, N (%)			
	Strongly Disagree	Disagree	Agree	Strongly Agree	Strongly Disagree	Disagree	Agree	Strongly Agree

Antibiotic resistance is the loss of antibiotics sensitivity among bacteria?	11 (8.7%)	15 (11.9%)	20* (15.9%)	80* (63.5%)	9 (14.1%)	26 (40.6%)	18* (28.1%)	11* (17.2%)
Incorrect use of antibiotics can lead to loss of sensitivity of a pathogen to a specific antibiotic?	5 (4%)	20 (15.9%)	23* (18.3%)	78* (61.9%)	12 (18.8%)	25 (39.1%)	19* (29.7%)	8* (12.5%)
If symptoms improve before the end of a full course of antibiotics, you can stop taking them?	86* (68.3%)	20* (15.9%)	10 (7.9%)	10 (7.9%)	24* (37.5%)	12* (18.8%)	17 (26.6%)	11 (17.2%)

*p<0.05 by chi square test

Table 5 represents the attitudes and practice of the students regarding antibiotic consumption. The inappropriate use of antibiotics was significantly higher among the College of Applied Medical Sciences students in comparison to the College of Medicine students.

Table 5: Attitudes and practice of students regarding consumption of antibiotics

Question	College of Medicine, N (%)		College of Applied Medical Sciences, N (%)	
	Yes	No	Yes	No
Do you take antibiotics for a cold or sore throat?	36 (28.6%)	90 (71.4%)*	38 (59.4%)	26 (40.6%)*
Do you usually take antibiotics for fever?	30 (23.8%)	96 (76.2%)*	41 (64.1%)	23 (35.9%)*
Do you keep leftover antibiotics at home because they might be useful in the future?	37 (29.4%)	89 (70.6%)*	29 (45.3%)	35 (54.7%)*
Have you ever started antibiotic therapy after a simple doctor's call, without a proper medical examination?	45 (35.7%)	81 (64.3%)*	39 (60.9%)	25 (39.1%)*
Do you stop antibiotics when feeling better?	58 (46%)	*68 (54%)	37 (57.8%)	27 (42.2%)*
Do you take antibiotics only if prescribed by doctor?	92(73%)*	34 (27%)	41 (64.1%)*	23 (35.9%)
Do you buy antibiotics without medical receipts?	45 (35.7%)	81 (64.3%)*	31 (48.4%)	33 (51.6%)*

*p<0.05 by chi square test

Table 6 shows the logistic regression results, including both the odds ratios and p values. The College of Medicine students showed significantly higher knowledge and were more aware of AMR. There were no significant differences in attitudes and practice.

Table 6: Results of logistic regression

Question	Odds ratio	95% confidence interval		p-value
		Lower	Upper	
Penicillin and amoxicillin are antibiotics	0.492	0.287	0.845	0.01
Aspirin is an antibiotic	1.943	1.005	3.756	0.048
Paracetamol is an antibiotic	1.694	0.898	3.197	0.104
Antibiotics are useful in bacterial infection	1.106	0.627	1.951	0.729
Antibiotics are useful in viral infection	1.094	0.64	1.871	0.743
Antibiotics are indicated to reduce any kind of pain and inflammation	1.917	1.064	3.455	0.03
Antibiotics can kill good bacteria present in our body	0.654	0.394	1.087	0.101
Antibiotics cause secondary infections after killing good bacteria present in our body	1.782	0.9	3.529	0.098
Antibiotics cause allergic reactions	0.571	0.328	0.994	0.048
Have you ever heard about antibiotic resistance?	11.58	2.332	57.503	0.003
Have you discussed the problem of antibiotic resistance during degree courses?	1.6	0.495	5.169	0.432
Have you ever heard of it outside of degree courses?	0.919	0.661	1.279	0.618
Antibiotic resistance is a phenomenon in which a bacterium loses its sensitivity to an antibiotic	0.851	0.489	1.481	0.568
Antibiotic misuse can lead to loss of sensitivity of a pathogen to a specific antibiotic	0.715	0.365	1.402	0.329

If symptoms improve before the end of a full course of antibiotics, you can stop taking them	1.008	0.573	1.775	0.977
Do you take antibiotics for a cold or sore throat?	0.363	0.096	1.382	0.137
Do you usually take antibiotic for fever?	0.412	0.126	1.345	0.142
Do you usually stop taking antibiotics when you start feeling better?	1.798	0.538	6.008	0.341
Do you take antibiotics only when prescribed by a doctor?	2.077	0.612	7.05	0.241
Do you keep leftover antibiotics at home because they might be useful in the future?	1.094	0.332	3.606	0.883
Do you use leftover antibiotics when you have a cold, sore throat, or flu without consulting your doctor?	4.463	0.971	20.507	0.055
Do you buy antibiotics without medical receipt?	1.79	0.509	6.292	0.364
Have you ever started antibiotic therapy after a simple doctor's call without a proper medical examination?	1.049	0.307	3.589	0.939

DISCUSSION

In most of the countries there are problems with antibiotics being consumed inappropriately and the people taking these medications have poor knowledge about the use of antibiotics and their adverse effects and hazards. The extensive and irrational use of antimicrobial agents in therapy is one of the major causes underlying the spread of AMR, and efforts to increase awareness and knowledge about this issue are of utmost importance.

Therefore, antimicrobial stewardship practices should be ensured to standardize the prescribing behavior of our future doctors. Educational initiatives on the correct use and prescription of antimicrobial agents, addressed to both the general population and health care professionals, should thus be promoted [20]. Future doctors and other health care professionals must be fully aware of the increasing problem of AMR [21,22].

Level of awareness and knowledge regarding antimicrobial use and resistance

The findings of this study showed that the College of Medicine students taking the Bachelor of Medicine and Bachelor of Surgery (MBBS) course had better knowledge about antibiotics, use of antibiotics in bacterial infections, and the fact that they should not be used in viral infections than the College of Applied Medical Sciences students. 92.9% of the College of Medicine students were aware of the term "antibiotic resistance." The College of Medicine students demonstrated less knowledge about the fact that antibiotics have no role in pain and inflammation and the problems associated with antibiotic use, such as the fact that they can destroy the normal flora and cause secondary infections and allergic reactions. This may be due to the inclusion of second- and third-year students in the study who are still not exposed to these concepts, and there is a need for early sensitization and emphasis regarding these aspects. The overall knowledge and awareness of the College of Applied Medical Sciences students was poor.

The results of this study of medical students concur with the findings of studies by Abbo *et al.* [24] and Napolitano *et al.* [25]. In a study by Huang *et al.*, it was noted that knowledge of antibiotic use among medical students was

significantly higher than that among non-medical students, but there was no significant difference between first-year medical and non-medical students [26]. In another study, only 32.9% of subjects were aware that antibiotics are effective for bacterial infection, while around 7% believed that antibiotics can be used to treat viral infection [27]. Similar findings were observed in studies performed by Barakh *et al.* and Awad *et al.* [28,29].

Attitudes and practice of medical students regarding antimicrobial use and resistance

Despite the good knowledge and awareness regarding antimicrobial use, especially among the College of Medicine students, the use of antibiotics in the previous year was higher among the College of Medicine students than among the College of Applied Medical Sciences students. This practice showed no correlation with the presence of a family member working in a health-related field. The practice of taking antibiotics inappropriately (e.g., for fever or a cold) was lower among the College of Medicine students. Incorrect behavior was noticed among the College of Applied Medical Sciences students regarding all aspects of practice, and this may be associated with their lower awareness of the facts regarding antimicrobial use and the hazards that accompany it. The results of this study are similar to the results of a study conducted by Sanya *et al.* [30]. The results of studies carried out by Khan *et al.* [31] and Suafian *et al.* [32] were less promising than the results of our study regarding medical students, which may be due to different sociocultural aspects and exposure to information in the curriculum.

Factors that lead to misuse of antimicrobial agents

The self-use of antimicrobial agents was found to be higher among the College of Medicine students in comparison to the College of Applied Medical Sciences students. Education and degree could influence the attitudes and practice regarding antimicrobial use, as seen in our study. Also, year of study could influence the choice of taking antibiotics without a doctor's consultation. Medical students may feel more confident about their knowledge in the final years of study and they may be more liable to misuse antibiotics in comparison

to students in their initial years of study. The inappropriate use of antimicrobial agents (especially to treat colds and fever and the use of leftover medicines) was low among College of Medicine students, implying that awareness and knowledge can reduce the misuse of antibiotics.

Lack of enforcement of drug regulations, which prohibit the purchase of antibiotics without a prescription, is a prime determinant of their overuse and misuse [32]. The World Health Organization has recommended training for medical undergraduates regarding the prudent prescription of antimicrobial agents [33]. It is necessary that our future doctors are equipped with better knowledge regarding appropriate antimicrobial use and resistance [33].

CONCLUSION

This study highlighted the need for educating medical students, especially allied health care students, regarding appropriate antibiotic use and resistance. The study also demonstrated disparities between knowledge and practice, as the students had some knowledge but still had poor practice.

Our recommendation is to introduce specific courses and training about antibiotics and AMR into the core curriculum of the College of Medicine and the College of Applied Medical Sciences. Emphasis should be placed on correct prescribing rules and prevention of inappropriate use. Implementation of an antimicrobial stewardship program for medical students should be ensured in order to standardize the prescribing behaviors of our future doctors. Educational initiatives on the correct use and prescription of antimicrobial agents, in the form of campaigns or awareness programs addressed at both the general population and health care professionals, should be promoted.

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CONTRIBUTIONS

All the participants contributed equally

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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