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Public knowledge, attitude and practice towards antibiotics use and antimicrobial resistance in Saudi Arabia: A web-based cross-sectional survey

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Ethical approval: Ethical approval was not required for this survey. As data were anonymously collected via an online survey, no personal information was obtained, such as name, phone, and address. Informed consent was obtained from all participants involved in the study. Furthermore, the study was conducted confidentially and voluntarily. Any individual or group's identity has not been collected, and all data were protected.

Availability of data and material

The datasets created and analyzed in the current study are not publicly accessible because of the confidentiality of participants but can be obtained from the corresponding author upon reasonable request.

Competing interests statement

The authors declare no potential conflict of interest.

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Authors' contributions

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Significance for public health

Antibiotics are considered the miracle of medicine that can cure patients with infectious diseases. In the Kingdom of Saudi Arabia, few studies described antimicrobial practices. Most of the surveys were limited to certain areas. Therefore, this study assessed general knowledge, practices, and attitudes towards antibiotics use in multiple regions of Saudi Arabia. The findings could be used to assess the level of awareness about antibiotic use and may help policymakers to develop plans, laws, and programs to limit misuse of antibiotics and to preserve the health of the general population of Saudi Arabia.

Abstract

Background: Antimicrobial resistance is a global issue that causes significant morbidity and mortality. Therefore, this study aims to assess knowledge, attitudes, and practices (KAP) of the general Saudi populations toward antibiotics use.

Design and methods: A cross-sectional, anonymous online survey was conducted from January 1 to May 11, 2020, across five major regions of Saudi Arabia. Participants (aged ≥18 years) were invited through social media to complete an online self-structured questionnaire. All data were analyzed by Statistical Package (SPSS v.25). Descriptive statistics, Pearson's Chi-squared, t-tests, one-way analysis of variance (ANOVA), and Pearson correlation analyses were conducted.

Results: Out of 443 participants, the majority (n=309, 69.8%) were females, 294 (64.4%) were married, 176 (39.7%) were 25-34 years of age, 338 (76.3%) were living in the Eastern Province, 313 (70.7%) had college or higher education, 139 (31.4%) were not working, and 163 (36.8%) had a monthly income of USD 800-1330. Overall, most participants demonstrated good knowledge and practice (88% and 85.6%, respectively). However, 76.8%had inadequate attitude score levels towards antibiotics use. Of all the respondents, 74.9% knew that not completing a full course of antibiotics may cause antibiotics resistance, 91.33% did not agree that antibiotics should be accessed without a prescription, and 94.04% will not hand over leftover antibiotics to family members. Factors associated with adequate knowledge were female, medical jobs, and higher income ($p < 0.05$).

Conclusions: Our findings revealed that while most participants were aware of antibiotics use and demonstrated good knowledge, good practices, they had negative attitudes towards antibiotics use.

Introduction

Antimicrobials are essential for the prevention and treatment of infections in humans, animals, and plants (1). Antimicrobial resistance (AMR) threatens the ability to cure infectious diseases and contributes to the cult increased risk of death (1). AMR is estimated to cause at least 700,000 deaths each year globally (2) and more than 35,000 people die each year in the United States (2) making it an urgent public health problem (3). The problem of AMR is also common in low and middle-income countries, and is mainly caused by common bacterial pathogens, including *Escherichia coli*, *Salmonella spp*., or *Streptococcus pneumoniae*, *Mycobacterium tuberculosis* (4).

In most developed countries, antibiotics can be obtained without a medical prescription (5). The prevalence of non-prescription use of antibiotics is estimated around 3% in developed countries and about 100% in developing countries (4). On April 17, 2018, the Saudi Ministry of Health (Saudi-MOH) has mandated that all pharmacies must not dispense antibiotics without prescription (6). Consequently, any pharmacy that dispenses antibiotics without a prescription is subjected to a fine of up to 100,000 Saudi riyals (equivalent to the US $ 26,600), to revocation of the license and to imprisonment for up to six months" (6). Such regulations had resulted in a significant reduction in over-the-counter selling of antibiotics from 70.7% to 12.9% after law enforcement (7).

According to a survey of twenty pharmacists conducted in Saudi Arabia's Eastern Province, most antibiotics are frequently sold over-the-counter (OTC) (8). Also, two such studies found that 77.6-97.9% of community pharmacists dispense antibiotics without a prescription (9,10). Additionally, a study of antibiotics in the pediatric population showed a need for a better antimicrobial prescription (11). However, lack of awareness is a major factor in the misuse of antibiotics s worldwide (12). Patients' knowledge, attitude, and practice (KAP) are considered important factors leading to such misuse (13). Few studies were conducted on the KAP towards antibiotics in Saudi Arabia, and most of them were confined to a specific region (14–16). Therefore, our study aims to assess KAP towards antibiotics use and AMR among the general public in Saudi Arabia.

Design and methods

Study area, design, and period

This web-based cross-sectional survey was conducted over four months, from January 1st to May 11th, 2020, covering all five regions of Saudi Arabia.

Study participants

A virtual snowball sampling method was used in this study and targeted Saudi adult citizens (18 years and over).

Questionnaire designed

The investigators developed the questionnaire through a literature review and consisted of 51 closed-ended type questions in the form of multiple-choice answers. The questionnaire was made both in English and Arabic languages. The questionnaire consisted of four parts. The first part related to the participant's sociodemographic data and had seven items (Gender, Age, Marital Status, Place of Residence, Educational Level, Occupational Status, and Income). The second part had 17 items to assess knowledge about antibiotics use and antimicrobial agent. The third part had ten items about the attitude towards antibiotics use and AMR. Attitudes' items have a 5-points Likert scale (1 strongly disagree to 5 strongly agree). The fourth part assessed the participants' practice towards antibiotics use and AMR, and each part had 16 questions in the form of a 5-points Likert scale (1 strongly disagree to 5 strongly agree).

A pilot pre-test questionnaire was conducted from January 15 to January 17, 2020. During that phase, 35 individuals undertook the questionnaire to examine its validity and reliability and ensure clarity and understanding. Relevant inputs of the participant were taken into consideration, and the questionnaire was modified accordingly. Cronbach's α coefficient was used to test the questionnaire's internal consistency and taken when it was above (0.7). Responses from the pilot study were not included in the final study results.

Data collection tools and procedure

Data were collected via Google Forms utilizing an online survey. The link to the questionnaire was sent by WhatsApp and other social media. Informed consent was obtained from the respondents before participating in this study.

Statistical analysis

All data were cleaned, coded, entered, and analyzed using Statistical Package (SPSS v.25). Frequencies and percentages described the basics. Pearson's Chi-squared test ($\chi 2$) was used to find the association between the level of antibiotics knowledge (Good – poor) and sociodemographic variables. According to sociodemographic variables, the T-independent sample and ANOVA tests were used to find the differences in antibiotics' attitudes and practices.

Finally, the Pearson correlation test was used to test the relation between the total score of knowledge and mean scores of antibiotics attitude and practice. A P-value of ≤ 0.05 was considered

significant. Data were reported as percentages and 95% confidence intervals (CI). The strength of the correlation between knowledge, attitude and practices of antibiotics describes as follow: 0.0-0.19 "very weak", 0.20-0.39 "weak", 0.40-0.59 "moderate", 0.60-0.79 "strong" and 0.80-1.0 "very strong". KAP's total scores were categorized into "good" and "poor" scores based on an 80% cut-off score.

Results

Sociodemographic characteristics of the study population

Table 1 shows the demographic status of the participants (N=443). Briefly, the study population was predominated by females (n=309, 69.8%), and by age group of 25-34 years, representing 176 (39.7%) of the participants. Of the total respondents, 338 (76.3%) were from the Eastern Province, and 294 (64.4%) were married. Furthermore, 313 (70.7%) of the participants had received college and higher degrees education, 39 (31.4%) of the responders were not working, and 163 (36.8%) of the participants earned a monthly income of USD 800-1330.

Table 1. Sociodemographic characteristics, total respondents (N=443).

Variables	Response options	N	(%)
Gender	Male	134	(30.2)
	Female	309	(69.8)
Age	18-24	71	(16.0)
	25-34	176	(39.7)
	35-44	107	(24.2)
	>44 year	89	(20.1)
Marital Status	Single	133	(30.0)
	Married	294	(66.4)
	Divorced	12	(2.7)
	Widowed	4	(0.9)
Place of Living	Central Province	37	(8.4)
	Eastern Province	338	(76.3)
	Western Province	55	(12.4)
	Northern Province	6	(1.4)
	Southern Province	7	(1.6)
Educational Level	Primary	3	(0.7)
	Middle	4	(0.9)
	Diploma/High school	123	(27.8)
	College and above	313	(70.7)
Occupational Status	Student	74	(16.7)
	Unemployed	139	(31.4)
	Medical job	108	(24.4)
	Non-Medical job	122	(27.5)
Income (Monthly)	800 USD - 1330 USD	163	(36.8)
	1331 USD - 2666 USD	93	(21.0)
	2667 USD - 4000 USD	88	(19.9)
	> $4000 USD	99	(22.3)

Knowledge towards antibiotics use

Figure 1 shows the percentage of correct answers to each of the knowledge questions related to antibiotics use. Of the total respondents, 76.5% knew that antibiotics could be used to treat a bacterial infection, 74.9% knew that not completing the full course of antibiotics may cause antibiotics resistance, 67.5% knew that antibiotics might kill the beneficial bacteria that normally live on the skin or in the stomach/intestines, and 56.9% knew that antibiotics should not be used to treat viral infections. Figure 2 shows that 88% of the respondents had good knowledge towards antibiotics use.

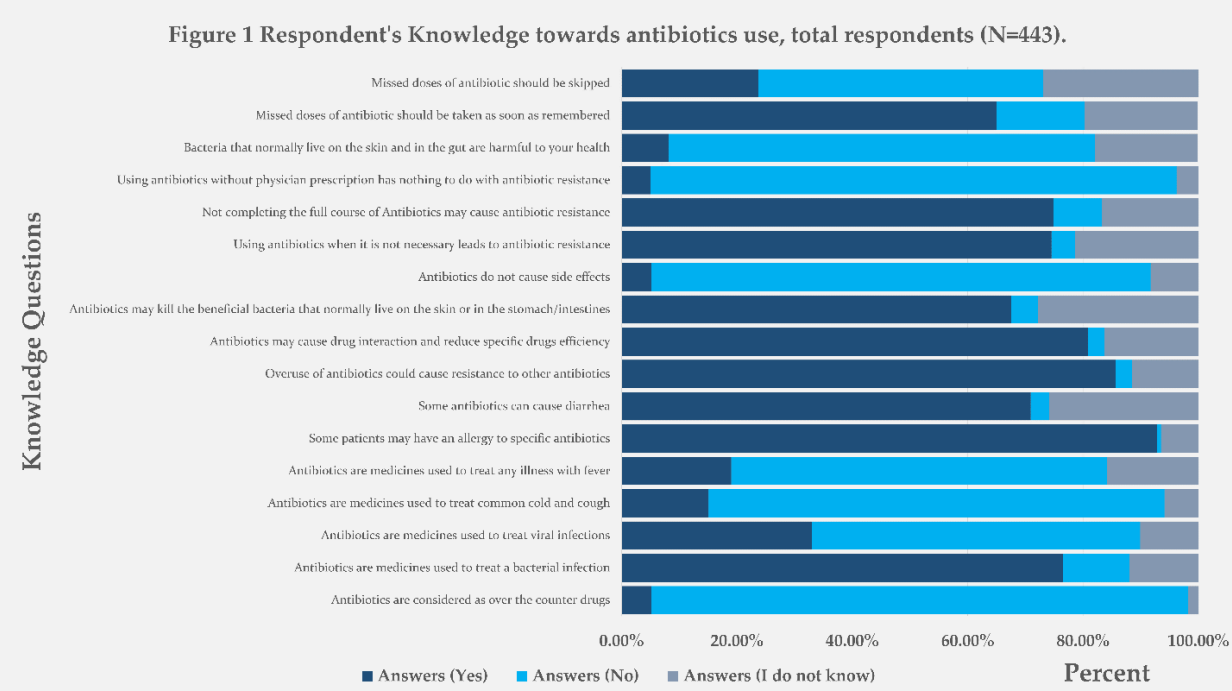

Figure 3. Respondents' knowledge towards antibiotics use of the total respondents (n=443).

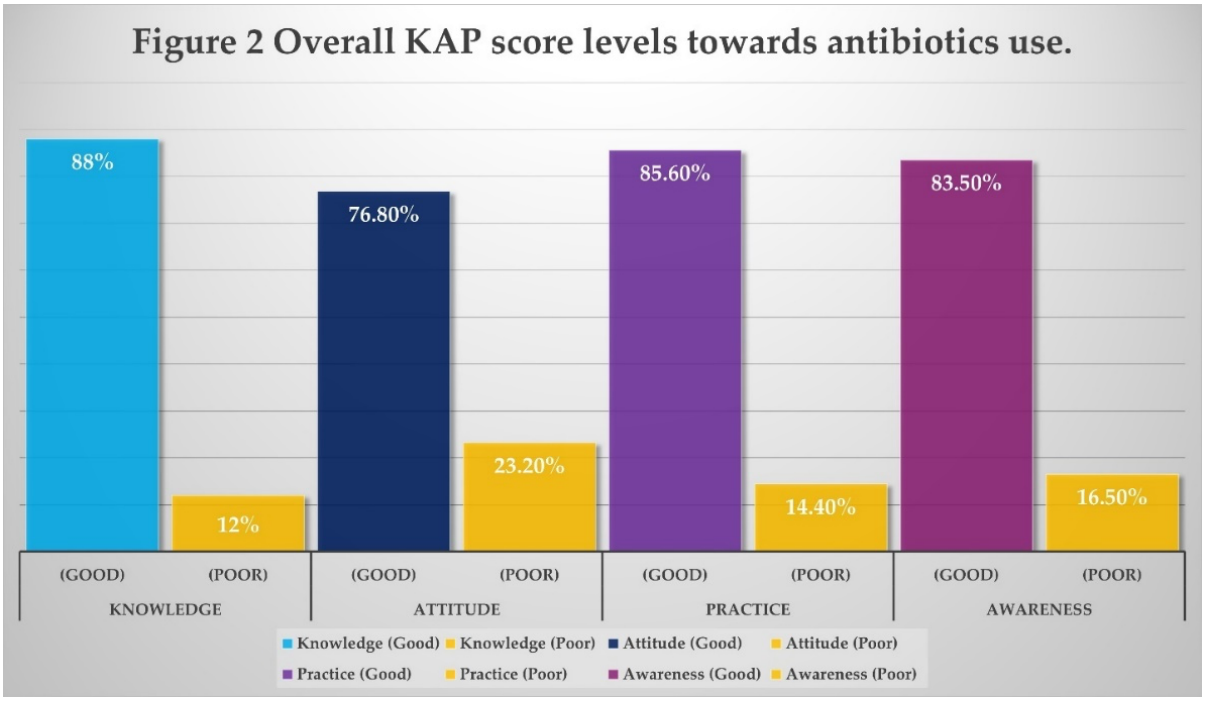

Figure 4. Overall KAP score levels towards antibiotics use.

Association between knowledge of antibiotics use and demographic variables

Demographic factors associated with good knowledge were female, medical staff, and higher income ($p<0.05$) (Table 2). In contrast, other demographic factors (age, marital status, place of living, and educational level) have no association with participant's knowledge. Female participants with medical jobs and higher income had better knowledge than male or female participants with non-medical jobs, unemployed, students, or lower income.

Table 2 Association between knowledge of antibiotics and sociodemographic variables.

Variables	Response options	Poor	Good	$\chi 2$	p-value
Gender	Male	19.4%	80.6%		
	Female	8.74%	91.26%	10.094	0.001**
Age	18-24	16.9 %	83.1%	3.324	0.344
	25-34	10.23%	89.77%		
	35-44	14.02%	85.98%		
	> 44 year	8.99%	91.01%		
Marital status	Single	15.03%	84.97%	2.212	0.530
	Married	10.89%	89.11%		
	Divorced	8.33%	91.67%		
	Widowed	0.0%	100%		
Place of living	Eastern Province	10.65%	89.35%	4.341	0.362
	Western Province	16.36%	83.64%		
	Northern Province	16.67%	83.33%		
	Southern Province	0.0%	100%		
	Central Province	18.92%	81.08%		
Educational level	Primary School	33.33%	66.67%	1.992	0.574
	Middle School	25%	75%		
	Diploma/High School	11.38%	88.62%		
	College and above	11.82%	88.18%		
Occupational status	Student	16.22%	83.78%		
	Unemployed	8.63%	91.37%		
	Medical Jobs	2.78%	97.22%	21.508	0.000**
	Non-Medical Jobs	21.31%	78.69%		
Income ($)	800 USD - 1333 USD	9.82%	90.18%		
	1334 USD – 2666 USD	19.35%	80.65%		
	2667 USD – 4000 USD	15.91%	84.09%		
	> 4000 USD	5.05%	94.95%	11.330	0.010*

**: Significant at 0.05 level. **: Significant at 0.01 level, Poor/Good within demographic variables.*

Attitudes towards antibiotics use

Overall, the respondents' score in relation to attitudes was 76.8% (Figure 5). Figure 3 shows the participants' attitude towards antibiotics use. Of all the respondents, 92.55% trusted the physician's decision when deciding not to prescribe an antibiotic, 91.87% believed that doctors should not give antibiotics when not needed, and 91.33% did not agree that antibiotics should be accessed without a prescription. On the other hand, approximately two-thirds (66%) of the participants did not believe that antibiotics could prevent any illness from becoming worse. Moreover, 63.7% did not believe that natural sources work better than antibiotics. Unfortunately, over half (50.5%) believed that lower doses could cause fewer side effects (Figure 3).

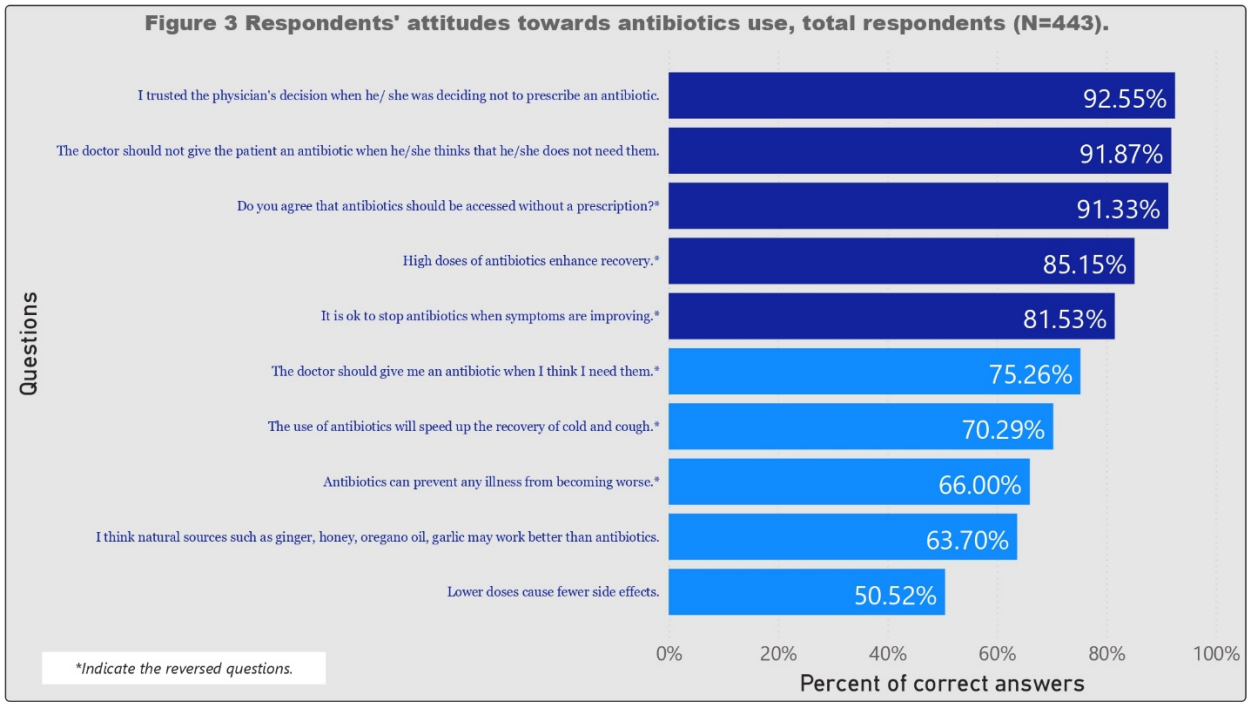

Figure 3. Respondents' attitudes towards antibiotics use total respondents (n=443).

Differences in attitude towards antibiotics use related to demographic variables

Table 3 shows differences in attitude towards antibiotics use according to demographic variables. There is a statistically significant difference in the mean score of attitudes towards antibiotics in relation to (age, marital status, and occupational status) ($p<0.05$). Whereas other demographic factors (gender, place of living, educational level, and income) were no statistically

significant difference in the mean score of the attitudes towards antibiotics use. Being single or married participants <35 years with medical jobs have a good attitude compared to others.

Practices towards antibiotics use

The overall respondents' score in relation to practice was 85.6% (Figure 6). Figure 4 shows the participants' practice towards antibiotics use. Of all the respondents, 94.54% did not get antibiotics from relatives without a physician's prescription, 94.04% will not hand over leftover antibiotics to family members if they were sick, and 93% would not have changed antibiotics if the physician had not prescribed antibiotics to them. Four-fifths (80.10%) of the participants disagreed that they had used leftover antibiotics in the event of repeated illness, and 79% did not use leftover antibiotics for a respiratory illness (runny nose/sore throat/fever). However, 78.1% did not stop taking antibiotics when they feel better (Figure 4).

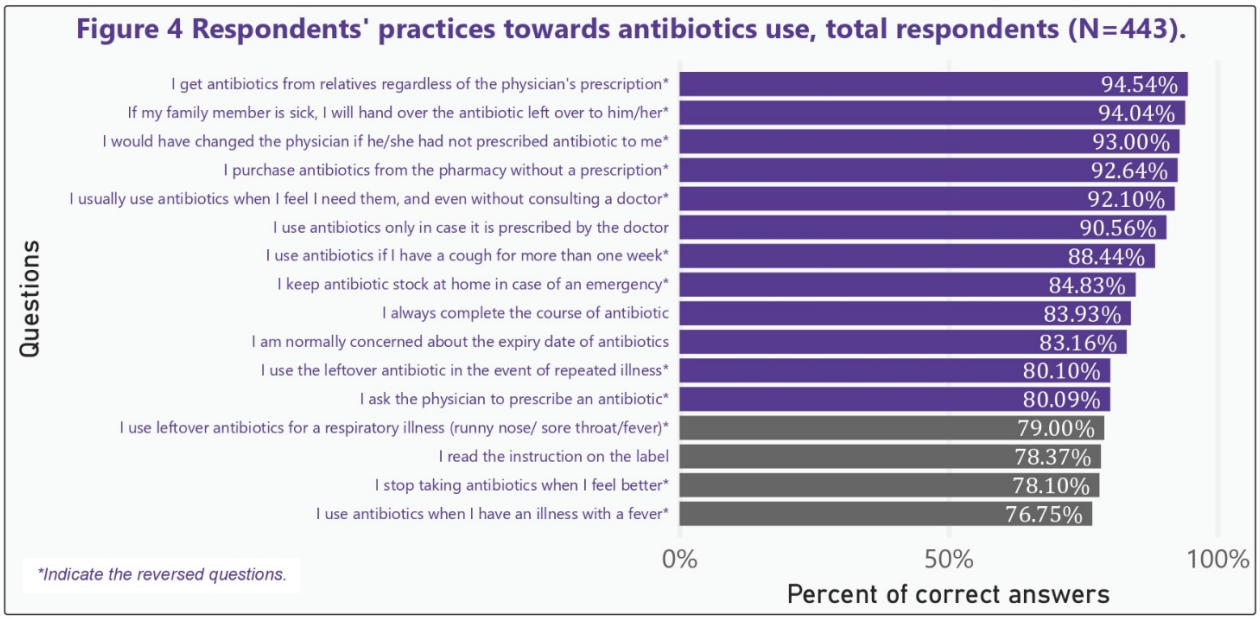

Figure 4. Respondents' practices towards antibiotics use total respondents (n=443).

Differences in practice towards antibiotics use related to demographic variables

Table 3 shows differences in practice towards antibiotics use according to demographic variables. There is a statistically significant difference in the mean score of the practices towards antibiotics use in (Gender, Marital Status, Place of Living, and Occupational Status) ($P < 0.05$). Whereas other demographic factors, (Age, Educational Level, and Income) were no statistically

significant difference in the mean score of the practices towards antibiotics use. Female, married or widow, living in the Eastern Region, and being in medical jobs have a good practice compared to others.

Correlation between knowledge, attitude, and practice towards antibiotics use

There is a statistically significant relationship between the three variables (knowledge, attitude, and practice) ($p < 0.01$). The highest correlation coefficient was found between attitude and practice (0.462; moderate relation), followed by 0.381 for the relationship between knowledge and attitude, then 0.301 for the relationship between knowledge and practices.

Table 3. Differences in the mean score of attitude and practice towards antibiotics use related to demographic variables.

		Attitude			Practice		
Variables	**Response options**	**Mean**	**SD**	**p-value**	**Mean**	**SD**	**p-value**
Gender	Male	3.7903	0.49095	0.173	4.1455	0.70527	
	Female	3.8631	0.52595		4.3374	0.58039	0.006**
Age	18-24	3.8535	0.50817		4.1294	0.62895	0.153
	25-34	3.9437	0.47577	0.003**	4.3303	0.64076	
	35-44	3.7439	0.48897		4.2880	0.60692	
	>44 year	3.7449	0.59372		4.2879	0.60951	
Marital status	Single	3.8579	0.50064	0.008**	4.1438	0.65275	
	Married	3.8561	0.51325		4.3499	0.59973	
	Divorced	3.5000	0.53258		3.9896	0.75652	
	Widowed	3.2000	0.63770		4.4688	0.34799	0.005**
Place of living	Eastern Province	3.8530	0.50441	0.590	4.3286	0.58490	0.016*
	Western Province	3.7436	0.54561		4.0955	0.69989	
	Northern Province	3.9167	0.67355		3.8958	0.82790	
	Southern Province	3.9857	0.45981		3.8750	1.15808	
	Central Province	3.8378	0.56880		4.2416	0.65338	
Educational level	Primary school	3.7000	0.70000	0.055	4.3542	0.68560	0.481
	Middle school	3.8500	0.43589		4.4844	0.42197	
	Diploma/high school	3.7350	0.53316		4.2093	0.62995	
	College and above	3.8840	0.50479		4.3035	0.62657	
Occupational status	Student	3.8959	0.51457		4.2171	0.61003	
	Unemployed	3.8165	0.52704		4.2662	0.60100	
	Medical Jobs	3.9944	0.50656	0.000**	4.4398	0.61617	0.015*
	Non-Medical Jobs	3.7000	0.47552		4.1901	0.65331	
Income	800 USD - 1330 USD	3.8620	0.51940	0.885	4.2113	0.63031	0.182
	1331 USD - 2666 USD	3.8140	0.49751		4.3367	0.56724	
	2667 USD - 4000 USD	3.8500	0.53820		4.3736	0.59610	
	> $4000 USD	3.8242	0.51411		4.2538	0.68928	

**: Significant at 0.05 level, **: Significant at 0.01 level, SD: Standard Deviation.*

Discussion

Antimicrobial resistance (AMR) is a global problem that is further complicated by the issue of antibiotics misuse in hospital settings and in the community. In Saudi Arabia, there had been an increasing prevalence of extended-spectrum *Escherichia coli* and *Klebsiella pneumoniae* (17). The Kingdom of Saudi Arabia is of particular importance as it hosts the annual Hajj with increasing AMR (18,19) and being in the Middle East as a focus of AMR (20). The use of antibiotics is affected by the interaction of knowledge, expectations, and interactions between prescribers and

patients, as well as economic, health systems, and environmental factors (12). Consequently, it is essential to assess the public's knowledge, practices, and attitudes (KAP) towards antibiotics use. In the current study, it was found that women, medical staff, and higher-income earners were significantly associated with a higher level of knowledge of antibiotics as opposed to men, unemployed participants, and low-income individuals.

There had been few studies addressing the KAP of antimicrobial agents among various populations in KSA. Those studies were limited to specific geographic regions of Saudi Arabia, such as the Eastern Province (14), Riyadh (15), and Al-Kharj area (16). However, in this study, we included respondents from several parts of Saudi Arabia. The study shows that most participants have good knowledge, good practice, and inadequate attitudes towards antibiotics, especially antibiotics' doses and effectiveness.

The study demonstrated that 88% of participants were knowledgeable about the use of antibiotics. Moreover, female participants and those with medical jobs and higher income had better knowledge regarding the use of antibiotics. In contrast, a previous study in the Eastern Province of Saudi Arabia's revealed a lack of knowledge of antibiotics use (14). Moreover, three-fourths of respondents knew that not completing a full course of antibiotics may cause AMR, in contrast to almost two-fifths of surveyed individuals in another study who stopped taking antibiotics once they are better (21).

Nearly 60% of participants knew that antibiotics should not be used to treat viral infections. This is in agreement with a previous study from Saudi where 53.2% indicated that antibiotics should not be used to treat viral infections (16). On the contrary, Saudi studies showed that most of the participants do not believe that antibiotics can be used in the treatment of viral infections (14,16). Most of the public might not be able to differentiate bacteria from viruses. Thus, they believe that antibiotics may be used to treat viral and bacterial infections.

More than two-thirds of respondents agree that antibiotics may kill the body's bacterial flora. In contrast with another study from Saudi Arabia, more than one-quarter of respondents did not agree that antibiotics can cause an imbalance in the body's bacterial flora (14). Almost three-quarters of study respondents agree that not completing the full course of antibiotics may cause AMR. In contrast to a Saudi study, more than half of the participants knew that AMR is caused by an incomplete course of antibiotics (15). It was found that three-fifths of the participants were

aware that antibiotics could be used to treat a bacterial infection. This is a higher rate than that found in similar studies in Al-Kharj Saudi Arabia (16).

The present study showed inadequate attitudes' score level towards antibiotics use with an overall attitude score was 76.8%. Approximately two-thirds of the participants did not believe that antibiotics could prevent any illness from becoming worse. Moreover, nearly two-thirds (63.7%) did not believe that natural sources work better than antibiotics. Unfortunately, more than half believed that the lower doses could cause fewer side effects. Most of the participants agree that doctors should not give antibiotics when not needed, followed by did not agree that antibiotics should be accessed without a prescription. An earlier study from Riyadh, Saudi Arabia, showed that more than two-thirds of participants had self-prescribed antibiotics and had access to these medications without a prescription (15). However, the Saudi Ministry of Health (Saudi-MOH) had long prohibited access to these agents without a prescription (6).

The current study revealed a good practice score towards antibiotics use with an overall practice score of 85.6%. Moreover, 80.10% of the participants did not agree that they had used leftover antibiotics in the event of repeated illness. This is lower than that reported in the Saudi study (16). Our study found that most participants used antibiotics with a physician prescription. This is higher than that reported in the Saudi study conducted in Al-Kharj city (16). This is consistent with WHO guidelines that leftover antibiotics should never be shared or used to prevent and control the spread of AMR (1). Preventing the spread of infection requires improving practices, strengthening legislation, and preventing antimicrobials' dispensing without the prescription as stated in the recommendations of the 1998 World Health Assembly (WHA) resolution (12).

Interestingly, most participants in this study reported that they were not self-medicating with antibiotics, according to instructions from the Saudi-MOH (6). This is consistent with studies conducted in Yemen, Kuwait, Saudi Arabia, and Uzbekistan, where approximately three-in-ten respondents reported self-medicating with antibiotics (14,21,22). On the contrary, a Saudi study showed that more than two-thirds of participants reported self-prescribed (15). Overuse of antibiotics and bacterial resistance can be enhanced through antibiotics self-medication. Interestingly, most of those surveyed would not switch doctors if they did not prescribe antibiotics. These demonstrate a good relationship of respect and appreciation between patients and clinicians, including expectations, negotiations, consistent and supportive policies, and a standardized

approach (23). It is also essential to implement shared decision-making strategies to resolve patients' discordant expectations and physicians' antibiotics prescribing practices (26) especially with newly approved antimicrobial agents with high cost in order to avoid the development of resistance (25).

The study found that more than three-fourths of the participants stated that they did not discontinue taking antibiotics when they feel better. This is a higher rate than that found in Saudi studies (28.6%-50.9%) (14,16). By stopping a complete antibiotics treatment, bacteria become more resistant to antibiotics. Patients who do not complete treatment are more likely to relapse, develop AMR, and go through another treatment (12). Most of the respondents trusted the physician's decision when deciding not to prescribe antibiotics. In contrast to previous Saudi study trust in doctor's decision (14).

Our Study had shown the highest positive correlation between attitude and practice towards antibiotics use. Similarly, in a previous study, there was a significant positive correlation between antibiotic knowledge and attitude scores ($r = 0.523$) (16). The study showed differences in attitude and practice among the respondents in relation to demographics. There is a statistically significant difference in the mean score of attitudes towards antibiotics use in relation to (Age, Marital Status, and Occupational Status). On the other hand, there is a statistically significant difference in the mean score of the practices towards antibiotics use in (Gender, Marital Status, Place of Living, and Occupational Status). In the current study, we had not found significant differences in scores between income in attitudes and practices towards antibiotic use. Other studies from Saudi Arabia had showed significant differences in scores between different monthly income groups (16).

Limitations

Our findings must be considered in the context of several limitations. First, the results were based on self-reported, online reports and may not reflect the actual behavior. Second, response to the survey was based on the author's network, and as such they might ignore valuable comments from other people who had not been surveyed. Third, since the sample was not random, most of the participants in the study were women, and the proportion of male and female observed in this study may not really represent the true gender. Fourth, most of the study participants had a high academic level. Finally, people who do not have access to the internet or devices may have been excluded from the study. Further longitudinal studies, a larger sample size, and face-to-face

questionnaires are needed to assess the effects of antibiotics awareness on use of antimicrobial agents. The current findings provide helpful information for determining antibiotics use awareness.

Conclusions

Our findings showed that most participants had good knowledge, practice towards antibiotics use but demonstrated an insufficient attitude toward antibiotics use. Health education programs and health promotion campaigns are essential to reduce antibiotic misuse by raising health awareness. Therefore, further studies are necessary to evaluate the effects of awareness on antibiotics use to minimize antibiotic resistance rates.

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