INTERNATIONAL DEVELOPMENT PLANNING REVIEW
ISSN:1474-6743 | E-ISSN:1478-3401

AWARENESS AND KNOWLEDGE OF ANTIBIOTIC RESISTANCE AMONG HEALTHCARE WORKERS IN KSA: A SYSTEMATIC REVIEW

Amin Abdulrahman Hafiz1, Dr.Manar Faya Alalmaie2, Dr.Afaf Abdulali Alsubhi3, Dr.Amjd Mohammed Alkalthami4, Dr.Essam Jamaan Alghamdi5, Dr.Radiah Ali Alrasheedi6, Dr.Futun Hamed Almufarriji7, Dr.Hatun Abdullah Alsuwat8, Dr.Fahad Awad Asiri9, Dr.Madhawi Saad Almoaafi10, Dr. Meshal Ibrahim Alfrayan11, Dr. Qayed Fuhayman AL-Balawi12, Ph. Asma Ali Abbas13, Ph. Hajar Mohammed Alqarni14 and Ahmed saleh alrashdi15

1 Assisstant professor, Department of Clinical Nutrition, Faculty of Applied Medical Sciences, Umm Al-Qura University, Kingdom of Saudi Arabia Email: aahafiz@uqu.edu.sa
2 Pediatric consultant, Ministry of Health, Abha,KSA.
3 Pediatric consultant, Ministry of Health, Riyadh, KSA.
4 Resident Doctor, king fahad armed forces hospital, Jeddah,KSA
5 Resident doctor, Prince Meshari Bin Saud General Hospital,Al Baha - Baljurashi city, KSA
6 Resident doctor, Jubail General Hospital, Eastern province, KSA
7 General Practice, Ministry of Defense, Taif, KSA
8 General Practice, Ministry of Health, Jeddah, KSA
9 ER Physician , Ministry of health , Abha, KSA
10 Medical intern, Specialist nurse, King Abdulaziz University Hospital, Jeddah, KSA
11 Medical intern , Imam Mohammad Ibn Saud Islamic University, Riyadh, KSA
12 Medical intern,University of Tabuk, Tabuk, KSA
13 Pharmacist , National Guard Hospital, Jeddah, KSA
14 Pharmacist, Hera general hospital, Makkah, KSA
15 Specialist nurse, ministry of health, Hail, KSA

Abstract

Background: Antibiotic resistance poses a significant threat to global public health, and healthcare workers (HCWs) play a crucial role in combating this issue. This systematic review aimed to evaluate the awareness and knowledge levels regarding antibiotic resistance among HCWs in the Kingdom of Saudi Arabia (KSA).

Methods: A comprehensive search was conducted across multiple databases including PubMed, MEDLINE, Embase, Scopus, and CINAHL, along with grey literature sources. Studies assessing awareness and knowledge levels of antibiotic resistance among various categories of HCWs in Saudi Arabia were included. Data extraction and synthesis were performed independently by two reviewers using predefined criteria.

Results: The initial search yielded 41 studies, of which 20 full-text articles were reviewed, and eight studies met the inclusion criteria. These studies employed a cross-sectional design and utilized structured questionnaires or surveys to collect data from HCWs. Sample sizes ranged from 266 interns to 671 community pharmacists. While some groups demonstrated good knowledge and positive attitudes towards antibiotic use and resistance, significant gaps in understanding and practice were identified across different categories of HCWs. Factors such as profession,

qualification, nationality, age, and workplace were found to influence knowledge, attitudes, and practices regarding antibiotic resistance among HCWs in Saudi Arabia.

Conclusion: This systematic review highlights the varied levels of awareness, knowledge, attitudes, and practices related to antibiotic resistance among HCWs in Saudi Arabia. While certain groups showed positive trends, there are notable gaps that need to be addressed through targeted educational interventions and training programs. Enhancing awareness, knowledge, and practices surrounding antibiotic use and resistance among HCWs is crucial for effective antimicrobial stewardship efforts in Saudi Arabia, especially amidst the ongoing COVID-19 pandemic. Further research and revisions to local antimicrobial guidelines are warranted to address the identified gaps and promote optimal antibiotic prescribing practices in the region.

Introduction

Globally, antibiotic resistance is a big concern for people's health. Infections produced by bacteria that are resistant to antibiotics are responsible for an estimated 700,000 fatalities every year [1, 2]. Concerning the financial toll, projections show that these illnesses might kill 10 million people per year by 2050, with a global economic cost of more than $1 trillion per year by 2030 [1, 3, 4].

Overuse and abuse of antibiotics, as well as inadequate infection prevention and control (IPC) policies, contribute significantly to antibiotic resistance, which is a complex problem with many causes [2, 5, 6, 7]. It has been shown in recent research that areas with lower levels of antibiotic awareness and understanding also have a wider prevalence of antibiotic resistance. Health care workers (HCW) play an important role in infection control since they are among the most prevalent professional figures engaged in prescribing, dispensing, and/or delivering antibiotics [6, 8,9,10], even though prior research has concentrated on the public's antibiotic use behavior.

In fact, healthcare throughout the EU and EEA accounts for the majority of the clinical and epidemiological burden of infections caused by antibiotic-resistant bacteria [2, 11]. But in a healthcare context, things changed drastically based on the kind of bacteria, the antibiotic class, and the area in question [6,7,8]. This highlights the need of raising HCW and professional understanding of antibiotic resistance and use [11]. The European Union's communication strategies are in keeping with this goal; they want to help Member States raise awareness of antibiotic resistance and educate the public and medical professionals so that they may make better clinical decisions and prescribe with caution [8,9,10].

A cross-sectional study among general population in KSA revealed that, among study participants, of those who knew of antibiotic resistance, 76.5% had heard of it, yet only 24.2% could name the root reasons. Half of the people surveyed had an attitude that said they would never take antibiotics for prevention, and almost half said they always followed doctors' orders. Antibiotics were prescribed to 68.8% of patients, and 50.5% of those patients seldom utilized them. Furthermore, it was only after finishing the course of antibiotics that 68.9% discontinued their use. Public health education programs should be launched, with an emphasis on the role of healthcare practitioners in educating the public, and strict rules should be enforced to limit the non-prescription distribution of antibiotics. Nevertheless, this is an area that will need further research in the coming years [12].

Methods

Review Question

This systematic review aimed to evaluate the awareness and knowledge levels regarding antibiotic resistance among healthcare workers (HCWs) in the Kingdom of Saudi Arabia (KSA). The review sought to identify gaps in understanding, common misconceptions, and areas where interventions may have been needed to improve awareness and knowledge among HCWs regarding antibiotic resistance.

Search Strategy

A thorough search was conducted across relevant databases including PubMed, MEDLINE, Embase, Scopus, and CINAHL. Grey literature sources such as conference proceedings, dissertations, and reports were also searched. The search included keywords related to antibiotic resistance, awareness, knowledge, healthcare workers, and Saudi Arabia. The search strategy was tailored to each database and incorporated appropriate Medical Subject Headings (MeSH) terms.

Types of Studies Included

The review included observational studies (cross-sectional studies, cohort studies), qualitative studies, surveys, and mixed-methods studies that assessed awareness and knowledge levels of antibiotic resistance among healthcare workers in KSA. Studies focusing on various categories of HCWs including physicians, nurses, pharmacists, and laboratory personnel were considered.

Participants

The participants of interest in this review were healthcare workers (physicians, nurses, pharmacists, laboratory personnel, etc.) practicing in various healthcare settings across the Kingdom of Saudi Arabia.

Search Keywords

Search keywords included variations of terms such as "antibiotic resistance," "awareness," "knowledge," "healthcare workers," "doctors," "nurses," "pharmacists," "laboratory personnel," and "Saudi Arabia."

Study Selection Process

Two independent reviewers screened titles and abstracts identified through the search strategy to determine eligibility based on predefined inclusion and exclusion criteria. Full-text articles of

potentially relevant studies were then retrieved and assessed for eligibility. Any discrepancies were resolved through discussion or consultation with a third reviewer if needed.

Outcomes

The primary outcomes of interest included the level of awareness and knowledge among healthcare workers regarding antibiotic resistance in KSA. Secondary outcomes may have included factors influencing awareness and knowledge, attitudes towards antibiotic use and resistance, and the impact of educational interventions on improving awareness and knowledge.

Data Extraction and Coding

Data extraction was conducted independently by two reviewers using a standardized data extraction form. Extracted data included study characteristics (e.g., study design, sample size), participant demographics, measures of awareness and knowledge, factors influencing awareness, attitudes towards antibiotic use, and key findings. Any discrepancies were resolved through discussion or consultation with a third reviewer.

Data Management

Data from included studies were managed using reference management software such as EndNote or Zotero. Duplicate records were identified and removed during the screening process. Extracted data were securely stored and accessible only to the review team to ensure confidentiality and data integrity throughout the review process.

Results

The initial search identified a total of 41 studies from PubMed, Embase, Cochrane Library, and CINAHL. There were no duplicates and 52 studies were screened based on their titles and abstracts. Of these, 20 full-text articles were reviewed, and only seven studies were eligible for inclusion in this systematic review (Figure 1).

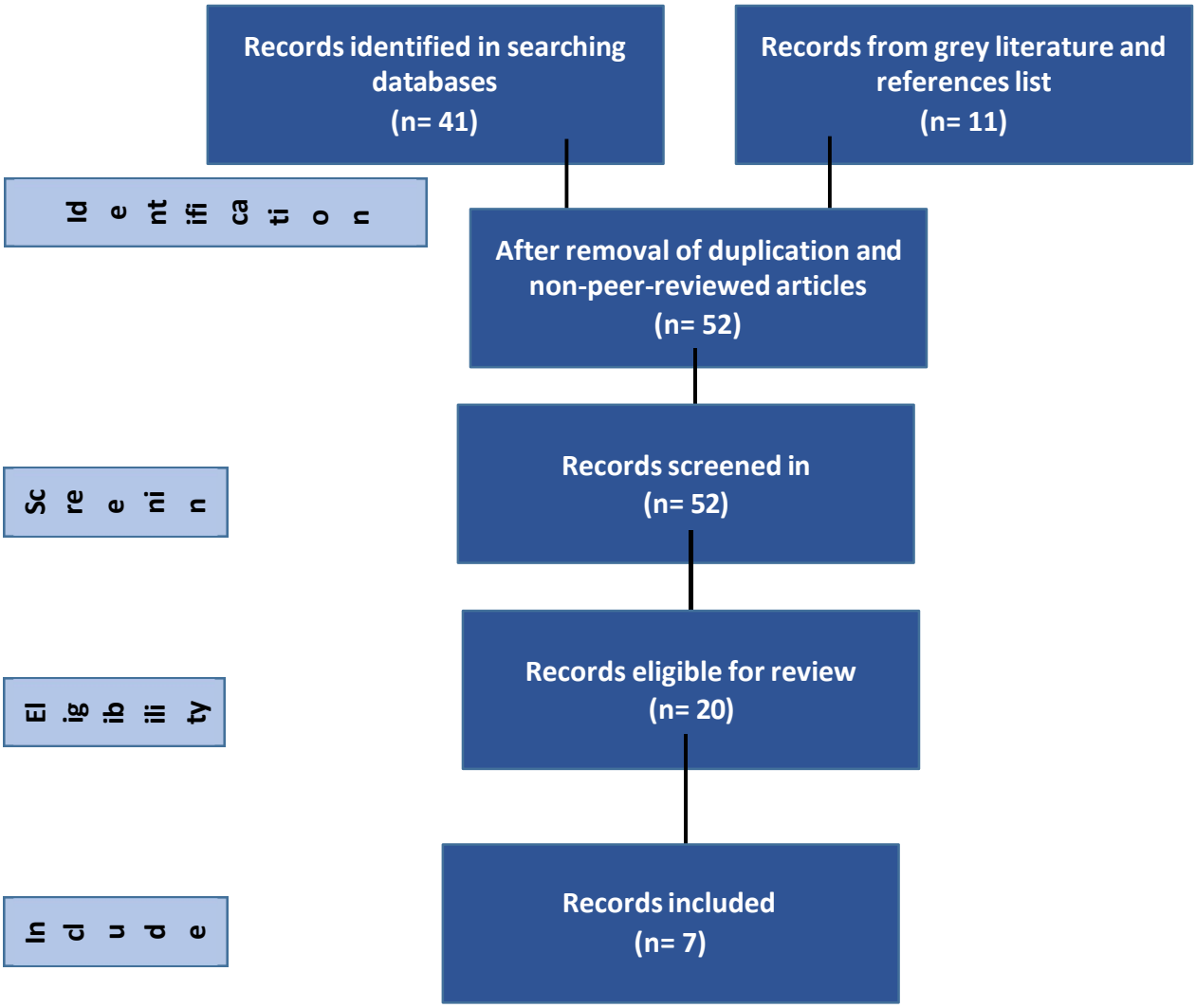

Figure 1: Flow chart of selection process

The study by Albalawi et al. (2023) investigated the knowledge, attitudes, and practices of pharmacy and non-pharmacy interns in Saudi Arabia regarding antibiotic use and resistance. The findings revealed that overall, interns scored well in knowledge and practice domains, followed by attitudes. However, there was a lack of belief among interns in their responsibility to prevent antibiotic resistance [13]. Al Sulayyim et al. (2023) conducted a study to assess healthcare workers' knowledge, attitude, and practice (KAP) regarding antibiotic resistance during the COVID-19 pandemic. The results indicated that while healthcare workers had a positive attitude toward antibiotic resistance, their knowledge and practice needed significant improvement, highlighting the urgent need for educational and training programs [14].

In the study by Alradini et al. (2023), primary healthcare physicians' perceptions about antibiotic prescription in Saudi Arabia were explored using the Theory of Planned Behavior (TPB). The study revealed insufficient awareness about antibiotic-resistant bacteria among physicians, emphasizing the need for continued medical education and training interventions [15]. Baraka et

al. (2023) investigated factors associated with antimicrobial resistance (AMR) and its consequences among healthcare providers in the Eastern Province of Saudi Arabia. The study identified poor skills and knowledge as key factors contributing to inappropriate prescribing of antimicrobials, highlighting the need for comprehensive education and training programs [16].

Alajmi et al. (2023) examined antibiotic dispensing practices and knowledge among community pharmacists in Saudi Arabia. The findings showed good antibiotic dispensing practices overall, but there were still antibiotic prescribing errors by physicians, indicating the importance of ongoing education and awareness efforts [17]. Baadani et al. (2013) assessed physicians' knowledge, perceptions, and attitudes toward antimicrobial prescribing in Riyadh, Saudi Arabia. The study revealed significant unmet training and education needs for physicians in antimicrobial prescribing, suggesting the need for revisions to local antimicrobial guidelines and enhanced educational interventions [18]. Al Qamariat and Almaghaslah (2023) conducted a study in Saudi Arabia to assess pharmacists' perceptions of handling antimicrobial resistance (AMR). The findings revealed that pharmacists faced barriers such as insufficient background education and limited access to relevant clinical journals. However, enabling factors like continuous professional development (CPD) activities and accessible educational resources were identified. The study highlighted the importance of providing pharmacists with adequate resources and educational opportunities to effectively address AMR [19].

In terms of methods, all seven studies employed a cross-sectional design to investigate various aspects of antibiotic resistance awareness, knowledge, attitudes, and practices among healthcare professionals (HCPs) in Saudi Arabia. The studies utilized structured questionnaires or surveys to collect data from participants, with sample sizes ranging from 266 interns to 671 community pharmacists. Data collection methods included online surveys, self-administered questionnaires, and distribution of validated instruments. Additionally, some studies conducted statistical analyses such as Mann–Whitney tests, Kruskal-Wallis tests, logistic regression, one-way ANOVA, and post-hoc Tukey-Kramer HSD multiple comparison tests to explore associations between variables and identify significant factors influencing knowledge, attitudes, and practices regarding antibiotic resistance among HCPs.

In terms of results, the studies revealed varied levels of awareness, knowledge, attitudes, and practices related to antibiotic resistance among different categories of healthcare professionals in Saudi Arabia. Overall, the findings indicated that while certain groups demonstrated good knowledge and positive attitudes towards antibiotic use and resistance, there were notable gaps in understanding and practice. Factors such as profession, qualification, nationality, age, and workplace were found to influence knowledge, attitudes, and practices among healthcare workers. Furthermore, the studies highlighted the need for targeted educational interventions and training programs to improve awareness, knowledge, and practices surrounding antibiotic use and resistance among healthcare professionals in Saudi Arabia, particularly during the COVID-19 pandemic.

Table 1: Summary of studies characteristics

Study	Year	Design	Setting	Main Findings	Implication
Albalawi et al.	2023	Cross-sectional descriptive study	Saudi Arabia	Interns achieved good scores in knowledge and practice regarding antibiotic use and resistance, with pharmacy interns showing insignificantly better overall scores compared to non-pharmacy interns. Interns lack belief in their responsibility to prevent antibiotic resistance.	Targeted educational interventions are needed to enhance interns' understanding of their role in preventing antibiotic resistance.
Al Sulayyim et al.	2023	Cross-sectional study	Najran, KSA	Healthcare workers (HCWs) demonstrated median scores for knowledge, attitude, and practice related to antibiotic resistance (AR). Despite a positive attitude, HCWs' knowledge and practice regarding AR require significant improvement.	Urgent implementation of effective educational and training programs is necessary to enhance HCWs' knowledge and practice concerning AR. Further prospective studies are needed to inform these programs.
Alradini et al.	2021	Cross-sectional study	Riyadh, Saudi Arabia	Primary care physicians (PCPs) exhibit poor knowledge of antibiotic-resistant bacteria but display favorable attitudes and satisfactory social pressure toward antibiotics. Increased awareness through continuous medical education (CME) and training interventions can enhance rational	Continued medical education (CME) and frequent training interventions can increase awareness and promote rational prescribing practices

				prescribing practices for antibiotics.	among PCPs, contributing to the control of antimicrobial resistance (AMR) spread.
Baraka et al.	2021	Cross-sectional study	Eastern Province, Saudi Arabia	Factors contributing to inappropriate antimicrobial prescribing include poor skills and knowledge, while effective factors influencing prescribing choices include effectiveness, previous experience, and reading scientific materials. Comprehensive education and training are needed to improve antimicrobial prescribing practices and minimize antimicrobial resistance.	Improvement in antimicrobial prescribing practices among healthcare providers is essential to minimize the risk of resistance and improve patients' clinical outcomes.
Alajmi et al.	2023	Online-based survey	Saudi Arabia	Community pharmacists demonstrate generally good practice in antibiotic dispensing and a significant understanding of their role in combating antimicrobial resistance (AMR). However, antibiotic prescribing errors persist, indicating the need for interventions to improve prescribing practices.	Decision-makers should focus on improving antibiotic usage and prescribing practices in community pharmacies to control the spread of AMR in Saudi Arabia.
Baadani et al.	2015	Questionnaire-based study	Riyadh, Saudi Arabia	Physicians in Riyadh perceive antimicrobial resistance (AMR) as a significant problem and recognize the importance of interventions to reduce it. However, there are unmet training and education needs, and	Addressing unmet training needs and revising local antimicrobial guidelines are crucial steps toward enhancing

				local antimicrobial guidelines require revision to ensure relevance and usefulness.	physicians' knowledge and practices related to antimicrobial prescribing, ultimately contributing to AMR prevention.
Al Qamariat & Almaghaslah	2021	Cross-sectional study	Saudi Arabia	Community pharmacists identify barriers such as insufficient background education and limited time, as well as enablers like continuous professional development (CPD) activities and access to educational resources, in handling antimicrobial resistance (AMR). These findings underscore the importance of facilitating pharmacist education and providing resources to enhance AMR management.	Improving pharmacist education and providing access to resources can help overcome barriers and strengthen pharmacists' role in AMR management, contributing to more effective antimicrobial stewardship programs in Saudi Arabia.

Discussion

Researchers have shown that a lack of understanding of antimicrobial resistance is often blamed for illogical behaviors in prescribing and distributing antimicrobials [20, 21]. The seven studies that made up this meta-analysis all used self-administered tests to gauge participants' AMR knowledge. That is why only around half of the people who took part had a solid grasp of AMR.

Comparative research from Japan (where 50% of the population had sufficient knowledge and awareness about AMR)[22], Saudi Arabia (where it was 55% [23, 24]), and rural areas of South and Southeast Asia (where it was 72.5% in Chiang Rai, Thailand) and Salvan (where it was 62.5% [25]) all showed higher levels of knowledge. In addition, almost 59% of the public was familiar with AMR, according to a meta-analysis by Gualano et al. [24] that included 24 research with a total of 40747 participants. However, studies in Nigeria showed that only 8.3% of the population had excellent awareness of AMR [27], but the pooled random effect mata-analysis of the [26] research was greater. Reasons for these differences include differences in sample size, availability of both online and offline media, level of support for the antibiotic stewardship program, and other

national policies pertaining to antibiotic usage and resistance. Furthermore, farmers, especially those who raise animals, utilize a lot of antimicrobials [28].

Given that Ethiopia has the highest livestock output in Africa [29], it follows that evaluating the KAP of livestock producers is crucial for bringing attention to the issue of antibiotic usage [26] and resistance and for crafting suitable laws in this area. Still, research shows that only about a quarter of cattle farmers have a solid grasp of antimicrobial resistance [26]. On the other hand, according to a review [26], approximately 74% of healthcare workers possessed a good level of antimicrobial resistance knowledge. This is substantially higher than the results of a national survey in Nigeria, where only 49.2% had adequate knowledge about AMR. Physicians possessed significantly better knowledge than other health care workers [30], and it is almost in agreement with a study that evaluated the knowledge, attitudes, and practices (KAP) of health workers in 30 EU/EEA countries regarding AMR [31]. Educational training programs have been shown to enhance healthcare personnel' understanding of antimicrobial stewardship [34], which might explain why our research and those from other nations [32, 33] indicate a greater pooled prevalence of excellent knowledge of antibiotic resistance [34].

Over two-thirds of the people surveyed felt positively about AMR, according to a meta-analysis and systematic review [26]. Prior studies have reached similar conclusions [35, 36]. Health care providers may have a more positive outlook on antimicrobial resistance (AMR) because they are more likely to be knowledgeable about the disease (44% vs. 43% for the general public, 28% for livestock keepers) [26].

It was also found that patients had an even lower estimate at 40%, and that the combined percentage with effective AMR practices was lower than average at 49%, when we calculated the pooled estimate using data retrieved from all seven investigations. Among the most common examples of bad practice were the following: dispensing antibiotics without a prescription when asked directly by a client [37], buying without first consulting a doctor [38], administering human antimicrobials to animals [38], and not finishing a full course of antibiotics [39, 40]. According to a review study in Sub-Saharan Africa, non-prescribed dispensing of antibiotics is frequent among community medication outlets [41], which is consistent with these poor or low levels of good antimicrobial resistance practices. An previous assessment of a substantial knowledge gap about AMR may reflect the observed inadequate AMR practices. Two studies [29, 42] found variables related to KAP out of fourteen that were part of a systematic review and meta-analysis [26]. Gebeyehu et al. found that less educated livestock breeders were ignorant about AMR [29]. Vietnamese individuals with a formal education were found to have information regarding antimicrobial resistance (AMR), according to Pham-duc et al. [43]. One possible explanation is that people may easily read and acquire information from a variety of sources. In addition, there were positive and statistically significant relationships between KAP and AMR in male individuals [29, 42]. In China, researchers have found similar results [44]. One possible explanation is that males spend a lot of time outside and are therefore more exposed to public gatherings and the media.

Conclusion

The systematic review identified eight studies focusing on antibiotic resistance awareness, knowledge, attitudes, and practices among healthcare professionals in Saudi Arabia. These studies

employed a cross-sectional design with structured questionnaires or surveys to collect data from interns, healthcare workers, physicians, and pharmacists. While certain groups demonstrated good knowledge and positive attitudes toward antibiotic use and resistance, there were notable gaps in understanding and practice, particularly regarding interns' and physicians' beliefs in their responsibility to prevent antibiotic resistance. Factors such as profession, qualification, nationality, age, and workplace influenced knowledge, attitudes, and practices among healthcare workers. The findings underscore the importance of targeted educational interventions and training programs to enhance awareness, knowledge, and practices surrounding antibiotic use and resistance among healthcare professionals in Saudi Arabia, especially amidst the COVID-19 pandemic. Further research and revisions to local antimicrobial guidelines are warranted to address the identified gaps and promote effective antimicrobial stewardship efforts in the region.

References

1. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations https://amr-review.org/Publications.html. Review on Antimicrobial Resistance; 2016.

2. A European One Health Action Plan against Antimicrobial Resistance (AMR). https://ec.europa.eu/health/amr/. European Commission; 2017.

3. Drug-Resistant Infections: A Threat to Our Economic Future. http://documents.worldbank.org/curated/en/323311493396993758/final-report: World Bank; 2017

4. Serra-Burriel M, Keys M, Campillo-Artero C, Agodi A, Barchitta M, Gikas A, et al. Impact of multi-drug resistant bacteria on economic and clinical outcomes of healthcare-associated infections in adults: systematic review and meta-analysis. PLoS ONE. 2020;15(1):e0227139.

5. Paget J, Lescure D, Versporten A, Goossens H, Schellevis F, van Dijk L. Antimicrobial resistance and causes of non-prudent use of antibiotics in human medicine in the UE.

6. Charani E, Edwards R, Sevdalis N, Alexandrou B, Sibley E, Mullett D, et al. Behavior change strategies to influence antimicrobial prescribing in acute care: a systematic review. Clin Infect Dis. 2011;53(7):651–62.

7. Pinder R, Sallis A, Berry D, Chadborn T. Behaviour Change and Antibiotic Prescribing in Healthcare Settings: Literature Review and Behavioural Analysis https://www.gov.uk/government/publications/antibiotic-prescribing-and-behaviour-change-in-healthcare-settings: Public Health England; 2015.

8. Special Eurobarometer 478 Report Antimicrobial Resistance. https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/Survey/getSurveyDetail/instruments/SPECIAL/surveyKy/2190: European Commission; 2018.

9. Special Eurobarometer 445 Report Antimicrobial Resistance. https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/Survey/getSurveyDetail/instruments/SPECIAL/surveyKy/2107: European Commission.

10. Special Eurobarometer 338 Report Antimicrobial Resistance. https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/Survey/getSurveyDetail/instruments/SPECIAL/surveyKy/802/p/4: European Commission; 2010.

11. Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. Infect Control Hosp Epidemiol. 2011;32(2):101–14.

12. Alkhuraisi LS, Mirghani H, Al Qahtani MM, Alrezqi WA, Alfaifi IA, Jathmi AS, Jathmi AS, Aianazi NS, Al qahtani Sr MM, AlANAZI NS. Knowledge, Attitude, and Practice of Antibiotic Resistance Among General Population in Saudi Arabia: A Cross-Sectional Study. Cureus. 2023 Dec 24;15(12).

13. Albalawi L, Alhawiti AS, Alnasser D, Alhumaidi J, Alrashidi T, Alnawmasi AM, Ali MA, Alqifari S, Alshareef H. Knowledge, Attitudes, and Practices among Pharmacy and Non-Pharmacy Interns in Saudi Arabia Regarding Antibiotic Use and Antibiotic Resistance: A Cross-Sectional Descriptive Study. InHealthcare 2023 Apr 29 (Vol. 11, No. 9, p. 1283). MDPI.

14. Al Sulayyim H, Ismail R, Hamid AA, Ghafar NA. Knowledge, attitude and practice of healthcare workers towards antibiotic resistance during the COVID-19 pandemic. JAC-antimicrobial resistance. 2023 Jun;5(3):dlad068.

15. Alradini F, Bepari A, AlNasser BH, AlGheshem EF, AlGhamdi WK. Perceptions of primary health care physicians about the prescription of antibiotics in Saudi Arabia: Based on the model of Theory of planned behaviour. Saudi Pharmaceutical Journal. 2021 Dec 1;29(12):1416-25.

16. Baraka MA, Alboghdadly A, Alshawwa S, Elnour AA, Alsultan H, Alsalman T, Alaithan H, Islam MA, El-Fass KA, Mohamed Y, Alasseri AA. Perspectives of healthcare professionals regarding factors associated with antimicrobial resistance (AMR) and their consequences: a cross sectional study in Eastern Province of Saudi Arabia. Antibiotics. 2021 Jul 19;10(7):878.

17. Alajmi AM, Alamoudi AA, Halwani AA, Almangour TA, Almozain NH, Al-Jedai A, Tawfik EA. Antimicrobial resistance awareness, antibiotics prescription errors and dispensing patterns by community pharmacists in Saudi Arabia. Journal of Infection and Public Health. 2023 Jan 1;16(1):34-41.

18. Baadani AM, Baig K, Alfahad WA, Aldalbahi S, Omrani AS. Physicians' knowledge, perceptions, and attitudes toward antimicrobial prescribing in Riyadh, Saudi Arabia. Saudi medical journal. 2015 May;36(5):613.

19. Al Qamariat Z, Almaghaslah D. Pharmacists' perceptions of handling antimicrobial resistance (Amr): a case study in Saudi Arabia. Infection and Drug Resistance. 2021 Oct 30:4517-28.

20. Apisarnthanarak A, Tunpornchai J, Tanawitt K, Mundy LM. Nonjudicious dispensing of antibiotics by drug stores in Pratumthani, Thailand. Infection Control & Hospital Epidemiology. 2008;29:572–575.

21. Kamuhabwa AA, Silumbe R. Knowledge among drug dispensers and antimalarial drug prescribing practices in public health facilities in Dar es Salaam. Drug, Healthcare and Patient Safety. 2013:181–189.

22. Kamata K, Tokuda Y, Gu Y, Ohmagari N, Yanagihara K. Public knowledge and perception about antimicrobials and antimicrobial resistance in Japan: A national questionnaire survey in 2017. PLoS One. 2018;13:e0207017.

23. 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:e31857.

24. Gualano MR, 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.

25. Haenssgen MJ, Charoenboon N, Zanello G, Mayxay M, Reed-Tsochas F, et al. Antibiotic knowledge, attitudes and practices: new insights from cross-sectional rural health behaviour surveys in low-income and middle-income South-East Asia. BMJ Open. 2019;9:e028224.

26. Woldegeorgis BZ, Kerbo AA, Obsa MS, Mokonnon TM. A systematic review and meta-analysis of antimicrobial resistance knowledge, attitudes, and practices: Current evidence to build a strong national antimicrobial drug resistance narrative in Ethiopia. PLoS One. 2023;18(6):e0287042.

27. Chukwu EE, Oladele DA, Awoderu OB, Afocha EE, Lawal RG, et al. A national survey of public awareness of antimicrobial resistance in Nigeria. Antimicrob Resist Infect Control. 2020;9:72.

28. Founou LL, Founou RC, Essack SY. Antibiotic Resistance in the Food Chain: A Developing Country-Perspective. Front Microbiol. 2016;7:1881.

29. Gebeyehu DT, Bekele D, Mulate B, Gugsa G, Tintagu T. Knowledge, attitude and practice of animal producers towards antimicrobial use and antimicrobial resistance in Oromia zone, north eastern Ethiopia. PLoS One. 2021;16:e0251596.

30. Chukwu EE, Oladele DA, Enwuru CA, Gogwan PL, Abuh D, et al. Antimicrobial resistance awareness and antibiotic prescribing behavior among healthcare workers in Nigeria: a national survey. BMC infectious diseases. 2021;21:1–12.

31. Ashiru-Oredope D, Hopkins S, Vasandani S, Umoh E, Oloyede O, et al. Healthcare workers' knowledge, attitudes and behaviours with respect to antibiotics, antibiotic use and antibiotic resistance across 30 EU/EEA countries in 2019. Eurosurveillance. 2021;26:1900633.

32. Rusic D, Bozic J, Bukic J, Vilovic M, Tomicic M, et al. Antimicrobial resistance: physicians' and pharmacists' perspective. Microbial Drug Resistance. 2021;27:670–677.

33. Atif M, Ihsan B, Malik I, Ahmad N, Saleem Z, et al. Antibiotic stewardship program in Pakistan: a multicenter qualitative study exploring medical doctors' knowledge, perception and practices. BMC infectious diseases. 2021;21:1–11.

34. Tahoon MA, Khalil MM, Hammad E, Morad WS, Ezzat S. The effect of educational intervention on healthcare providers' knowledge, attitude, & practice towards antimicrobial stewardship program at, National Liver Institute, Egypt. Egyptian Liver Journal. 2020;10:1–7.

35. Mudenda S, Hankombo M, Saleem Z, Sadiq MJ, Banda M, et al. Knowledge, Attitude, and Practices of Community Pharmacists on Antibiotic Resistance and Antimicrobial Stewardship in Lusaka, Zambia. medRxiv. 2020.

36. Afzal Khan A, Banu G, Reshma K. Antibiotic resistance and usage—a survey on the knowledge, attitude, perceptions and practices among the medical students of a Southern Indian teaching hospital. Journal of clinical and diagnostic research: JCDR. 2013;7:1613.

37. Belachew SA, Hall L, Selvey LA. Community drug retail outlet staff's knowledge, attitudes and practices towards non-prescription antibiotics use and antibiotic resistance in the Amhara region, Ethiopia with a focus on non-urban towns. Antimicrob Resist Infect Control. 2022;11:64.

38. Dejene H, Birhanu R, Tarekegn ZS. Knowledge, attitude and practices of residents toward antimicrobial usage and resistance in Gondar, Northwest Ethiopia. One Health Outlook. 2022;4:10.

39. 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.

40. Geta K, Kibret M. Knowledge, attitudes and practices of animal farm owners/workers on antibiotic use and resistance in Amhara region, north western Ethiopia. Sci Rep. 2021;11:21211.

41. Belachew SA, Hall L, Selvey LA. Non-prescription dispensing of antibiotic agents among community drug retail outlets in Sub-Saharan African countries: a systematic review and meta-analysis. Antimicrobial Resistance & Infection Control. 2021;10:1–15.

42. Simegn W, Dagnew B, Weldegerima B, Dagne H. Knowledge of Antimicrobial Resistance and Associated Factors Among Health Professionals at the University of Gondar Specialized Hospital: Institution-Based Cross-Sectional Study. Front Public Health. 2022;10:790892.

43. Pham-Duc P, Cook MA, Cong-Hong H, Nguyen-Thuy H, Padungtod P, et al. Knowledge, attitudes and practices of livestock and aquaculture producers regarding antimicrobial use and resistance in Vietnam. PLoS One. 2019;14:e0223115.

44. Dyar OJ, Zhang T, Peng Y, Sun M, Sun C, et al. Knowledge, attitudes and practices relating to antibiotic use and antibiotic resistance among backyard pig farmers in rural Shandong province, China. Preventive veterinary medicine. 2020;175:104