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Population opinions and knowledge around antibiotic use and resistance

Abdulhadi Hashim Halawani*[1], Shaya salman mesfer Alqahtani[2], Doaa.A.Zamzamy[3], Sarah Abdullah Albassam[4], Hadeel Zuhair Abdulrahman Alraddadi[5], Rami Mohammed Dada[6], Rawan Salman Alhazmi[7], Asma Abdullah Wan[8], Bashaiyer Mohammed Alshahrani[9]

1. Department of Pharmacy, Saudi German Hospital, Makkah, Saudi Arabia
2. Pharmacy, Aseer (AlHARAJA GENERAL HOSPITAL)
3. Pharmacist, Hera general hospital
4. Doctor of Pharmacy , Qassim University
5. PharmD , Al-nahas Company
6. Pharmacist, Hera General hospital
7. Pharmacist, Hera General hospital
8. Pharmacist , Heraa General hospital , Ministry of health
9. Pharmacist, king Abdullah medical city

Abstract

Background: Antimicrobial resistance (AMR) is a major global public health challenge, resulting in increased healthcare costs, higher mortality rates, and more difficult-to-treat infections. Improper use of antibiotics, including self-medication and overprescription, contributes significantly to AMR. This study aims to assess the knowledge, attitudes, and behaviors of the population regarding antibiotic use and resistance,

Methods: This study targeting the general population . A 25-item questionnaire was administered online, capturing antibiotic usage patterns, reasons for usage, and knowledge of antibiotic effectiveness and risks. The study employed stratified sampling to ensure demographic and regional representation, with a sample size of 700 respondents. The survey data were analyzed using descriptive statistics, chi-square tests, and multivariate ordinal logistic regression to identify predictors of antibiotic knowledge.

Results: Of the 1014 respondents, 76.8% reported using antibiotics in the past year, with 78.6% using them based on a doctor's prescription. The average Antibiotic Knowledge Score (AKS) was 2.6 out of 4, with 32.5% of participants answering all knowledge questions correctly. Factors associated with higher antibiotic knowledge included being female, having a higher level of education, and being open to changing views on antibiotic use after receiving new information. Only 31.3% of participants had received advice on rational antibiotic use in 2022, with half of them reporting a change in their perspective.

Conclusion: This study provides valuable baseline data on public knowledge and behaviors related to antibiotic use Findings suggest that education, gender, and willingness to learn play significant roles in improving antibiotic knowledge. Future public health interventions should focus on targeted educational campaigns to raise awareness about the responsible use of antibiotics and combat antimicrobial resistance, particularly in the wake of the COVID-19 pandemic.

Introduction

The antibiotics discovery marks a landmark achievement in medical history, yet antimicrobial resistance (AMR) is now recognized as one of the most pressing global public health challenges (1), (2), (3), (4), (5). AMR refers to the phenomenon where microorganisms develop resistance to drugs that were once effective against them (6). The repercussions of AMR are far-reaching, resulting in severe health complications, increased hospitalizations, greater reliance on costly second-line medications, higher overall healthcare expenditures, and elevated mortality rates (7), (8), (9). AMR is not confined by borders and poses a significant threat to public health worldwide. Contributing factors to the spread of AMR include self-medication or improper antibiotic use without a prescription (2), as well as the overprescription of antibiotics (8), (10), (11). Over recent decades, antibiotic consumption has risen, with studies indicating an increase in use (12), (13). This growing trend can largely be attributed to improper prescription practices, particularly in primary healthcare settings in low- and middle-income countries (11). The COVID-19 pandemic has introduced new challenges, including an irrational surge in antibiotic consumption, further exacerbating the AMR problem (14), (15), (16). During the pandemic, antibiotics were included in treatment protocols, and additional studies are needed to better understand the impact of this surge in usage, particularly during the SARS-CoV-2 crisis.

A robust system exists, consisting of the National Reference Laboratory for Monitoring Bacterial Strain Resistance and a network of 22 clinical laboratories serving over 60% of the population, which monitors antibiotic

susceptibility of invasive isolates from blood and cerebrospinal fluid using EU-compliant methodologies (17). This situation underscores the urgent need for stronger measures promoting rational antibiotic use and more research on public knowledge, attitudes, and behaviors surrounding antibiotics.

The European Commission's Directorate-General for Health and Consumers has conducted several surveys to assess public knowledge and usage of antibiotics, with surveys in 2009, 2013, 2016, and 2018 providing insights into trends over time (6). Regularly conducting such surveys allows for evaluating changes in antibiotic usage, helping to gauge the effectiveness of interventions and public health education efforts. By adopting methodologies similar to those of other countries, the findings can be contextualized globally, fostering the exchange of knowledge and best practices (21), (22), (23), (24). This study aims to explore antibiotic usage patterns in the general population and identify factors influencing these behaviors.

A 2015 study conducted among adults who visited general practitioners in four health centers in Novi Sad revealed insights into knowledge, attitudes, and behaviors regarding antibiotics (25). The findings from this smaller-scale study highlighted the need for broader research to capture a more diverse population, enabling a deeper understanding of antibiotic usage and misuse across the country (25).

Methods

This study was conducted, with participants responding to a 25-item questionnaire regarding their behavior .The study targeted the general population of a middle-income country, with sample demographics designed to reflect the national distribution . This included urban and rural populations, with urban dwellers comprising 60% and rural populations making up 40%. The sample encompassed four distinct regions, and demographic factors such as gender, age, and educational background were considered to align with census data. To ensure statistically reliable results, a sample size of 700 respondents was determined, using a precision of 2%, a 95% confidence level, and an estimated 7.1% prevalence rate of the phenomenon under investigation (22). Participants were selected through a three-stage stratified sampling process, designed to ensure regional and demographic representation. The first stage involved selecting municipalities and cities as primary sampling units, followed by the second stage, where local communities were chosen based on their population size, ensuring a proportional representation of larger and smaller communities. In the final stage, respondents were randomly selected from these communities, ensuring that every individual had an equal chance of being included. Contact details of potential participants were drawn from a database of email addresses, in compliance with national privacy regulations. The Public Opinion Research Agency managed the study, ensuring that the sampling process was randomized and met the study's requirements.

The data collection was carried out online using the Computer-Assisted Web Interviewing (CAWI) method. Participants filled out the survey on a website, enabling fast and accurate data collection. The survey was voluntary and anonymous, and the sequence of questions was automatically adjusted based on previous responses to ensure logical consistency. Respondents had the flexibility to complete the survey at their own pace, which was particularly advantageous for reaching remote areas and specific population groups. Prior to the study, ethical approval was obtained from the Ethics Committee, and the questionnaire was pre-tested with a smaller group to ensure clarity and comprehensibility.

Research Instruments

The study employed a Eurobarometer questionnaire (6) with permission from the Directorate-General for Communication Unit, in line with European Commission guidelines on document reuse. The questionnaire covered several areas: antibiotic use and acquisition in the past year, reasons for usage, whether any tests were conducted before taking antibiotics, and an Antibiotic Knowledge Score (AKS) consisting of four items that assessed participants' understanding of antibiotics, their effectiveness, and the risks of misuse. It also explored the general public's awareness of unnecessary antibiotic use and the sources of information influencing their behavior. Given that the study was conducted during the COVID-19 pandemic, questions were added to assess antibiotic usage during this period.

Participants' knowledge of antibiotics was evaluated through four statements:

1. Antibiotics kill viruses (false)
2. Antibiotics are effective against colds (false)
3. The unnecessary use of antibiotics makes them ineffective (true)
4. Taking antibiotics often causes side effects like diarrhea (true)

Each correct response earned 1 point, with a maximum possible score of 4 and a minimum of 0. Respondents could answer "Yes", "No", or "I don't know" to each statement. Additionally, the questionnaire assessed respondents' willingness to change their views on antibiotic use after receiving information from various sources (e.g., healthcare professionals, family, or media). This was based on responses to questions about whether they had received information on rational antibiotic use and whether it influenced their opinions.

Statistical Methods

Data were reported as frequencies (percentages), while continuous variables were described using means and standard deviations. For hypothesis testing, the Chi-square Test, Fisher's exact test, and McNemar's Test were employed to examine differences in frequencies. Multivariate ordinal logistic regression was used to analyze predictors of correct antibiotic knowledge. A p-value of less than 0.05 was considered statistically significant. Statistical analysis was performed using IBM SPSS Statistics 22 and R-4.0.0 software.

Results

A total of 1200 individuals participated in the study, with 65 non-respondents. The average age of the participants was 43.4 years (± 12.9), and 54.2% were female (Table 1). A small proportion of respondents reported very poor or poor health (0.2% and 3.4%), and only 1.7% had completed only elementary school. The majority of participants reported a moderate financial status (50.3%), and most were employed in the private sector (48.7%) (Table 1).

The average Antibiotic Knowledge Score (AKS) across the respondents was 2.6 out of 4. A small percentage (7.3%) answered all knowledge questions incorrectly, while 32.5% answered all four questions correctly. Approximately a quarter of respondents provided two correct answers, and a similar proportion gave three correct answers.

Of the respondents, (76.8%) reported using antibiotics in the previous 12 months. Of these, (78.6%) used antibiotics based on a doctor's prescription, and 57.8% of those who used antibiotics had undergone a test (blood, urine, or throat swab) either before or simultaneously with taking the antibiotic (Table 2). The most frequent reasons for antibiotic use were symptoms of upper respiratory infections, including sore throat (9.7%), cold (22.7%), cough (20.7%), and rhinopharyngitis (17.5%). The least common reasons were diarrhea (2.8%) and skin or wound infections (5.0%) (Table 2).

In comparing antibiotic users and non-users, a higher proportion of women were among the antibiotic users (56.7% vs. 46.0%). Antibiotic users were less likely to be aged 60 or older (10.4% vs. 19.5%) and were less likely to report very good health (16.8% vs. 29.2%). Antibiotic users were also more likely to be aware of the potential side effects of antibiotics, such as diarrhea (71.5% vs. 58.0%)

Only 318 participants (31.3%) reported having received advice on the rational use of antibiotics . Of those, about half (158) indicated that the advice led to a change in their views on antibiotic use. Antibiotic users more frequently expressed a desire for further information regarding antibiotic resistance, proper use, prescribing practices, and the conditions for which antibiotics are prescribed

The multivariate ordinal logistic regression analysis identified seven factors that predicted a higher level of knowledge about antibiotics. The overall model was statistically significant ($p < 0.001$).

Key predictors of a higher level of antibiotic knowledge included being female (OR=0.55; $p < 0.001$), having a higher level of education (OR=1.44; $p = 0.001$), and being open to changing one's opinion after receiving information about antibiotic use (OR=1.28; $p = 0.046$). Males had a 45% lower likelihood of demonstrating higher antibiotic knowledge levels compared to females, after adjusting for other factors. For each increase in education level, the likelihood of having a higher level of antibiotic knowledge increased by 44%. Additionally, respondents who were open to changing their opinion after receiving information about antibiotic use had a 28% higher chance of exhibiting greater knowledge on the topic, adjusting for other factors.

Table 1. Frequency distribution by categories of demographic features, health and social status of respondents, and antibiotic use in the total study sample (N = 1200).

Variable	Categories	%
Gender	Man	45.8
	Women	54.2
Age category (years)	18 – 29	16.5
	30 – 44	38.2
	45 – 59	32.8
	≥60	12.5
Self-rated health	Very bad	0.2
	Bad	3.4
	Average	25.7
	Good	51.3
	Very good	19.4
Education	Elementary school	1.7
	Secondary school	46.6
	College and university	51.7
Socio-economic status	Very bad	1.6

	Bad	7.2
	Average	50.3
	Good	35.0
	Very good	5.9
Work status	Employed in the public sector	23.8
	Employed in the private sector (Entrepreneur)	48.7
	Farmer	1.3
	Unemployed	13.2
	Student	3.0
	Retired (Pensioner)	10.1
Use of antibiotics in the last 12 months	Yes	76.8
	No	22.3
	Refusal	0.1
	Don’t know	0.8

f frequency.

Table 2. Frequency distribution by categories of application and prescription of antibiotics, medical analyses performed before or with the application of antibiotics, and the reason for their last taking.

Variable	**Category**	**%**
Use of antibiotics in the last 12 months (orally as tablets, powder, or syrup)	Yes	76.8
	No	22.3
	Refusal	0.1
	Don't know	0.8
How did you obtain the last course of antibiotics that you used?	From a medical prescription	78.4
	I had some leftovers from a previous course	10.0
	Without a prescription from a pharmacy	8.7
	Without a prescription from elsewhere	2.6
	Don’t know	0.3
Did you have a test, for example, a blood or urine test, or throat swab, to find out what was causing your illness, before or at the same time as you started antibiotics?	Yes	57.8
	No	39.9
	Don’t know	2.3
The reason for last taking the antibiotics	Pneumonia	6.7
	Bronchitis	10.3
	Rhino pharyngitis	17.5
	Flu	14.2
	Cold	23.7
	Sore throat	29.7
	Cough	20.7
	Fever	22.7
	Headache	10.0
	Diarrhea	2.8
	Urinary tract infection	11.2
	Skin or wound infection	5.0
	Other	15.9
	Don't know/Don't want to answer	0.9

f frequency.

Discussion

Our findings revealed that a significant portion of the population (76.8%) reported using antibiotics, which is notably higher than the rates seen in many European Union countries, where fewer than half of respondents have taken antibiotics (6). However, antibiotic usage varies across EU nations, with Italy showing the highest usage at 47%, while countries like Poland and Slovenia reported lower usage rates (24%), and other nations such as Germany, the Netherlands, and Sweden had even lower rates (6). It is important to note that the study was conducted during the COVID-19 pandemic, which has been linked to an increase in antibiotic consumption in various studies (26), (27), (28), (29).

The National Antibiotic Resistance Control Programme in the country aims to educate healthcare professionals about appropriate prescribing, dispensing, and antibiotic use, while also revising university curricula to emphasize rational antibiotic use and antimicrobial resistance (17). One of the programme's key targets was to ensure that 42% of the population understands that antibiotics are not effective for treating colds or flu. Our results suggest this goal has been met, with 49.7% of participants who used antibiotics and 60.6% of those who did not reporting this knowledge.

Most respondents who used antibiotics in the past year indicated they did so based on a doctor's prescription, which likely reflects the success of regulations controlling the dispensing of antibiotics only through prescriptions (17). While nearly 80% of respondents obtained antibiotics with a prescription, 21.3% did so without one. This figure is higher than the EU average, where about 7% of respondents acquired antibiotics without a prescription, with varying rates between 1% and 15% across EU countries (6). Among those who used antibiotics without a prescription, a significant number had leftover antibiotics from previous courses (10.0%), while others obtained them without a prescription from pharmacies (8.7%), violating regulations. This underscores the importance of enforcing regulations and educating both healthcare professionals and the public to prevent misuse and curb antimicrobial resistance.

Upper respiratory tract infections were the leading reasons for antibiotic use, including sore throat, cold, cough, and rhinopharyngitis, which mirrors findings from previous studies (6). However, diarrhea and skin infections were less common reasons for use. More than half of those who used antibiotics had undergone tests to determine the cause of their illness before or during treatment, but a notable portion (39.9%) did not. This highlights the need for improved public and professional education on the risks associated with unnecessary antibiotic use.

The average Antibiotic Knowledge Score was 2.6 out of 4, which is higher than in Japan (22) and similar to EU countries. Finland and Sweden reported the highest scores (3.1), while Latvia and Romania had the lowest (2.1) (6). This result provides a useful benchmark for future monitoring of antibiotic knowledge in the population. It's important to note that the Japanese study was conducted in 2017, while ours was in 2022, which may affect direct comparisons. Despite this, our respondents' knowledge scores align more closely with those in the EU. A higher proportion of our participants knew that antibiotics do not kill viruses compared to those in the EU, and fewer were aware that antibiotics are ineffective against colds. Knowledge about the risks of overusing antibiotics and the side effects, such as diarrhea, was similarly high (6).

Interestingly, those who knew about the potential side effects of antibiotics, like diarrhea, were more likely to use them. This may suggest that knowledge alone does not always drive appropriate antibiotic usage, as various other factors—including attitudes, beliefs, social norms, and accessibility—play a role in influencing behavior (25). Although knowledge is a key factor, it is not the only determinant, and several models of health behavior, including the Health Belief Model and Theory of Planned Behavior, have been used to explain these complex relationships (30), (31), (32), (33). However, these models have not fully explained the variance in antibiotic-related behavior, pointing to the need for further research and more comprehensive interventions.

Prescribing behaviors are also influenced by various factors, such as socio-cultural influences, financial incentives, and patient attitudes (11). To address these issues, it is vital to develop targeted interventions aimed at bridging the knowledge-behavior gap, such as educational campaigns that utilize multimedia tools, which have shown success in promoting health knowledge (35). These interventions should consider the widespread use of the internet and social media as potential educational tools for the public.

Our study also revealed that older adults (aged 60 and above) were less likely to have used antibiotics in the past year, contrary to other studies that have identified the elderly as frequent users (36). This difference may be due to COVID-19-related health measures prioritizing the protection of older individuals. Additionally, participants who self-reported excellent health were less likely to use antibiotics, underscoring the importance of general health improvement and the establishment of antimicrobial stewardship as a key public health strategy (37). Future studies could explore health-related factors in greater detail and conduct qualitative research to better understand the impact of educational interventions on public perceptions of antibiotic use.

Although fewer than a third of participants reported receiving information on the proper use of antibiotics in 2022, our findings underscore the need for more widespread educational campaigns on antibiotic resistance and proper antibiotic use. Key factors associated with higher antibiotic knowledge included being female, having a higher level of education, and being open to changing one's views after receiving new information on antibiotic use. This highlights the importance of personalized interventions and suggests that people who are receptive to new information about antibiotics are likely to have a better understanding overall. Furthermore, respondents who used antibiotics expressed a desire for more information about antibiotic resistance, appropriate usage, and the diseases for which antibiotics are prescribed, suggesting an openness to further educational efforts. These findings point to the potential for more targeted interventions in antibiotic stewardship, tailored to individual needs (38), (39).

Conclusions

This research aimed to explore antibiotic use within the population and identify factors influencing such use. As the first study of its kind on public knowledge, attitudes, and practices regarding antibiotics and antimicrobial resistance (AMR) in the country, it provides valuable baseline data for future investigations. The findings offer insights into the complex factors affecting antibiotic use, including demographics (gender, education, health status) and the general population's awareness of proper antibiotic use. Future studies can monitor shifts in the population's knowledge about antibiotics by replicating this research periodically, helping assess the effectiveness of educational and other interventions. Raising awareness among the public about the responsible use of antibiotics could contribute significantly to addressing the global threat of antimicrobial resistance.

Acknowledging the study's limitations, its results could assist policymakers in designing targeted strategies to improve public understanding of antibiotic use. The existing National Antibiotic Resistance Control Programme outlines continuous training for healthcare professionals on rational antibiotic use, which should be expanded in future programs. Raising awareness and improving knowledge about antibiotic resistance should be emphasized at both undergraduate and graduate levels, and the findings suggest that further educational efforts should include both the public and healthcare providers in the coming years. Although the current program covered the period from 2019 to 2021, and the next program has not yet been adopted, the need for targeted educational interventions remains pressing.

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