

Original Research

Behind the Pharmacy Counter: An Exploration of Antimicrobial Resistance (AMR) from a Customer-Centric Perspective. A National Study of Saudi Pharmacies.

Mohammed Kanan, Hind M.A.Osaimi, Mubarak Almatr, Sana Alassaf, Norah Alkodari, Nada Asiri, Amirah Alfaifi, Haneen Asiri, Amani Subaykhi, Manal Asiri, Salha Alasmari, Raghad Alqahtani, Majd Ladnah, Fawaz Al Thabet, Amal Al-Thabet.

Received (first version): 30-Jun-2024

Accepted: 29-Aug-2024

Published online: 02-May-2025

Abstract

The misuse of antibiotics contributes to the development of antibiotic resistance, posing serious global health risks. Understanding public awareness is crucial in addressing this issue. This research investigates the awareness, attitudes, and behaviours related to antibiotics and their use among pharmacy customers in Saudi Arabia. **Methods:** A comprehensive questionnaire was developed and refined through expert evaluation and field testing. The study was conducted in pharmacies. Data collection involved a systematic approach using Google Forms and QR codes. The analysis was conducted through descriptive statistics and ANOVA to assess demographic influences by using SPSS. **Results:** This study involves the 718 customers, 16 withdrew, yielding a 97.8% response rate. A significant portion (46.2%) of participants were aged 25 years or younger, with males comprising 71.1%. More than half (56.4%) held bachelor's degrees. About 53.1% perceived antibiotics and anti-inflammatory drugs as dissimilar medications. A notable majority (70.7%) understood antibiotics as intended solely for bacterial infections, while 80.3% expressed concern about excessive antibiotic use. Around 43.3% believed expensive antibiotics didn't guarantee safety or effectiveness. Additionally, 66.3% believed in the efficacy of multiple antibiotics, but 69.5% cautioned against saving and reusing leftover antibiotics. A minority (21.1%) admitted to never reading antibiotic instructions, contrasting with 40.7% who reported consulting doctors before changing antibiotics. Educational level significantly influences the knowledge, attitudes, and practices concerning antibiotic usage. **Conclusion:** Positive and concerning trends in antibiotic awareness and usage reveal the need for targeted education campaigns to promote responsible antibiotic usage and combat the growing threat of antimicrobial resistance.

Mohammed Kanan*. Department of Pharmaceutical Care, Rafha General Hospital, Northern Border Health Cluster, Rafha, Saudi Arabia. Mokaalshammari@moh.gov.sa

Hind M.A.Osaimi. Department of Pharmacy Services Administration, King Fahad Medical City, Riyadh Second Health Cluster, Riyadh, Saudi Arabia. Halosaimi@kfmc.med.sa

Mubarak Almatr. Oncology Pharmacy, King Faisal Specialist Hospital and Research Centre , Riyadh Kingdom of Saudi Arabia. Almatr.m20@gmail.com

Sana Alassaf. Department of Doctor of pharmacy , College of Pharmacy, King Khalid University, Kingdom of Saudi Arabia, Abha. Sna.sae99@gmail.com

Norah Alkodari. Department of Doctor of pharmacy ,Nahdi Medical Company , Jeddah , Kingdom of Saudi Arabia. Nouraahmed.1276@gmail.com

Nada Asiri. Department of Doctor of pharmacy, College of pharmacy , king Khalid university, Abha, Kingdom of Saudi Arabia. nd_4x@hotmail.com

Amirah Alfaifi. Clinical pharmacy department, King Khalid university, Kingdom of Saudi Arabia, Abha Amirah.sa.99@hotmail.com

Haneen Asiri. Department of clinical pharmacy , king Khalid university , Abha , Kingdom of Saudi Arabia. haneenawdahasiri@hotmail.com

Amani Subaykhi. Department of pharmacy , United Pharmaceutical Company , Abha , Kingdom of Saudi Arabia. Aalsebekhi@gmail.com

Manal Asiri. Department of clinical pharmacy , king Khalid university , Abha , Kingdom of Saudi Arabia. mnalalkhirat@gmail.com

Salha Alasmari. Department of clinical pharmacy , king Khalid university , Abha , Kingdom of Saudi Arabia. x.salha48@gmail.com

Raghad Alqahtani. Department of clinical pharmacy , king Khalid university , Abha , Kingdom of Saudi Arabia. radrad1440@gmail.com

Majd Ladnah. Department of clinical pharmacy, king Khalid university, Abha , Kingdom of Saudi Arabia. Majd.lad@hotmail.com

Fawaz AlThabet. Department of pharmacy, king khalid university, Abha fwthabit@hotmail.com

Amal AlThabet. Department of Pharmacy, King Khalid University, Abha, Saudi Arabia. amalali9917@gmail.com

INTRODUCTION

Antibiotics represent a major medical advancement, revolutionizing treatment and saving countless lives¹. In the past eighty years, the discovery of antibiotics has revolutionized the management, treatment, and outcomes of infectious diseases^{2,3}. Antibiotic resistance (ABR) stands as a significant global threat to both health systems and food security⁴, endangering human life and public health⁵. Approximately 700,000 people succumb annually to infections stemming from



resistant bacteria^{6,7}, with projections from the World Health Organization (WHO) suggesting a potential increase to 10 million deaths by 2050 without the development of new and improved treatments⁸. The inappropriate use of antibiotics arises from a multifaceted interplay of various factors, encompassing prescriber behaviour, diagnostic uncertainty, patient demand, self-medication, and inadequate patient-prescriber interaction. Macro-level influences such as sociocultural, economic, and healthcare regulatory policies also play a role^{9,10}. Furthermore, patients' knowledge, beliefs, attitudes, expectations, and past experiences with antibiotics contribute to the proliferation of resistant microorganisms¹¹. Heightened self-medication practices can lead to resource wastage, pathogen resistance, adverse reactions, incorrect self-diagnosis, delayed appropriate care, and the risks of drug dependence and abuse^{12,13}.

The leading cause of ABR is the use of antibiotics without a doctor's prescription¹⁴. Multiple factors drive high antibiotic consumption, including over-the-counter sales, inconsistent use policies, and exposure to increasingly resistant microorganisms¹⁵. Poor knowledge and awareness contribute to irrational antibiotic use^{16,17}. ABR arises from various factors, including the use of previously prescribed antibiotics, sharing with others, or obtaining them without prescriptions^{18,19}. In developing countries, ABR leads to significant mortality, morbidity, and costs¹⁹. Globally, antibiotic consumption surged by 65 percent between 2000 and 2015^{20,21}.

Infections from resistant bacteria often result in longer illness durations and require more aggressive treatment, leading to higher complication and mortality rates compared to those from non-resistant bacteria. Additionally, treating patients affected by ABR pathogens consumes considerable resources, including lost working days and reduced productivity due to extended hospital stays. These factors increase treatment costs and strain healthcare resources²². Furthermore, in our interconnected world, antibiotic-resistant bacteria can swiftly spread from one continent to another, facilitating the global dissemination of these resistant strains²³. While ABR is not a new issue, there has been a historical assumption that continuous development of novel drugs could solve the problem. However, antibiotic development has declined significantly over time²⁴. Studies have revealed numerous public misconceptions surrounding antibiotic use and resistance²⁵. Many individuals remain unaware of the link between antibiotic-resistant bacteria and antibiotic use¹⁶. Despite being knowledgeable about when antibiotics are necessary, some people express confidence in self-medicating with leftover antibiotics without consulting a physician²⁶. A systematic review of 54 studies on public knowledge and beliefs about ABR found that while some participants were familiar with the concept, most believed it referred to changes within the human body. Many participants perceived themselves as having a low risk of contributing to ABR and felt that strategies to minimize it should primarily target physicians. Researchers concluded that the public lacks a comprehensive understanding of ABR, harbouring misconceptions about its causes and their role in its development²⁷. In the Gulf Cooperation Council region, almost half of the general public lacks knowledge about antibiotic

use and holds negative attitudes toward its utilization. Most respondents reported obtaining information on antibiotics from pharmacists, with pharmacies being the primary source of antibiotics used for self-medication²⁸. Public education is a key intervention recommended by the WHO to promote rational medicine use²⁹. Enhancing public awareness and understanding of antibiotic-related issues is a primary strategic objective of the WHO Global Action Plan on Antimicrobial Resistance³⁰. Studies have highlighted variations in public knowledge about antibiotics across different countries³¹. Higher levels of antibiotic resistance are often observed in countries with lower awareness of ABR, such as Sweden and the Netherlands, where public knowledge is higher and ABR rates are lower³². People's perceptions of medicines may influence their understanding of antibiotics and ABR^{32,33,34}. In Kingdom Saudi Arabia (KSA), numerous studies have explored public knowledge and attitudes towards antibiotics, yet there has been a gap in research focusing specifically on pharmacy clients. This study aims to address this gap by examining the knowledge, attitudes, and practices of individuals visiting pharmacies in KSA regarding antibiotics and ABR. The main objective of the study was to evaluate the understanding of antibiotics and ABR among pharmacy customers in KSA. Additionally, the study aimed to investigate the extent to which beliefs, attitudes, and sociodemographic factors correlate with this knowledge. These insights can inform targeted interventions and educational campaigns aimed at promoting responsible antibiotic use and combating ABR within the KSA context.

METHODS

A multicentred, online survey was conducted across the KSA after the approval of research ethics department at King Fahad Medical City of KSA. (IRB Log Number: 23-645)

Study instrument

A comprehensive literature review was conducted to inform the development of the questionnaire^{11,16,17,28,31-39}. This involved thoroughly examining existing research and publications relevant to the topic of interest. Subsequently, an initial version of the questionnaire was created, drawing upon insights and findings from the literature. To ensure the quality and relevance of the questionnaire, it underwent rigorous evaluation for both content and face validity. This was assessed by a team of experts in the field. Ratings for each item were determined using an item-objective congruence (IOC) score method, where a score of 1 indicated clear measurement, 0 signified unclear content, and 1 indicated the content was clearly not measured. An average IOC score exceeding 0.5 was deemed indicative of good content validity. Following feedback and input from experts, several adjustments were made to the questionnaire to address redundancy and improve clarity. Questions that were deemed difficult to understand were either modified or removed altogether. Additionally, field tests were conducted on a small sample of 25 customers, although their data were ultimately excluded from the analysis. These steps were taken to refine the questionnaire and ensure its suitability for gathering accurate and meaningful insights from the target



population regarding antibiotics and ABR in the context of KSA pharmacies. The reliability of the questionnaire was assessed through pre-testing on a sample of 30 customers, with their data subsequently excluded from the analysis. The values of Cronbach's α for the knowledge, attitude, and practice sections were 0.81, 0.80, and 0.77, respectively. These values suggest a satisfactory level of internal consistency and reliability for each section of the questionnaire.

The final version of the questionnaire comprised 28 items organized into five sub-sections. The first section included 6 questions aimed at gathering demographic information, such as gender, age, education level, monthly income and employment status. The participants were presented with seven questions to assess their knowledge about antibiotics. Responses were recorded as 'yes,' 'no,' or 'unclear.' The third section consisted of eight questions designed to gauge participants' attitudes towards antibiotics. Responses were rated on a Likert scale, ranging from 'strongly agree' to 'strongly disagree.'

The fourth section focused on participants' practices regarding antibiotics, featuring five questions with response options ranging from 'always' to 'never.' Overall scoring for knowledge, attitude, and practices was categorized accordingly. Additionally, one question was added about the participation consent. Additionally, questionnaire underwent translation by three language experts, employing both forward and back translation techniques. Finally, a bilingual questionnaire was developed for the understanding of diverse range of customers. To ensure translation accuracy, an inter-rater reliability method was utilized. Agreement among two or more raters was deemed indicative of good agreement.

Sampling and sample size

Firstly, a sample size of 648 customers was calculated using Raosoft online software⁴⁰. This calculation was based on specific parameters set to achieve a margin of error of 4%, a high confidence level of 96%, and an assumed response distribution of 50%. These parameters were chosen to ensure the statistical accuracy and validity of the results. To translate these findings into a broader context, it was assumed the representation of average 2 customers from each pharmacy. This scaling factor was applied to reflect the diverse customer base of pharmacies across the country. Considering the vast number of pharmacies in KSA⁴¹, reported at 17,815, the study aimed to encompass a wide geographical and demographic range. However, to further enhance the robustness of the study, an additional 70 clients were included, bringing the total number of participants to 718. Customers visiting these community pharmacies were recruited through the systematic random method. This approach was involved by selecting every 10th customer who enters the pharmacy, ensuring that each potential participant has an equal chance of being included in the study. Additionally, participants purchasing cosmetics, baby formula milk, OTC medicine and nutraceuticals were excluded from the study.

Data collection

The data collection method employed for this study involved the development of a "Google Form" accompanied by a QR

code for easy access. Participants could effortlessly answer the survey questions by scanning the provided QR code. The objectives of the study were clearly stated on the first page of the form, ensuring participants understood the purpose of the survey from the outset. Prior to proceeding with the survey, obtaining informed consent was deemed crucial. Participants were provided with detailed information regarding confidentiality measures, their right to withdraw from the study at any time, and the voluntary nature of their participation. This ensured that participants were fully aware of their rights and the implications of their involvement in the study. It's noteworthy that no incentives were offered to participants, indicating that their participation was solely based on their willingness to contribute to the research objectives. Between Oct to Dec 2023, each pharmacist in the pharmacy informs customers about the opportunity to participate in this study by simply scanning a provided QR code.

Data Analysis

Descriptive analysis was utilized to study the percentages and frequencies within the dataset by using SPSS. One way ANOVA was employed to evaluate the relationship between demographic characteristics and knowledge, attitudes & practices ($p < 0.05$). Statistical significance was determined based on p -values.

RESULTS

Out of the 718 total customers involved in the study, 16 withdrew, resulting in a response rate of 97.8%. The majority of participants, comprising 46.2%, were aged 25 years or younger. Among all participants, 71.1% were male. Approximately 32.6% reported an income of less than or equal to 3000 SAR. The vast majority, accounting for 96.2%, held Saudi nationality. In terms of education, over half (56.4%), had earned a bachelor's degree, as given in Table 1. Over half (53.1%) of respondents perceived antibiotics and anti-inflammatory drugs as dissimilar medications. A substantial majority (70.7%) expressed that antibiotics are specifically intended for treating bacterial infections. Furthermore, a significant portion (80.3%) of participants showed concern regarding the risks associated with the excessive use of antibiotics, as depicted in Table 2.

Approximately 43.3% of respondents hold the belief that expensive antibiotics are not necessarily safer or more effective. A majority, comprising over two-thirds (66.3%) of participants, perceive that using multiple antibiotics may lead to better outcomes. Furthermore, a significant majority (69.5%) believe that saving and reusing leftover antibiotics is not advisable, as outlined in Table 3. Only a small percentage (21.1%) of participants reported never reading the instructions before taking antibiotics, while a larger portion (40.7%) stated they had never changed antibiotics without consulting a doctor, as indicated in Table 4.

Knowledge regarding antibiotics and their usage is notably influenced by educational attainment, as evidenced by the findings presented in Table 5. Education significantly influences antibiotic usage behaviour, while factors such as age, income,



nationality, and employment status show no notable impact, as outlined in Table 6. The pattern of practice remains unaffected

by factors such as employment status and nationality, as illustrated in Table 7.

Table 1. Demographics of study participants			
Age (Years) *	Category	n	% age
	less than or 25 26-30	322	46.2
	26-30	102	14.2
	31-35	66	9.2
	36-40	79	11
	41-45	43	5.9
	46-50	44	6.1
	More than or 50	41	5.7
Gender	Male	203	71.1
	Female	499	28.9
Income (SAR**)	less than or 3000	234	32.6
	3001-5000	80	11.1
	5001-10,000	229	31.9
	10,001-20,000	133	18.5
	More than or 20,000	60	9.3
Educational level	Middle	4	0.6
	Secondary	160	22.9
	Below secondary	33	4.7
	Bachelor	395	56.4
	Graduation	47	5.9
	PhD	1	0.1
	Other (Diploma)	66	9.4
Employment status	Employed	287	40.9
	Retired	35	5
	Students	248	35.3
	Unemployed	132	18.8
Nationality	Saudi	674	96.2
	Non-Saudi	27	3.8

Table 2. Knowledge of study participants						
Questions	No		Yes		Not clear	
	n	%	n	%	n	%
Q 1. Are antibiotics and anti-inflammatory medicine being similar	373	53.1	240	34.2	89	12.7
Q 2. Can antibiotics be applied to cure bacterial infections i.e. typhoid, pneumonia and wounds	156	22.2	496	70.7	50	7.1
Q 3. Can antibiotic be the treatment of common cold	264	37.6	391	55.7	47	6.7
Q 4. The antibiotics are safe for normal flora of body	249	35.5	214	30.5	239	34.5
Q 5. Health risk is associated with the redundant antibiotic's use	87	12.4	564	80.3	51	7.3
Q 6. Antibiotics use without prescription in pregnant women is harmless	536	76.4	113	16.1	53	7.5
Q 7. Can antibiotics concomitantly be used with herbal therapies	412	58.7	177	25.2	113	16.1

Table 3. Behaviour of study participants

Questions	Strongly Agreed		Agreed		Neutral		Disagreed		Strongly Disagreed	
	n	%	n	%	n	%	n	%	n	%
Q1. Expensive antibiotics are safe and effective	92	13.1	125	17.8	181	25.8	242	34.5	62	8.8
Q2. Expensive antibiotics possesses less adverse drug reactions	73	10.4	78	11.1	86	12.3	231	32.9	234	33.3
Q3. Use of antibiotic without prescription is harmless	108	15.4	104	14.8	183	26.1	256	36.5	51	7.3
Q4. Increasing the dose of antibiotics can accelerate the healing process	93	13.2	125	17.8	175	24.9	248	35.3	61	8.7
Q5. Administering multiple antibiotics results more favourable outcomes	72	10.3	81	11.5	83	11.8	232	33	234	33.3
Q6. Not completing a antibiotics full treatment reduces treatment effectiveness	85	12.1	109	15.5	82	11.7	194	27.9	232	33
Q7. Ceasing antibiotic therapy is safe when symptoms are improved	87	12.4	108	15.4	120	17.1	189	26.9	198	28.2
Q8. Saving and reusing leftover antibiotics is recommended	287	40.9	201	28.6	125	17.8	72	10.3	17	2.4

Table 4. Practices by study participants

Questions	Always		Often		Sometime		Seldom		Never	
	n	%	n	%	n	%	n	%	n	%
Q1. Before taking antibiotics, I carefully read the instructions provided in the package insert	104	14.8	121	17.2	108	15.4	221	31.5	148	21
Q2. I complete the entire course of antibiotic treatment as prescribed	84	12	137	19.5	119	17	178	25.4	184	26
Q3. Dose of antibiotics is altered by me during treatment	81	11.5	106	15.1	97	13.8	153	21.8	265	38
Q4. I don't change antibiotics without consulting a doctor	72	10.3	90	12.8	103	14.7	151	21.5	286	41
Q5. I store leftover antibiotics at home for potential future use	120	17.1	137	19.5	102	14.5	120	17.1	223	32

Table 5. Association of demographics with knowledge of participants

Demographics	Responses Knowledge (<i>P</i> values)						
	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7
Age	0.001	0.07	0.32	0.87	0.07	0.09	0.37
Gender	0.001	0.07	0.32	0.87	0.07	0.09	0.37
Income	0.21	0.97	0.537	0.171	0.13	0.91	0.1
Education	0	0.94	0.03	0.34	0.61	0	0.86
Employment	0.006	0.75	0.69	0.27	0.77	0.15	0.06
Nationality	0.048	0.97	0.82	0.92	0.78	0.24	0.09

Table 6. Association of demographics with behaviour of participants

Demographics	Responses behaviour (<i>P</i> values)							
	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8
Age	0.86	0.41	0.67	0.81	0.82	0.68	0.48	0.32
Gender	0.07	0.19	0.043	0.2	0.55	0.11	0.37	0.62
Income	0.81	0.98	0.83	0.58	0.52	0.62	0.62	0.43
Education	0.15	0.4	0	0.006	0.007	0	0.029	0.006
Employment	0.14	0.55	0.81	0.83	0.27	0.12	0.22	0.67
Nationality	0.5	0.8	0.81	0.65	0.57	0.73	0.84	0.14

DISCUSSION

The findings indicate a favorable level of understanding among customers regarding antibiotics in various regions of the KSA compared to earlier research in Sweden and Norway^{32,35,42}. However, a diverse pattern emerges when examining previous studies in India, Romania, Saudi Arabia, Yemen, and Uzbekistan^{43,44,45,46}. Aligned with a meta-analysis, it is revealed that more than half (53.1%) of respondents perceive antibiotics and anti-inflammatory drugs as distinct medications^{47,48}. Conversely to Ethiopian findings, this study demonstrates that 70% of customers correctly believe antibiotics are utilized to treat bacterial infections⁴⁹. On a concerning note, echoing previous findings from Italy and Kuwait^{50,51}, it is disconcerting that over half (55%) of respondents perceive antibiotics as a remedy for the common cold. According to a study conducted in Nepal, approximately 31.6% of respondents endorse this viewpoint⁵².

Certain aspects of knowledge share similar concerns with previous findings from KSA^{46,53}. Participants' perception regarding the safety of antibiotics for the normal flora of the body is not adequately understood. These results align with research conducted in India as well as the findings of researchers from Kuwait and Nepal^{50,54,55}. In contrast, most people (80%) also think that using antibiotics when they're not really needed can be risky for health. This belief is widely shared and highlights concerns about the unnecessary use of antibiotics⁵⁶. In contrast to findings from an Indian study, the current research reveals that over half of the participants believe that antibiotics cannot be simultaneously used with herbal therapies⁵⁷. The Knowledge about antibiotic used without prescription during pregnancy was very poor like a previous study from Lao PDR⁵⁸. Various health concerns in newborns, including hereditary abnormalities, asthma, atopic dermatitis, and alterations in the gut microbiome, have been associated with antibiotic exposure during pregnancy⁵⁹.

However, there is potential for shifting patient perspectives on antibiotic usage through messaging initiatives. Engaging interventions such as videos can be utilized to positively influence public awareness and enhance attitudes towards addressing antibiotic resistance (ABR)^{60,61,62}. Additionally, the younger generation has swift access to antibiotic information through various channels such as television, the internet, and notably social media platforms, owing to their convenient accessibility⁶³.

Among the surveyed individuals, about 43.3% share the perspective that the costlier antibiotics may not guarantee enhanced safety or efficacy. Conversely, in the Ethiopian study, 22.4% of participants expressed disagreement with

this notion⁶². Around 66.2% of the study participants express dissent regarding the statement suggesting that expensive antibiotics entail fewer adverse drug reactions. However, the study revealed that second- or even third-line antibiotics come at a considerable cost, resulting in extended hospital stays and an increased likelihood of experiencing side effects⁵². Similarly, over 67% of study participants did not subscribe to the notion that using antibiotics without a prescription is inoffensive, mirroring findings from another study conducted in the Western Region of KSA⁶⁴. In a parallel to the study from Bangladesh, the behaviour of respondents regarding the misuse of antibiotics, such as multiple administrations of various antibiotics and incomplete therapy, does not meet the desired standard. In both studies, the majority of respondents expressed a reluctance to store and reuse antibiotics⁶⁵. The respondents in the research from Thailand demonstrate superior practices, particularly in terms of reading the label before taking antibiotics. Conversely, our study yielded less favourable results in this regard⁶⁶. Merely 14.8% of our respondents consistently study the package insert.

In our study, it was found that only 12% of respondents ever complete the full course of antibiotic therapy. This is concerning because incomplete or short antibiotic courses may contribute to ABR⁶⁷. More than half of our study participants reported that they never alter the dosage during their therapy until completion. This finding contrasts with a report from Indian villages⁶⁸. Similar to a previous study conducted in the KSA⁶⁴, our study also demonstrates that educational level significantly influences knowledge, attitudes, and practices regarding antibiotics. Previous studies^{52,38,69,70} have identified educational level as a significant factor associated with influencing antibiotic use.

CONCLUSION

It is evident that there are both positive and concerning trends in antibiotic awareness and usage practices. While a significant majority understood the intended use of antibiotics and expressed concerns about their overuse, effectiveness and safety. The influence of educational attainment on these attitudes underscores the importance of targeted education campaigns that promotes the responsible antibiotic usage and combating the growing threat of ABR.

ACKNOWLEDGMENT

The authors would like to thank the Research Center at King Fahad Medical City, Riyadh R2, Second Health Cluster, for the valuable and technical support provided for the manuscript.

References

1. Duan L, Liu C, Wang D, Lin R, Qian P, Zhang X, Liu C. The vicious cycle of the public's irrational use of antibiotics for upper respiratory tract infections: A mixed methods systematic review. *Front. Public Health*. 2022; 10:1-11
2. Raihan MA, Islam MS, Islam S, Islam AFMM, Ahmed KT, Ahmed T, Islam MN, Ahmed S, Chowdhury MS, Sarker DK, Lamisa AB. Knowledge, attitudes, and practices regarding antibiotic use in Bangladesh: Findings from a cross-sectional study. *PLoS One*. 2024;19(2):1-12
3. Buke AC, Ermertcan S, Hosgor-Limoncu M, Ciceklioglu M, Eren S. Rational antibiotic use and academic staff. *International journal of antimicrobial agents*. 2003;21(1):63-6
4. Choudhury S., Medina-Lara A., Smith R. Antimicrobial resistance and the COVID-19 pandemic. *Bull. World Health Organ*. 2022; 100:103-106
5. World Health Organization W.H.O. 10 Threats to Global Health in 2018. [accessed on 16 Feb 2023]. Available : <https://medium.com/@who/10-threats-to-global-health-in-2018-232daf0bbef32018>
6. Mancuso G., Midiri A., Gerace E., Biondo C. Bacterial Antibiotic Resistance: The Most Critical Pathogens. *Pathogens*. 2021;10: 1-12
7. Mancuso G., Midiri A., Gerace E., Biondo C. Bacterial Antibiotic Resistance: The Most Critical Pathogens. *Pathogens*. 2021; 10:1-12
8. Abdelaziz S.M, Aboshanab K.M, Yahia I.S, Yassien M.A, Hassouna N.A. Correlation between the Antibiotic Resistance Genes and Susceptibility to Antibiotics among the Carbapenem-Resistant Gram-Negative Pathogens. *Antibiotics*. 2021;10: 1-18
9. Davey P, Pagliari C, Hayes A. The patient's role in the spread and control of bacterial resistance to antibiotics. *Clinical Microbiology and Infection*. 2002; 8:43-68.
10. Buke C, Hosgor-Limoncu M, Ermertcan S, Ciceklioglu M, Tuncel M, Köse T. Irrational use of antibiotics among university students. *Journal of infection*. 2005;51(2):135-9
11. Chen C, Chen Y-M, Hwang K-L, Lin S-J, Yang C-C, Tsay R-W. Behavior, attitudes and knowledge about antibiotic usage among residents of Changhua, Taiwan. *J Microbiol Immunol Infect*. 2005;38(1):53-9
12. Hutchings ML, Truman AW, Wilkinson B. Antibiotics: Past, present and future. *Curr. Opin. Microbiol*. 2019; 51:72-80
13. Atif M, Zia R, Malik I, Ahmad N, Sarwar S. Treatment outcomes, antibiotic use and its resistance pattern among neonatal sepsis patients attending Bahawal Victoria Hospital, Pakistan. *PLoS One*. 2021 13;16(1): 1-13
14. Septimus EJ. Antimicrobial Resistance: An Antimicrobial/Diagnostic Stewardship and Infection Prevention Approach. *Med. Clin. North Am*. 2018; 102:819-829
15. Mohanna M. Self-medication with Antibiotic in Children in Sana'a City, Yemen. *Oman Med J*. 2010; 25 (1): 41-3
16. McNulty CA, Boyle P, Nichols T, Clappison P, Davey P. Don't wear me out—the public's knowledge of and attitudes to antibiotic use. *Journal of Antimicrobial Chemotherapy*. 2007;59(4):727-38
17. Aponte-González J, González-Acuña A, Lopez J, Brown P, Eslava-Schmalbach J. Perceptions in the community about the use of antibiotics without a prescription: Exploring ideas behind this practice. *Pharmacy Practice (Granada)*. 2019;17(1): 1-9
18. Reynolds L, McKee M. Factors influencing antibiotic prescribing in China: an exploratory analysis. *Health policy*. 2009;90(1):32-6
19. Founou RC, Founou LL, Essack SY. Clinical and economic impact of antibiotic resistance in developing countries: a systematic review and meta-analysis. *PloS one*. 2017;12(12): 1-16
20. Klein EY, Van Boeckel TP, Martinez EM, Pant S, Gandra S, Levin SA. Global increase and geographic convergence in antibiotic consumption between 2000 and 2015. *Proceedings of the National Academy of Sciences*. 2018;115(15):3463-70
21. Bryce A, Costelloe C, Wootton M, Butler CC, Hay AD. Comparison of risk factors for, and prevalence of, antibiotic resistance in contaminating and pathogenic urinary *Escherichia coli* in children in primary care: prospective cohort study. *Journal of Antimicrobial Chemotherapy*. 2018;73(5):1359-67
22. Madhav N, Oppenheim B, Gallivan M, Mulembakani P, Rubin E, Wolfe N. Pandemics: Risks, Impacts, and Mitigation. In: Jamison D.T., Gelband H., Horton S., Jha P., Laxminarayan R., Mock C.N., Nugent R., editors. *Disease Control Priorities: Improving Health and Reducing Poverty*. 3rd ed. The International Bank for Reconstruction and Development/The World Bank; Washington, DC, USA: 2018.
23. Singh R, Singh A, Kumar S, Giri B, Kim KH. Antibiotic Resistance in Major Rivers in the World: A Systematic Review on Occurrence, Emergence, and Management Strategies. *J Clean Prod*. 2019; 234:1484-1505
24. Gottlieb T, Nimmo GR. Antibiotic resistance is an emerging threat to public health: An urgent call to action at the Antimicrobial Resistance Summit 2011. *Med J Aust*. 2011;194: 281-283
25. Halls A, Van't Hoff C, Little P, Verheij T, Leydon GM. Qualitative interview study of parents' perspectives, concerns and experiences of the management of lower respiratory tract infections in children in primary care. *BMJ Open*. 2017; 7:1-12
26. Huttner B, Saam M, Moja L, Mah K, Sprenger M, Harbarth S., Magrini N. How to improve antibiotic awareness campaigns: Findings of a WHO global survey. *BMJ Glob Health*. 2019; 4:1-16



27. McCullough AR., Parekh S, Rathbone J, Del Mar CB, Hoffmann TC. A systematic review of the public's knowledge and beliefs about antibiotic resistance. *J. Antimicrob Chemother.* 2016; 71:27–33
28. 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):159-166.
29. Chang J, Ye D., Lv B, Jiang M, Zhu S, Yan K, Fang Y. Sale of antibiotics without a prescription at community pharmacies in urban China: A multicentre cross-sectional survey. *J Antimicrob Chemother.* 2017; 72:1235–1242
30. World Health Organization The Pursuit of Responsible Use of Medicines. [accessed on 23 December 2023]; 2012 Available: https://www.who.int/medicines/publications/responsible_use/en/
31. Grigoryan L, Burgerhof JG, Degener JE, Deschepper R, Lundborg CS, Monnet DL, SAR Consortium Attitudes, beliefs and knowledge concerning antibiotic use and self-medication: A comparative European study. *Pharmacoepidemiol. Drug Saf.* 2007; 16:1234–1243
32. Andre M, Vernby A, Berg J, Lundborg CS. A survey of public knowledge and awareness related to antibiotic use and resistance in Sweden. *J Antimicrob Chemother.* 2010; 65:1292–1296
33. Vallin M, Polyzoi M, Marrone G, Rosales-Klintz S, Wisell KT, Lundborg CS. Knowledge and attitudes towards antibiotic use and resistance—a latent class analysis of a Swedish population-based sample. *PLoS ONE.* 2016; 11:1-15
34. Jose J, Jimmy B, Alsabahi AG, Al Sabei GA. A study assessing public knowledge, belief and behavior of antibiotic use in an omani population. *Oman Med J.* 2013;28(5):324-30.
35. Waaseth M, Adan A, Røen IL, Eriksen K, Stanojevic T, Halvorsen KH, Ariansen H. Knowledge of antibiotics and antibiotic resistance among Norwegian pharmacy customers—A cross-sectional study. *BMC Public Health.* 2019; 19:66–70
36. Al Omari S, Al Mir H, Wrayde S, Merhabi S, Dhaybi I, Jamal S, Al Atrouni A. First Lebanese Antibiotic Awareness Week campaign: Knowledge, attitudes and practices towards antibiotics. *J Hosp Infect.* 2019; 101:475–479.
37. Asghar S, Atif M, Mushtaq I, Malik I, Hayat K, Babar ZU. Factors associated with inappropriate dispensing of antibiotics among non-pharmacist pharmacy workers. *Res Social Adm Pharm.* 2020;16(6):805-811
38. Huang Y, Gu J, Zhang M, Ren Z, Yang W, Chen Y. Knowledge, attitude and practice of antibiotics: a questionnaire study among 2500 Chinese students. *BMC medical education.* 2013;13(1):1–9
39. Jairoun A, Hassan N, Ali A, Jairoun O, Shahwan M. Knowledge, attitude and practice of antibiotic use among university students: a cross sectional study in UAE. *BMC public health.* 2019;19(1):1–8
40. Raosoft Sample Size Calculator. Available o: <http://www.raosoft.com/samplesize.html> (accessed on 8 Nov 2023).
41. Alenezi S, Alanazi M, Aljazeera R, Almuzaini M, Alrasheidi S, Shamlan WB, Aljohani R, Alhawiti G, Alqarni M, Aljabri E, Qmmash M, Kanan M. Community Pharmacies in the Asian Countries of Developing Health System: Formation, Regulation, and Implication. *Pharmacy (Basel).* 2023; 11(4):1-18
42. Vallin M. Knowledge and attitudes towards antibiotic use and resistance - a latent class analysis of a Swedish population-based sample. *PLoS One.* 2016;11(4): e0152160.
43. Kotwani A, Joshi J, Lamkang AS, Sharma A, Kaloni D. Knowledge and behavior of consumers towards the non-prescription purchase of antibiotics: An insight from a qualitative study from New Delhi, India. *Pharm Pract (Granada).* 2021;19(1): 1-12
44. Alhomoud F, Aljamea Z, Basalelah L. “Antibiotics kill things very quickly” - consumers’ perspectives on non-prescribed antibiotic use in Saudi Arabia. *BMC Public Health.* 2018;16;18(1):1-17
45. Belkina T, Alwarafi A, Hussein Eltom E, Tadjieva N, Kubena A, Vlcek J. Antibiotic use and knowledge in the community of Yemen, Saudi Arabia, and Uzbekistan. *J Infect Dev Ctries.* 2014;8(4):424–429.
46. 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):550–554
47. Anghel IB, Craciun C. Self-medication with over-the-counter drugs and antibiotics in Romanian consumers: a qualitative study. *Cogn Brain Behav.* 2013;17(3):215–235
48. Gualano M.R., Gili R., Scaioli G., Bert F., Siliquini R. General population's knowledge and attitudes about antibiotics: A systematic review and meta-analysis. *Pharmacoepidemiol. Drug Saf.* 2015;24:2–10.
49. Sitotaw B, Philipos W. Knowledge, Attitude, and Practices (KAP) on Antibiotic Use and Disposal Ways in Sidama Region, Ethiopia: A Community-Based Cross-Sectional Survey. *ScientificWorldJournal.* 2023, 26;1-20
50. Awad A.I., Aboud E.A. Knowledge, attitude and practice towards antibiotic use among the public in Kuwait. *PLoS ONE.* 2015;10: 1-15
51. Cuzzolin L, Benoni G. Safety of non-prescription medicines: knowledge and attitudes of Italian pharmacy customers. *Pharm World Sci.* 2010;32(1):97–102.
52. Shah P, Shrestha R, Mao Z, Chen Y, Chen Y, Koju P, Liu X, Li H. Knowledge, Attitude, and Practice Associated with Antibiotic Use among University Students: A Survey in Nepal. *Int J Environ Res Public Health.* 2019;16(20): 1-13
53. Al Rasheed Abdulrahman, Yagoub Umar, Alkhashan Hesham, Abdelhay Osama, Alawwad Ahmad, Al Aboud Aboud, Al Battal Saad. Prevalence and Predictors of Self-Medication with Antibiotics in Al Wazarat Health Center, Riyadh City, KSA. *BioMed Research International.* 2016; 16:1–8.
54. Kumar KS, Saranya S, Rani NV. Community Pharmacists' Knowledge, Attitude, and Nonprescription Dispensing Practices of Antibiotics: An Explorative Study in a Selected City of South India. *J Res Pharm Pract.* 2022,14;11(2):51-58.

55. Nepal A, Hendrie D, Robinson S, Selvey LA. Knowledge, attitudes and practices relating to antibiotic use among community members of the Rupandehi District in Nepal. *BMC Public Health*. 2019;19(1):1-13
56. Vijay D, Bedi JS, Dhaka P, Singh R, Singh J, Arora AK, Gill JPS. Knowledge, Attitude, and Practices (KAP) survey among veterinarians, and risk factors relating to antimicrobial use and treatment failure in dairy herds of India. *Antibiotics (Basel)*. 2021;10(2):1-21.
57. Kounnavong S, Yan W, Sihavong A, Sychareun V, Eriksen J, Hanson C, Chaleunvong K, Keohavong B, Vongsouvath M, Mayxay M, Brauner A, Stålsby Lundborg C, Machowska A. Antibiotic knowledge, attitudes and reported practice during pregnancy and six months after birth: a follow- up study in Lao PDR. *BMC Pregnancy Childbirth*. 2022;22(1): 1-17.
58. Bookstaver PB, Bland CM, Griffin B, Stover KR, Eiland LS, McLaughlin M. A Review of Antibiotic Use in Pregnancy. *Pharmacotherapy*. 2015;35(11):1052-62.
59. Ahmed R, Bashir A, Brown J, Cox J, Hilton A, Hilton C, Lambert P, Theodosiou E, Tritter J, Watkin S. The drugs don't work: Evaluation of educational theatre to gauge and influence public opinion on antimicrobial resistance. *J Hosp Infect*. 2020;104:193–197
60. Parveen S, Garzon-Orjuela N, Amin D, McHugh P, Vellinga A. Public health interventions to improve antimicrobial resistance awareness and behavioural change associated with antimicrobial use: A systematic review exploring the use of social media. *Antibiotics (Basel)*. 2022;11(5):1-19
61. Burstein VR, Trajano RP, Kravitz RL, Bell RA, Vora D, May LS. Communication interventions to promote the public's awareness of antibiotics: a systematic review. *BMC Public Health*. 2019;19(1)1-9.
62. Kennedy J., Tuleu I., Mackay K. Unfilled prescriptions of medicare beneficiaries: Prevalence, reasons, and types of medicines prescribed. *J. Manag. Care Pharm*. 2008;14:553–560
63. Geta K, Kibret M. Knowledge, Attitudes and Practices of Patients on Antibiotic Resistance and Use in Public Hospitals of Amhara Regional State, Northwestern Ethiopia: A Cross-Sectional Study. *Infect Drug Resist*. 2022;15:193-209
64. Shatla M, Althobaiti FS, Almqaiti A. Public Knowledge, Attitudes, and Practices Towards Antibiotic Use and Antimicrobial Resistance in the Western Region of Saudi Arabia. *Cureus*. 2022;14(11): 1-16
65. Azim MR, Iftakhar KMN, Rahman MM, Sakib QN. Public knowledge, attitudes, and practices (KAP) regarding antibiotics use and antimicrobial resistance (AMR) in Bangladesh. *Heliyon*. 2023;9(10):1-14
66. Precha N, Sukmai S, Hengbaru M, Chekoh M, Laohaprapanon S, Makkaew P, Dom NC. Knowledge, attitudes, and practices regarding antibiotic use and resistance among health science and non-health science university students in Thailand. *PLoS One*. 2024 5;19(1): 1-19
67. Borek AJ, Edwards G, Santillo M, Wanat M, Glogowska M, Butler CC, Walker AS, Hayward G, Tonkin-Crine S. Re-examining advice to complete antibiotic courses: a qualitative study with clinicians and patients. *BJGP Open*. 2023;7(2): 1-17
68. Pattnaik M, Nayak AK, Karna S, Sahoo SK, Palo SK, Kanungo S, Kshatri JS, Parai D, Walia K, Singh T, Choudhary HR, Pati S, Bhattacharya D. Perception and determinants leading to antimicrobial (mis)use: A knowledge, attitude, and practices study in the rural communities of Odisha, India. *Front Public Health*. 2023;10:10
69. Odetokun IA, Akpabio U, Alhaji NB. Knowledge of antimicrobial resistance among veterinary students and their personal antibiotic use practices: a national cross-sectional survey. *Antibiotics*. 2019;8(4):1-14.
70. Yang C, Xie J, Chen Q, Yuan Q, Shang J, Wu H, Yang Y, Wang M, Shu X, Yue J, Tu D, Lin Y, Zheng R, Wu X. Knowledge, Attitude, and Practice About Antibiotic Use and Antimicrobial Resistance Among Nursing Students in China: A Cross Sectional Study. *Infect Drug Resist*. 2024;17:1085-1098.