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Awareness of Antimicrobial Resistance: Surveillance among Visitors of a Tertiary Care Center, Riyadh, Saudi Arabia

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Keywords
Antimicrobial resistance · Awareness · Antibiotics · Knowledge · Saudi Arabia

Abstract

Introduction: Antimicrobial resistance (AMR) is a worldwide issue that was declared by the World Health Organization as a high-priority issue. However, there is a lack of awareness about AMR noticed in our community. Therefore, this study aims to assess the knowledge of the community regarding AMR. ***Methodology:*** A validated 24-item questionnaire was administered to the visitors of the outpatient clinic pharmacy waiting area to investigate their awareness of antibiotic resistance. ***Results:*** 397 questionnaires were received and analyzed. The questionnaire included questions asking what antibiotic resistance is, how to use antibiotics properly, and for which infections antibiotics are used. The findings showed that 161 (40.55%) of the respondents were classified as having sufficient knowledge of AMR. Moreover, the results revealed that there was a significant association between gender and the level of knowledge where females showed a better knowledge of AMR than males. Age was also an influencing factor since respondents aged between 18 and 45 (31.49%) years proved to have higher knowledge. ***Conclusion:*** Our findings showed that awareness of AMR and the proper usage of antibiotics seems to be lacking among the general population. Educating the general population through the health care system and public campaigns could change the community's perception of antimicrobial usage and, consequently, increase awareness of AMR.

Study Area: This study was conducted in the King Abdulaziz Medical City, a tertiary hospital. It is considered one of the most comprehensive healthcare medical cities in Saudi Arabia. It provides all levels of care to the Ministry of National Guard personnel and their families, starting from public health and primary healthcare to the most advanced tertiary services. The KAMC-RD currently has 1,973 operational beds. The current workforce includes 2,451 physicians, dentists, and residents – the medical city employs 8,584 allied health and medical support professionals and 5,282 administrative and support professionals.

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Introduction

Introducing antibiotics (ABs) to the medical practice has made huge advancements in patient care and the control of infectious diseases. However, the efficacy of ABs in medical care has been threatened by the growing issue of AB resistance [1]. At a universal level, rates of AB-resistant species have increased substantially in the past several years which has resulted in a lot of outbreaks and increased mortality [2]. The Center for Disease Control and Prevention declared that each year 2 million people in the USA had resistant bacteria, with a mortality of at least 23,000 [3]. Antimicrobial resistance (AMR) is a worldwide issue that was declared a high-priority issue by the World Health Organization.

The high number of AB prescriptions has largely contributed to medical concerns about ABresistance. A study done in the USA investigated penicillin and fluoroquinolone, and the findings suggested a directly proportionate relationship between AB prescription and AB resistance [4]. Society members, physicians, and laypersons should have sufficient knowledge and awareness regarding AB resistance to contain and slow its evolution.

There has been a noticeable lack of studies done in Saudi Arabia correlating important variables (such as gender, age, and educational level) to the knowledge of AB resistance and the proper use of ABs in the general population. There have been a few Saudi studies investigating AMR, but they only assessed the participants' awareness regarding the proper use of ABs [5, 6]. Therefore, our study aims to assess knowledge and awareness regarding AB resistance in the Saudi community by targeting the visitors of the outpatient clinic pharmacies at a tertiary hospital in Riyadh, Saudi Arabia. We also aim to assess the source of patients' medical information about AMR, as well as the relationship between educational level, age, gender, and other variables and knowledge about AMR.

Methods

Study Design and Population

A cross-sectional questionnaire survey targeted visitors from January 25 to February 12 at the outpatient clinic pharmacy waiting area at the King Abdulaziz Medical City (KAMC), Riyadh, Saudi Arabia. The KAMC provides services for a rapidly growing patient population in all its catchment areas. The study population comprised all individuals visiting the outpatient clinic pharmacy, aged between 18 and 60 years, regardless of gender and nationality, transplant patients were excluded. The sample size for this research was estimated with a 95% confidence level and a 5% margin of error, keeping the prevalence at 50% for knowledge of AB use, and the target population as 6,000. The estimated sample size was around 362; taking 10% extra for the final size was 398 participants. The sampling technique was a nonprobability convenience for the visitors who were available and willing to participate in the study at the time of data collection and fulfilled the inclusion criteria.

Data Collection Tool and Process

A literature review was done to identify a survey similar to our study objectives and to adapt the questionnaire from the study [7]. The survey was done using a pretested and validated questionnaire [7]. The original questionnaire was in English. However, it was translated into Arabic to make it more compatible for those that would not be able to complete it in English. After the translation process, a pilot study was conducted with 30 participants to assess the reliability of the translated version of the questionnaire. Based on the feedback from participants and the low Cronbach alpha, the response categories were revised. The revised questionnaire was tested again with 20 participants, and the final content validity was done by independent experts who gave additional suggestions for changes and confirmed it in Arabic and English. The final reliability using Cronbach alpha was calculated for the whole questionnaire, including the awareness and knowledge parts, which was 0.87, showing good internal reliability for the questionnaire in Arabic.

The final questionnaire was composed of 24 questions. A demographics information section had six items related to patients' age and gender, area of residence, degree, and household composition. The AB knowledge section had eight items, and the questions were asked on a scale from 1 to 3, which was coded as yes, no, and I do not know, respectively. In the AB awareness section, the mode of data collection was self-administered, and each participant had a 10-min duration to complete the survey during which they were supervised. Participants' answers were checked to overcome any misunderstanding. The questionnaire was accompanied by an informed consent form, and personal identifiers were taken from the participant.

Data Cleansing and Analysis

The raw data were audited and cleaned prior to the statistical analysis. Data were entered in a Microsoft Excel sheet and transferred for further analysis to Statistical Package for Social Sciences (SPSS) software, version 25. The initial descriptive analysis was performed, and the categorical variables (such as gender and educational level) were presented as frequency and percentages summary tables. At the same time, the continuous variables were presented as mean and standard deviation. The items related to knowledge and awareness were marked based on the correct answers, and for each correct answer, 1 point was added to the score. The total scores for the knowledge items ranged from 0 to 8. For the 11 awareness-related items, a correct answer meant being aware of the use of ABs. The association of the demographic's variables with the level of knowledge was computed using the χ^2 test. For predictors of knowledge level, binary logistic regression was applied, and the odds ratio with 95% confidence intervals was reported. The p value of <0.05 was considered significant for all the tests applied. Ethical approval for the study was granted by the King Abdullah International Medical Research Center, Riyadh.

Results

Demographic Information

After excluding those who had not completed the survey, 397 of 404 participated in the study and were used for data analysis (response rate of 98.27%). Of the 397 participants, 246 (61.96%) were females. One-hundred-seventy-five (44.08%) were between 18 and 32 years old. Most (74.5%) of respondents did not have a medical background. Of the 397 respondents, 194 (48.87%) had taken ABs in the previous 6 months (25.44% in the last month). Of those, 70.7% were prescribed their medication from the hospital pharmacy and received detailed information about the dosage and timing of the medication, and they followed the instructions (Table 1).

Awareness of AB Use

Ninety out of the 397 participants (22.67%) stopped their ABs once they felt better and did not complete their prescribed dosage. In addition, 41.31% (n = 164) of the participants used or bought the same ABs that they had before to treat an illness with similar symptoms. Moreover, 30.9% (n = 123) of the respondents admitted using the same ABs prescribed to a friend or a family member if they treat the same illness. Only a few of the participants (18.89%) were familiar with the term "superbugs" and less than half (46.85%) with the term "antibiotic resistance," and the source of information about AMR for most of them was healthcare providers and/or social media (Table 2). In terms of knowledge about AB indications, diarrhea (88.92%) and urinary tract infections (39.80%) were the most popular indications for taking ABs. Sore throat, cold and flu, and measles were chosen as proper indications for AB use by 175 (44.08%), 139 (35.01%), and 52 (13.10%) participants, respectively (Fig. 1).

Knowledge about AMR

Evaluation of participants' knowledge revealed that only about 161 (40.55%) of the respondents were classified as having sufficient knowledge about AMR, and 236 (59.45%) of the participants were classified as not having sufficient knowledge. The cutoff score for having knowledge about AMR was based on the mean score of the sample, which was 3.1 ± 2 SD. Those who had a score of <3 were labeled as having insufficient knowledge, while those with a score of >3.1 were grouped as having sufficient knowledge about AMR (with a mean of 3.1385 ± 2.19007, and a median of 3). In item 3, most (73.55% [n = 292/397]) of the sample answered incorrectly, stating

Table 1. Sociodemographic characteristics of the respondents

Variables	Frequency *n* (%)
Gender	
Male	151 (38)
Female	246 (62)
Age, years	
18–32	175 (44)
33–45	152 (38)
46–60	69 (17)
Area of residence	
Village	21 (5)
City	370 (95)
Educational level	
Illiterate	9 (2)
Elementary	11 (3)
Middle school	23 (6)
High school	113 (29)
College	227 (57)
High educational studies	14 (4)
Household composition	
Single lives with family	120 (30)
Single lives alone	32 (8)
Married	221 (56)
Divorced	16 (4)
Widow	8 (2)
Health science background	
No	296 (75)
Yes	101 (25)
When did you last take AB	
Last month	101 (26)
Last 6 months	93 (24)
Last year	61 (16)
>a year	75 (19)
Never	13 (3)
Do not remember	50 (13)
Source of AB	
Cannot remember	59 (15)
Pharmacy	46 (12)
Internet	0 (0)
Friend or family	6 (2)
Saved from previous time	3 (1)
Someone/somewhere	2 (1)
Hospital/pharmacy with prescription	281 (71)
Advice on how to use AB given	
No	39 (39)
Yes	291 (74)
Cannot remember	65 (17)
Heard about superbugs	
No	318 (81)
Yes	75 (19)
Heard about AMR	
No	207 (53)
Yes	186 (47)
Cannot remember	38 (19)
Source of information about the AMR for the first time	
Health care provider	67 (33)
Family/friend	15 (7)
Media/social media	57 (28)
Other	28 (14)

Table 2. Awareness and knowledge of AB use

	Wrong answer, *n* (%)	Correct answer, *n* (%)
Use ABs that were given to a friend or family member, as long as they were used to treat the same illness	123 (31)	274 (69)
Buy the same ABs, or request these from a doctor, if you are sick and they helped you get better when you had the same symptoms before	164 (41)	233 (59)
Once the treatment is started, when should it be stopped	128 (32)	269 (68)
AB resistance occurs when your body becomes resistant to ABs and they no longer work as well	233 (59)	164 (41)
Bacterial resistance increases with AB treatments	236 (59)	161 (41)
AB resistance is only a problem for people who take ABs regularly	292 (74)	105 (26)
AB resistance is an issue that could affect me or my family	220 (55)	177 (45)
AB resistance is an issue in other countries but not here	253 (64)	144 (36)
If bacteria are resistant to ABs, it can be very difficult or impossible to treat the infections they caused	239 (60)	158 (40)
Bacteria which are resistant to ABs can be spread from person to person	227 (57)	170 (43)
AB-resistant infections could make medical procedures like surgery, organ transplants, and cancer treatment much more dangerous	230 (58)	167 (42)

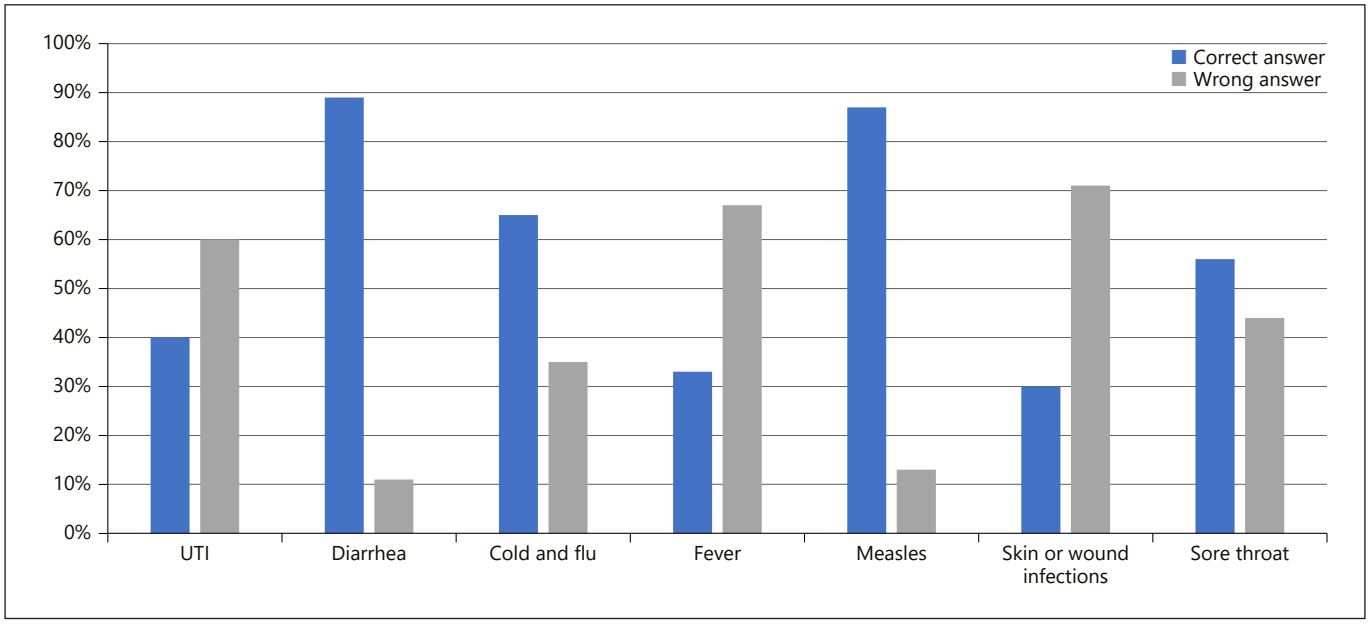

Fig. 1. Summary of participants' knowledge of AB use among various infections. The figure displays the section of the questionnaire assessing knowledge of AB use. The participants were asked what infections are treated with ABs. UTI, urinary tract infections.

that the problem of AB resistance was only for people who regularly take ABs. For item 5, it was asked whether AMR was an issue only in other countries, with 63.72% (n = 253/397) of the sample answering incorrectly. Two hundred and twenty-seven of the 397 respondents (57.17%) did not have sufficient knowledge about the possibility of AB-resistant bacteria spreading among people, as shown in item 7. Finally, in item 8, only 42.07% (n = 167/397) of

Table 3. Association between demographic characteristics and knowledge of AMR

Knowledge about AMR	Do not have sufficient knowledge of AMR, *n* (%)	Have sufficient knowledge, *n* (%)	*p* value
Gender			
Male	104 (69)	47 (31)	0.003*
Female	132 (54)	114 (46)	
Age in years			
18–32 years	106 (61)	69 (39)	
33–45 years	96 (63)	56 (37)	0.09
46–60 years	33 (48)	36 (52)	
Area of residence			
Village	12 (57)	9 (43)	0.853
City	219 (59)	151 (41)	
Educational level			
Illiterate	6 (67)	3 (33)	
Elementary	8 (73)	3 (27)	
Middle School	17 (74)	6 (26)	0.063†
High School	73 (65)	40 (35)	
College	128 (56)	99 (44)	
High educational studies	4 (29)	10 (71)	
Household Composition			
Single lives with family	71 (59)	49 (41)	
Single lives alone	16 (50)	16 (50)	
Married	128 (58)	93 (42)	0.05†
Divorced	14 (88)	2 (13)	
Widow	7 (88)	1 (13)	
Health science background			
No	193 (65)	103 (35)	<0.001*
Yes	43 (43)	58 (57)	
Advice on how to use AB given			
No	23 (59)	16 (41)	
Yes	167 (57)	124 (43)	0.213
Cannot remember	45 (69)	20 (31)	

* The χ^2 statistic is significant at the 0.05 level. † Fishers exact applied.

the participants recognized that AB-resistant infections could make medical procedures (e.g., surgery, organ transplants, and cancer treatment) much more dangerous (Table 2).

Association between Demographic Characteristics and Knowledge of AMR

There was a significant association between gender and the level of knowledge. Females showed significantly better knowledge than males, with 46% versus 31% with a χ^2 value of $\chi^2 = 8.9$ and a p value of 0.003. Furthermore, people with a health science background also showed significantly better results than those who had not, with 57% versus 35% with a χ^2 value of $\chi^2 = 15.9$ and a p value of less than 0.001. The household composition was also associated with knowledge; the results showed that single people who live alone had greater knowledge about AMR than those who live with a family or are married (50%, 41%, and 42%, respectively). People who had a higher educational level and those in college and higher education showed better knowledge than those who had elementary education or were illiterate (44%, 71%, 27%, and 33%, respectively), but this did not reach statistical significance (Table 3).

Predictors of Knowledge about AMR

All six demographic variables were considered in multiple logistic regression analysis. Age and gender were significantly associated with the knowledge items. Being a female was a predictor of better knowledge with an OR of 0.41 (CI = 0.24–0.67) and a p value of <0.001, where the female was set as the reference group. For age, it also shows that younger participants had significantly better knowledge about AMR than the elder group, where the

Table 4. Predictors of knowledge of AMR (logistic regression table)

Variables	Odds ratio	95% confidence interval		*p* value
		lower	upper	
Gender				
Male (female as Ref)	0.40	0.24	0.67	<0.001*
Age group, years				
46–60	Ref			
18–32	0.49	0.25	0.96	0.03*
33–45	0.46	0.23	0.92	0.02*
Residence				
Village (city as Ref)	1.65	0.64	4.28	0.29
Educational level				
High educational studies	Ref			
Illiterate	0.2	0.02	1.81	0.15
Elementary	0.21	0.03	1.50	0.12
Middle school	0.27	0.05	1.40	0.12
High school	0.31	0.08	1.20	0.09
College	0.40	0.11	1.46	0.17
Health science background				
No (yes as Ref)	0.59	0.33	1.03	0.06
Heard of superbugs				
No (yes as Ref)	2.85	1.49	5.45	<0.002*
Heard of AB resistance				
No (yes as Ref)	1.58	0.94	2.65	0.07

Ref: reference category. Logistic regression applied; the reference group taken as last one.

46–60 years age category was set as the reference group. Moreover, not having heard about superbugs was associated with poor knowledge about AMR (OR = 2.86, CI = 1.49–5.45, $p = 0.01$). The area of residence, health science background, and educational levels did not show a significant association for being predictors of sufficient knowledge level (Table 4).

Discussion

In this study, general knowledge about AB resistance and the proper AB use was found to be below average among all participants, which was in line with other local studies [8, 9]. Many factors contribute to the emergence of AB resistance, most of which are related to health care practitioners' responsibility for counseling patients on the safe, rational, and effective way to use ABs. In general, a low level of knowledge and misuse of ABs in a population could be attributed to physicians' and pharmacists' low level of knowledge, leading to irrational prescription and overuse of ABs. Many local studies highlighted the problem of overprescription of ABs in health practice, especially in dental health practice [10–12]. This indicates the need for efforts of higher authorities to educate health practitioners from all specialties.

AB resistance in the Kingdom of Saudi Arabia has accelerated in recent decades [13]. In this regard, in 2018, the Saudi Ministry of Health (MOH) implemented new regulations on dispensing nonprescribed ABs. One Saudi study found no difference in the public's attitude towards ABs before and after the enforcement of the new regulations [14]. However, the majority of our participants had good knowledge regarding the right source of ABs which may be influenced by the new regulations enforced by the Saudi Ministry of Health.

Despite the new regulations on AB dispensing, there is still misuse of ABs, and people can still manage to find ABs from a friend or leftovers from previously used containers. Saudi Arabia scored the highest in rates of self-medication with ABs according to a systematic review assessing the variation of AB awareness in Gulf countries [15]. Self-medication with ABs is associated with poorer prognosis and may endanger the general population's safety by contributing to AB resistance [16]. One primary cause of self-medication is the consumer's poor under-

standing of ABs and the conditions for which ABs are used as reported in the literature [16]. A study done in Ethiopia found that self-medication was one of the leading factors identified for the development of AMR [17].

The findings of this study highlight that AMR knowledge is significantly related to the practice of health in our society, which is in line with many other studies conducted in Saudi Arabia, European Union countries, and Pakistan [18–20]. However, some studies investigating AMR in other parts of the world (e.g., Ethiopia and Grenada) have reported insufficient knowledge even among health care practitioners [17, 21]. This might be attributed to the lack of data concerning local antibiograms and updated health care provider training. The superbugs concept is not widely known; in this study, the term "superbugs" was recognized by only 75 participants. Knowing key terms related to AMR is usually associated with a better knowledge of AMR. A study in Poland (2017) emphasized a significant improvement in the population's awareness after AMR educational campaigns [22].

Awareness regarding AB resistance was found to be greatly influenced by gender. The results of this study indicate that females had a higher level of awareness about AMR than males, which was concurrent with other studies done in Saudi Arabia [8–18]. However, some studies done in Nigeria and Italy revealed contrary results [23, 24]. Moreover, in our study, younger participants (18–45 years) had better knowledge and awareness than participants older than 45 years, which is concurrent with the findings of another Saudi study [14]. However, another local study showed contrary results [18]. The findings of this current study can be best explained by the better education received by younger age groups, social media, and television influence.

Limitations

The study was done at a single center, with a sample of almost 400, it was a cross-sectional study with a one-point time measurement that has limitations and cannot be generalized to the whole population. However, the KAMC is one of the largest tertiary care hospitals in Riyadh. Thus, the findings can be generalized to hospitals with similar backgrounds. The convenient sampling technique with nonproper randomization was another limitation as patients were taken upon their availability at the time. Therefore, this could not be controlled during data collection.

The study highlights people's general knowledge of ABs. Measures have been taken at a national level to halt over-the-counter sales and purchases of ABs. However, a great need still exists to improve the public's AB use. We suggest conducting future community-based research to measure the actual difference in the overall improvement in the awareness about misuse of ABs. Also, a qualitative study should be conducted to understand why people tend to misuse ABs and other medications. This would identify more successful interventions for behavioral change among the general population based on their perceptions.

Conclusion

The study showed overall unsatisfactory awareness and knowledge of AMR. Being a female, younger, and having heard of superbugs was a significant predictor of better knowledge among the community members. However, gaps in knowledge of AB use exist among our population, which explains improper AB usage in society. These gaps highlight the need to plan educational campaigns to raise the community's awareness of antimicrobial practice. A large-scale study is recommended to assess people's perceptions of AMR, and based on the results, public awareness can be raised. Also, efforts should be made to expand knowledge of AB use through awareness campaigns and further government restrictions.

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Statement of Ethics

Ethical approval was granted by the Institutional Review Board (IRB) of the King Abdullah International Medical Research Center (KAIMRC) IRB/SP19/371/R. Participants were required to sign a written informed consent form while information obtained from the participants was treated as confidential, and personal identifiers were not used.

Conflict of Interest

All authors declare no conflicts of interest.

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Author Contributions

All authors have participated in the conception and design, analysis, and interpretation of the data; drafting of the article; and revising it critically for publication. All authors have read the final version of the manuscript and approved it for publication.

Data Availability Statement

All data generated or analyzed during this study are included in this published article. Original data are available from the corresponding author upon responsible request.

References

1 Alós JI. Antibiotic resistance: a global crisis. Enfermedades Infecciosas y Microbiología Clínica. 2015;33(10):692–9.
2 Zowawi HM, Balkhy HH, Walsh TR, Paterson DL. β-Lactamase production in key gram-negative pathogen isolates from the arabian peninsula. Clin Microbiol Rev. 2013;26(3):361–80.
3 U.S Department of Health and Human Services. Antibiotic resistance Threats in the United States. 2013. Available from: http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf.
4 Goldstein E, Olesen SW, Karaca Z, Steiner CA, Viboud C, Lipsitch M. Levels of outpatient prescribing for four major antibiotic classes and rates of septicemia hospitalization in adults in different US states: a statistical analysis. BMC Public Health. 2019;19(1):1138.
5 Alghadeer S, Aljuaydi K, Babelghaith S, Alhammad A, Alarifi MN. Self-medication with antibiotics in Saudi Arabia. Saudi Pharmaceut J. 2018;26(5):719–24.
6 Abu-Mostafa NA, Al-Mejlad NJ, Al-Yami AS, Al-Sakhin FZ, Al-Mudhi SA. A survey of awareness related to the use of antibiotics for dental issues among non-medical female university students in Riyadh, Saudi Arabia. J Infect Public Health. 2017;10(6):842–8.
7 World Health Organization. Antibiotic resistance: multi-country public awareness survey [Internet]. World Health Organization; 2015. Available from: https://www.who.int/drugresistance/documents/baselinesurveynov2015/en/.
8 El Zowalaty ME, Belkina T, Bahashwan SA, El Zowalaty AE, Tebbens JD, Abdel-Salam HA, et al. Knowledge, awareness, and attitudes toward antibiotic use and antimicrobial resistance among Saudi population. Int J Clin Pharm. 2016;38(5):1261–8.
9 Benmerzouga I, Al-Zammay SA, Al-Shammari MM, Alsaif SA, Alhaidan TM, Aljofan M. Practices of patients consuming antibiotics and knowledge about antibiotic resistance in Hail region – Saudi Arabia. Future Sci OA. 2019;5(10):FSO420.
10 El-Kholey KE, Wali O, Elkomy A, Almozayen A. Pattern of antibiotic prescription for oral implant treatment among dentists in Saudi Arabia. Implant Dentistry. 2018;27(3):317–23.
11 Konde S, Jairam L, Peethambar P, Noojady S, Kumar N. Antibiotic overusage and resistance: a cross-sectional survey among pediatric dentists. J Indian Soc Pedodontics Prev Dentistry. 2016;34(2):145.
12 AboAlSamh A, Alhussain A, Alanazi N, Alahmari R, Shaheen N, Adlan A. Dental students' knowledge and attitudes towards antibiotic prescribing guidelines in Riyadh, Saudi Arabia. Pharmacy. 2018;6(2):42.
13 Zowawi HM. Antimicrobial resistance in Saudi Arabia. Saudi Med J. 2016;37(9):935–40.
14 Kurdi S, Faran A, Eareeni E, Alhalal N, Joseph R, Wali H, et al. Assessment of knowledge and attitude toward the new antibiotic dispensing law and its effect on antibiotic use in Saudi Arabia. Saudi Pharm J. 2020;28(1):58–67.
15 Almohammed RA, Bird EL. Public knowledge and behaviours relating to antibiotic use in Gulf Cooperation Council countries: a systematic review. J Infect Public Health. 2019;12(2):159–66.
16 Emeka PM, Al-Omar M, Khan TM. Public attitude and justification to purchase antibiotics in the Eastern region Al Ahsa of Saudi Arabia. Saudi Pharm J. 2014;22(6):550–4.
17 Abera B, Kibret M, Mulu W. Knowledge and beliefs on antimicrobial resistance among physicians and nurses in hospitals in Amhara Region, Ethiopia. BMC Pharmacol Toxicol. 2014;15(1):26.
18 Alqarni SA, Abdulbari M. Knowledge and attitude towards antibiotic use within consumers in Alkharj, Saudi Arabia. Saudi Pharm J. 2019;27(1):106–11.
19 Ashiru-Oredope D, Hopkins S, Vasandani S, Umoh E, Oloyede O, Nilsson A, et al. Healthcare workers' knowledge, attitudes and behaviours with respect to antibiotics, antibiotic use and antibiotic resistance across 30 EU/EEA countries in 2019. Euro Surveill. 2021;26(12).
20 Shan H, Mashhadi SF, Mahmood H. Awareness of antimicrobial resistance from one health perspective and its relation to social determinants in residents of WAH. PAFMJ [Internet]. 2018 Oct 30.
21 Lindonne G, Stephanie FL, Owen G, Martin F. Health care practitioners level of awareness on antimicrobial resistance in Grenada. J Fam Med Dis Prev. 2018;4(4):1–8.
22 Mazińska B, Strużycka I, Hryniewicz W. Surveys of public knowledge and attitudes with regard to antibiotics in Poland: did the European Antibiotic Awareness Day campaigns change attitudes? PLoS One. 2017;12(2):e0172146.
23 Alex IO. Knowledge of antibiotic use and resistance among students of a medical school in Nigeria. Malawi Med J. 2019;31(2):133.
24 Prigitano A, Romanò L, Auxilia F, Castaldi S, Tortorano AM. Antibiotic resistance: Italian awareness survey 2016. J Infect Public Health. 2018;11(1):30–4.