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Assessment of knowledge, attitudes, and practices of antibiotic resistance among university students in Saudi Arabia

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Abstract

Objective Antibiotic resistance is a global health threat, driven by widespread misconceptions and the misuse of antibiotics. This study aims to assess the knowledge, attitudes, and practices of undergraduate students at the University of Tabuk, Saudi Arabia, regarding antibiotic use and resistance, identifying key misconceptions and behaviours contributing to antibiotic resistance.

Results The analysis revealed misconceptions about antibiotic use and resistance among 800 undergraduate students at the University of Tabuk. Approximately 46% of respondents incorrectly believed that antibiotics could treat viral infections, while 23% were uncertain about their effectiveness against bacterial infections. Although 56% acknowledged that antibiotics might lose effectiveness over time, 24% were unsure about the reason. Additionally, 53% mistakenly believed that viruses could develop antibiotic resistance. These findings highlight persistent gaps in understanding among students. Strengthening awareness through workshops and structured interventions could improve knowledge and promote responsible antibiotic use. Addressing these misconceptions is essential to reducing inappropriate antibiotic practices and mitigating the risks associated with antibiotic resistance.

Keywords Antibiotic resistance, Knowledge, attitudes, Practices, Survey, Undergraduates, Saudi Arabia

Introduction

When bacteria adapt to antibiotics, a phenomenon known as antibiotic resistance (ABR) develops, reducing the effectiveness of antibiotic drugs and limiting treatment options [1]. Antibiotic resistance is one of the most pressing threats to public health, posing a significant global challenge with substantial socioeconomic consequences [2, 3]. Addressing ABR requires healthcare systems to have skilled professionals who can develop effective policies and ensure the appropriate prescription of antibiotics [4, 5]. However, studies indicate that pre-service education programmss are inadequate, leading to a limited understanding of ABR in these sectors. This highlights the urgent need for enhanced educational curricula and targeted awareness campaigns [2, 6].

Antibiotic overuse and misuse are the main causes of ABR, as they facilitate the emergence, multiplication, and spread of resistant strains. The transmission of resistant organisms between humans, animals, and the environment further exacerbates this [7]. Approximately 75% of antibiotics used in veterinary medicine share their composition with those used for humans. Moreover, using

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manure from antibiotic-treated livestock as crop fertiliser promotes the selection and dissemination of resistant bacteria. Even though antibiotic use in crops is relatively low, this indirect exposure still contributes to resistance [8–10].

Antibiotic resistance significantly impacts global health by increasing morbidity, mortality, hospital stays, and medical costs [11–13]. Multiple factors drive this crisis, such as medication errors, therapy non-adherence, self-medication, and the use of antibiotic growth promoters in agriculture and livestock [14–17]. A lack of incentives for drug innovation and weak surveillance systems further worsens the problem [18]. According to the Interagency Coordination Group (IACG) on ABR, it is responsible for more than 700,000 deaths annually, a number that could rise to 10 million per year by 2050, with economic losses projected to rival those of the 2008 global financial crisis [19].

In response to this growing crisis, the World Health Organisation (WHO) has made combating ABR a top priority. In 2015, the World Health Assembly adopted a global action plan with strategic objectives, including increasing awareness and understanding of ABR and optimising antibiotic use [20]. To support these objectives, the WHO launched a global campaign to promote the best practices in antibiotic use among healthcare providers, decision-makers, and the public. Each country is encouraged to develop a national roadmap to enhance awareness and promote prudent antibiotic usage.

The aim of this study is to assess the knowledge, attitudes, and practices (KAP) of undergraduate students at the University of Tabuk regarding antibiotic use and its resistance. The findings will inform strategies aligned with the WHO's global objectives.

Study design and questionnaire methods

This descriptive cross-sectional study was conducted at the University of Tabuk, Saudi Arabia, from July to October 2024, involving 800 undergraduate students. A structured questionnaire was used to assess KAP regarding antibiotic use and resistance. Descriptive statistical methods, including frequency distributions, percentages, means, standard deviations, and range values, were used to summarise the participants' responses.

The questionnaire was developed based on a review of previous studies on antibiotic use and resistance. It comprised 14 questions: one demographic question on gender and 13 questions addressing KAP related to antibiotic use and resistance. A sample size of 800 students was selected to ensure representativeness within the university setting.

Ethical considerations

Participants received detailed information about the study and were assured of privacy and anonymity. The data were analysed and presented in such a way that the participants could not be identified. Ethical approval was obtained from the Local Research Ethics Committee (LREC) at the University of Tabuk, Saudi Arabia, in accordance with the ethical guidelines and regulations of the National Committee of Bioethics (NCBE). The study was approved under reference number UT-400-273-2024 on February 18, 2024.

Results

Knowledge, attitudes, and practices of antibiotic resistance

The survey assessed the knowledge, practices, and attitudes of 800 University of Tabuk undergraduates regarding antibiotic use and ABR as shown in Table 1; Fig. 1. The findings revealed gaps in knowledge, misconceptions about ABR, and varying levels of appropriate practices.

Among the participants, 56% ($n = 448$) correctly identified the use of antibiotics for treating bacterial infections. However, 46% ($n = 368$) mistakenly believed that antibiotics could treat colds, and 41% ($n = 328$) thought they could be used to relieve pain. Furthermore, 49% ($n = 392$) incorrectly assumed that antibiotics are effective against viral infections. Misconceptions about the cause of the common cold were also evident, with 38% ($n = 304$) believing it is caused by bacteria, while 70% ($n = 560$) correctly identified viruses as the cause. Additionally, 53% ($n = 424$) wrongly believed that viruses can develop resistance to antibiotics.

Awareness of ABR was moderate, with 56% ($n = 448$) recognising that antibiotics could lose effectiveness over time and 52% ($n = 416$) correctly understanding that resistance can be transmitted between bacteria. However, 28% ($n = 224$) expressed uncertainty about ABR transmission. Regarding how people use antibiotics, 50% ($n = 400$) agreed that individuals shouldn't stop taking them once they start feeling better, and 61% ($n = 488$) correctly identified that taking antibiotics for less time than prescribed can lead to ABR. A notable misconception in attitudes toward ABR was observed, as 60% ($n = 480$) of respondents incorrectly believed that humans, rather than bacteria, develop resistance to antibiotics. Overall, the results highlight gaps in knowledge and misconceptions about antibiotics and ABR, despite some awareness of proper antibiotic use practices.

Positive responses, misconceptions, and uncertainty: analysis of survey findings

The survey responses, as shown in Table 2, indicate the distribution of responses, presenting the mean, standard deviation, minimum, and maximum percentages for correct, incorrect, and "I Don't Know" responses.

Table 1 Participants' demographics and knowledge about antibiotics

		***n* (%)**
Gender	Female	544 (68%)
	Male	256 (32%)
1. Antibiotics are always effective in treating the same infection in the future.	Yes	360 (45%)
	No	272 (34%)
	I don't know	168 (21%)
2. Antibiotics are used to treat bacteria.	Yes	448 (56%)
	No	168 (21%)
	I don't know	184 (23%)
3. Antibiotics are used to treat colds.	Yes	368 (46%)
	No	248 (31%)
	I don't know	184 (23%)
4. Antibiotic are used to treat pain.	Yes	328 (41%)
	No	256 (32%)
	I don't know	216 (27%)
5. Antibiotic are used to treat viral infections.	Yes	392(49%)
	No	256(32%)
	I don't know	152(19%)
6. Antibiotic can lose their ability to cure infections they were previously effective against.	Yes	448 (56%)
	No	160 (20%)
	I don't know	192 (24%)
7. Antibiotic resistance can be transmitted from one bacteria to another.	Yes	416 (52%)
	No	160(20%)
	I don't know	224 (28%)
8. Common cold is caused by bacteria.	Yes	304 (38%)
	No	352(44%)
	I don't know	144 (18%)
9.Common cold is caused by viruses.	Yes	560)70%)
	No	136 (17%)
	I don't know	104 (13%)
10. Humans can become resistant to Antibiotic.	Yes	480(60%)
	No	128 (16%)
	I don't know	192 (24%)
11. Individuals should not stop taking antibiotics when they start to feel better.	Yes	400 (50%)
	No	272(34%)
	I don't know	128 (16%)
12. Important cause of antibiotic resistance is taking antibiotic for shorter duration than prescribed.	Yes	488 (61%)
	No	176 (22%)
	I don't know	136 (17%)
13.Viruses can become resistant to antibiotic.	Yes	424 (53%)
	No	176 (22%)
	I don't know	200 (25%)

The mean percentage of correct responses was 42.77% (± 16.22), with scores ranging from 16 to 70%. However, misconceptions were prevalent, as reflected in the mean percentage of incorrect responses (35.85% ±14.55) with scores ranging from 17 to 60%. Additionally, uncertainty was evident, with an average of 21.38% (± 4.50) of responses categorised as 'I Don't Know,' ranging from 13 to 28%.

Discussion

Antibiotic resistance continues to be a significant global health challenge, driven in part by the inappropriate use of antibiotics and misconceptions surrounding their usage. Table 1; Fig. 1 show the results of our study of undergraduates' KAPs about antibiotics and ABR at the University of Tabuk. They show that there are big knowledge gaps, even though some students know how to use antibiotics correctly. One of the major findings of our study was the presence of widespread misconceptions regarding the use of antibiotics.

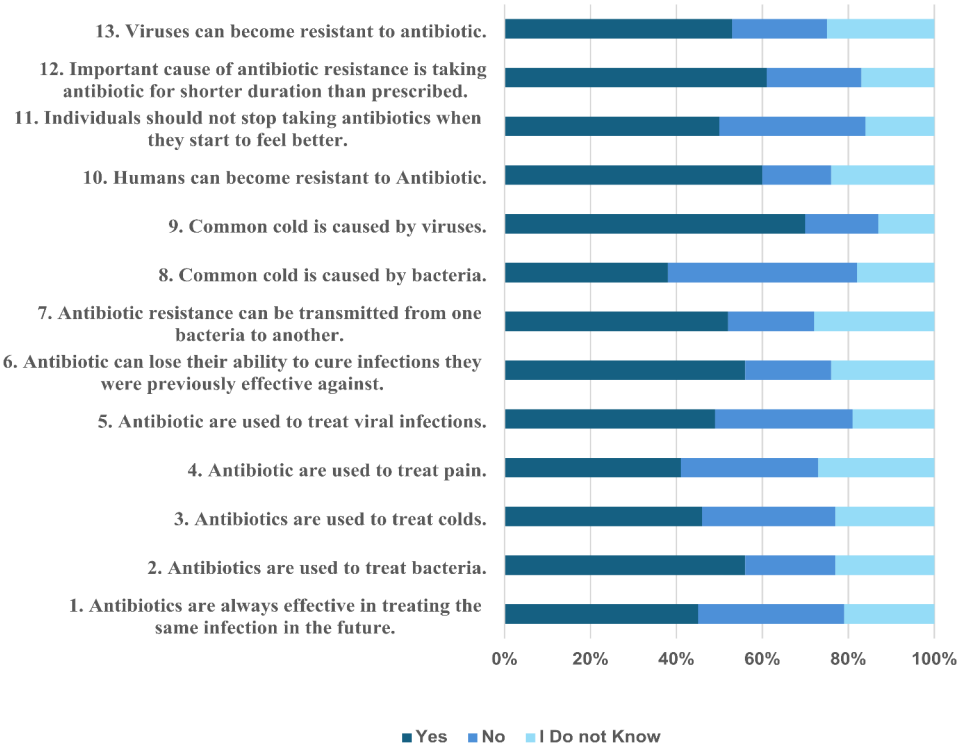

Fig. 1 Responses to antibiotic resistance -related knowledge questions. Participants responded to the questions with 'Yes,' 'No,' or 'I don't know.' For questions 2, 6, 7, 9, 11, and 12, the correct answer is 'Yes.' For questions 1, 3, 4, 5, 8, 10, and 13, the correct answer is 'No.''I Don't Know' was regarded as an incorrect response for all questions

Table 2 Descriptive statistics of survey responses

Response Type	Mean (%)	Standard Deviation (%)	Minimum (%)	Maximum (%)
Correct Responses	42.77	16.22	16	70
Incorrect Responses	35.85	14.55	17	60
I Don't Know	21.38	4.50	13	28

While 56% of the participants who took the survey knew that antibiotics are used to treat bacterial infections. However, 46% of the participants believed that they could also use antibiotics to treat colds, and 49% believed they could also treat viral infections. These misconceptions are concerning, as they directly contribute to the misuse of antibiotics, a primary driver of ABR. Similarly, 41% of respondents held the belief that they could use antibiotics for pain relief, indicating a misunderstanding about their proper use. This trend reflects the findings of a nationwide survey conducted in Myanmar, where a significant portion of the population was unaware of the appropriate use of antibiotics. The survey found that 58.5% of participants purchased antibiotics without a prescription, which is particularly prevalent among younger people and those in rural areas [21]. Such behaviours point to a broader lack of awareness and education regarding the correct use of antibiotics, which increases the risk of contributing to ABR.

In our study, 38% of respondents incorrectly believed that bacteria cause the common cold, while 70% correctly identified it as a viral infection. This finding suggests some participants may conflate bacteria and viruses, reflecting a misunderstanding that coexists with accurate knowledge. The result highlights a gap in understanding infection biology. In Pakistan, a study involving 948 final-year medical and pharmacy students found that reliance on textbooks and digital resources failed to address misconceptions about antibiotic use and its resistance [22]. To improve antibiotic knowledge, we recommend more interactive learning methods, such as workshops, which could actively engage participants and correct misunderstandings.

Awareness of ABR was moderate in our study, with 56% of participants correctly understanding that antibiotics can lose effectiveness over time. Similarly, 52% of respondents understood that AR can be transmitted between bacteria. However, 28% expressed uncertainty regarding the transmission of resistance, which indicates a lack of complete understanding about the mechanisms of ABR. This aligns with the findings from study evaluated antimicrobial resistance KAP among 1115 final-year public

health undergraduates in China. Results revealed a moderate knowledge score (mean 7.68 ± 2.56) and concerning practices, with 75.2% engaging in incorrect antimicrobial use. Key factors positively associated with higher knowledge included enrollment in a top-tier university, male gender, clinical experience, and affirmative attitudes toward ABR. Importantly, greater knowledge correlated with improved practices [23].

A notable misconception among students was the belief that humans, rather than bacteria, develop resistance to antibiotics. In our study, 60% of students held this misunderstanding, highlighting a fundamental lack of awareness regarding the biological mechanisms of ABR. Similar misconceptions have been reported in European studies. For instance, a comparative survey conducted in Bari, Italy, found that high school students had significantly more misconceptions about antibiotics than Veterinary Medicine students. The most common misunderstandings included: (i) antibiotics kill viruses, (ii) they are effective against colds and flu, and (iii) antibiotics can be purchased without a prescription [24]. Further evidence of knowledge gaps was observed in a modified Delphi study involving healthcare professionals across various settings in France, Greece, Lithuania, Poland, and Spain. Among 44 statements related to antibiotic use and resistance, only 30% achieved cross-setting consensus (≥ 80% agreement), while just 50% reached consensus within individual settings. This variability in understanding, particularly concerning antibiotic prescribing practices, underscores the persistence of context-specific misconceptions [25].

Concerning appropriate antibiotic use, our study found that 50% of respondents agreed that individuals should not stop taking antibiotics when they start to feel better. Additionally, 61% recognised that taking antibiotics for a shorter duration than prescribed could contribute to ABR. Similarly, a study conducted in Jazan, Saudi Arabia, which assessed public awareness and practices related to antibiotics, found that individuals who had heard about ABR comprised more than half of the participants and demonstrated better knowledge of antibiotic use. Furthermore, more than half of those aware of ABR correctly understood its implications [26]. However, despite these positive responses, 41% of students incorrectly believed that antibiotics could relieve pain, reflecting a misunderstanding of their proper indications. This finding highlights a key area for further education and clarification, particularly regarding the appropriate use of antibiotics for non-bacterial illnesses.

The analysis of responses regarding antibiotic use and its resistance, as presented in Table 2, revealed notable variations in KAP levels among participants. On average, 42.77% of responses were correct, indicating a moderate level of awareness. However, the substantial standard deviation (16.22%) suggests considerable variability in understanding among respondents, with correct response rates ranging from 16 to 70%. This variation underscores the presence of knowledge gaps and inconsistencies in antibiotic use and its resistance awareness within the study population. Conversely, 35.85% of responses were incorrect, further highlighting the prevalence of misconceptions about antibiotic use and resistance. The standard deviation (14.55%) and the range (17–60%) indicate that while some participants demonstrated a strong grasp of the topic, others held significant misunderstandings. Such misconceptions may contribute to inappropriate antibiotic use, which in turn exacerbates the problem of ABR. Additionally, 21.38% of responses fell under the "I Don't Know" category, with relatively low variability (SD = 4.50%, range 13–28%). This finding suggests that while some participants acknowledged gaps in their knowledge, others may have responded incorrectly rather than admitting uncertainty. The fact that "I Don't Know" responses were less common than false responses suggests that many participants have strong but wrong ideas about antibiotics and resistance, which makes it even more important to target educational interventions.

A study conducted in Italy assessed parents of children from 0 to 14 years old for knowledge and perception of antibiotic resistance, highlighting significant gaps in awareness. Among 610 participants, 91% had used antibiotics for their children, yet only 36% answered at least 9 out of 12 knowledge-based questions correctly. The study also found that fever-related anxiety influenced antibiotic use, with lower anxiety levels, higher education, and healthcare-related occupations associated with better awareness. These findings emphasize the need for targeted educational programs to enhance parental understanding and promote responsible antibiotic use, reinforcing the importance of improving antibiotic stewardship through tailored interventions [27]. Similarly, our study, which focuses on university students, is particularly important as these students will become future parents. Raising their awareness about antibiotic resistance now can help ensure more responsible antibiotic use in the future, ultimately benefiting both public health and future generations.

Limitations

The primary limitation of the study is its cross-sectional design. Additionally, the sample was limited to undergraduate students at the University of Tabuk, which may reduce the generalisability of the findings to other populations or individuals from different regions or universities across Saudi Arabia.

Conclusion

The results of this study conducted at the University of Tabuk reveal significant gaps in KAP of antibiotic use and resistance among undergraduate students. The mean percentage of correct responses was 42.77% (± 16.22) However, misconceptions were prevalent, as reflected in the mean percentage of incorrect responses (35.85% ±14.55). Additionally, uncertainty was evident, with an average of 21.38% (± 4.50) of responses categorised as 'I Don't Know, these findings highlight the need for targeted interventions at the University of Tabuk to address misconceptions and increase awareness regarding antibiotic resistance among undergraduate students.

Future recommendations

- Workshops and Interactive Sessions: Organize workshops at the University of Tabuk to engage students in discussions and activities that clarify misconceptions about antibiotic use and resistance. Interactive sessions can encourage active learning and provide students with practical knowledge.
- Digital Campaigns and Social Media Outreach: Develop online campaigns through social media platforms and the university's website to spread awareness about antibiotic resistance.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13104-025-07241-z.

Supplementary Material 1

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Author contributions
Rana K. Albadrani and Aysha H. Alyenbawi were instrumental in data collection and analysis. Mody Albalawi, Amnah Obidan, Hayam A. Alwabsi, and Sahar Khateeb handled data visualization, including tables and figures, and contributed to the discussion, conclusion, and manuscript editing. Ahmed S. Aly and Mervat S. Mohamed provided leadership and oversight, managing the study from design to manuscript preparation.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study received ethical approval from the Local Research Ethics Committee (LREC) at the University of Tabuk (Approval No. UT-400-273-2024). The research was approved in accordance with the regulations of the National Committee of Bioethics (NCBE), Saudi Arabia. Written informed consent was obtained from all participants prior to data collection, as required by the LREC guidelines. This study was conducted in compliance with the Declaration of Helsinki, ensuring that all procedures involving human participants adhered to internationally accepted ethical standards.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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