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Knowledge, attitudes, and practices of healthcare workers on antimicrobial resistance and antibiotic use in Erbil city, Iraq: a cross-sectional study

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Abstract

Background and objective: Antimicrobial resistance (AMR) is a growing global health threat, with predictions of a substantial rise in AMR-related deaths over the coming decades. Healthcare workers (HCWs) are central to the fight against AMR through their prescribing and counselling practices. This study assessed the knowledge, attitudes, and practices (KAP) regarding antibiotic use and AMR among HCWs in Erbil City, Iraq, and examined how these vary across professions.

Methods: A cross-sectional study was conducted in five government hospitals in Erbil City, Iraq: Erbil Teaching Hospital, West Emergency Hospital, Rizgary Teaching Hospital, Raparin Hospital, and Gynecology and Maternity Hospital. Physicians, pharmacists, dentists, and nurses were recruited using a convenience sampling approach. A total of 408 healthcare workers were interviewed face-to-face using a standardized questionnaire between September 2024 and March 2025. Data were analyzed using SPSS version 27.

Results: Participants' ages ranged from 19 to 99 years (mean 34.0 ± 8.6 years), and years of professional experience averaged 10.3 ± 8.1 (range 1–35). Males comprised 46.3% of the sample and females 53.7%. Physicians (38.5%) and nurses (30.1%) were the most represented professions, and most participants (83.8%) held permanent positions. Knowledge of AMR was inconsistent: although 82.4% correctly identified prevention of post-operative infection as an appropriate use of antibiotics, misconceptions about antibiotic use remained common. Adherence to prescribing guidelines, discussion of antibiotic use with patients, and knowledge scores all differed significantly across professions ($P < 0.001$), with physicians scoring highest and nurses lowest.

Conclusion: There are substantial gaps in the knowledge, attitudes, and practices of healthcare workers in Erbil City regarding antibiotic prescribing. Targeted interventions, particularly among nurses, are needed to strengthen antimicrobial stewardship and curb the emergence and spread of AMR.

Keywords: Knowledge, Healthcare workers, Antibiotic usage, Antimicrobial resistance.

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Introduction

Antimicrobial resistance (AMR) is a global health threat that jeopardizes the efficacy of existing treatments and is associated with increased morbidity and mortality (1). According to the World Health Organization (WHO), AMR was associated with more than 1.27 million deaths worldwide in 2019, a figure projected to rise substantially in the coming decades if left unaddressed (2). Healthcare workers (HCWs) are at the forefront of the fight against AMR: because they prescribe and administer antibiotics, their knowledge, attitudes, and practices directly influence the pace at which resistance develops (3, 4). Nevertheless, several studies have identified persistent knowledge gaps and disparities in attitudes among HCWs that may compromise patient safety and undermine efforts to promote appropriate antibiotic use (5).

AMR has rapidly become a major concern alongside infectious disease more broadly, particularly in low- and middle-income countries (6). Its root causes include weaknesses in infection control, antibiotic use beyond what is prescribed, and self-medication (2, 7, 8), compounded by limited availability of guidelines and training in infection prevention (9). A health worker's knowledge, attitudes, and practices (KAP) are shaped by several factors, including education, clinical experience, and exposure to training (10-12), and these factors need to be understood separately across professions in order to design effective interventions for optimizing antibiotic prescribing and promoting prudent use.

Iraq is a middle-income country with a high burden of infectious disease and correspondingly limited resources to address AMR; poor healthcare infrastructure, conflict, and economic constraints further compound the problem (13). In the Kurdistan Region specifically, a recent survey of community pharmacists in Erbil City similarly reported gaps in antimicrobial-stewardship-related practices and limited access to guidelines, underscoring the local relevance of this issue. Understanding HCWs' knowledge and practices in this context is therefore critical. This study aimed to assess the knowledge, attitudes, and practices of healthcare workers in Erbil City, Iraq, regarding antibiotic use and AMR, with a focus on how these vary among different healthcare professions.

Material and Methods

This cross-sectional study was conducted in five government hospitals in Erbil City, Iraq: Erbil Teaching Hospital, West Emergency Hospital, Rizgary Teaching Hospital, Raparin Hospital, and Gynecology and Maternity Hospital, representing a range of health facilities across the city. Eligible participants were physicians, pharmacists, dentists, and nurses

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directly involved in patient care, recruited using a convenience sampling approach, which is both feasible and practical in healthcare settings and allows recruitment of participants who are readily accessible and meet the inclusion criteria.

The minimum required sample size was calculated using the formula: $n = Z^2P(1–P)/E^2$, where Z = 1.96 for a 95% confidence level, P = 0.50 (a conservative estimate used in the absence of established local prevalence data on AMR-related knowledge gaps among HCWs), and E = 0.05 (5% margin of error), yielding a minimum required sample of 385 participants ($n = 1.96^2 \times 0.50 \times 0.50 / 0.05^2 = 384.16$). A target of 400 participants was set to allow for incomplete questionnaires and attrition, and 408 healthcare workers were ultimately enrolled.

Participants were eligible if they were currently employed as a physician, pharmacist, dentist, or nurse at one of the study hospitals, were engaged in direct patient care, were willing to provide informed consent, and had at least six months of experience at the institution. Healthcare workers not directly involved in patient care, those on extended leave during data collection, those unable or unwilling to provide informed consent, and those with less than six months of experience were excluded.

Questionnaire: A standardized questionnaire, developed and validated by infectious disease and public health experts, was administered through face-to-face interviews from September 2024 to March 2025. It comprised four sections: demographic data (age, sex, profession, years of experience, and employment status); familiarity with AMR (six items assessing knowledge of correct antibiotic use, the definition of AMR, and its impact); attitudes toward AMR (eight items assessing perceptions of AMR as a public health threat and confidence in antibiotic decision-making); and self-reported antibiotic-use practices (seven items on adherence to prescribing guidelines, patient counselling, and prescribing for viral infections). Interviews were conducted during working hours and lasted 10–15 minutes.

Ethical Considerations: This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the College of Medicine, Hawler Medical University, with formal permission granted by the Erbil Health Directorate and the administrations of the participating hospitals. Written informed consent was obtained from all participants before data collection, and their anonymity and confidentiality were maintained throughout the study. Participation was voluntary, and participants were informed of their right to withdraw at any time.

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Statistical Analysis: Data were analyzed using SPSS version 27. Descriptive statistics (means, standard deviations, frequencies, and percentages) were used to summarize demographic characteristics and knowledge, attitude, and practice scores. Chi-square tests were used to assess associations between categorical variables, such as profession and guideline adherence, and t-tests and one-way ANOVA were used to compare mean scores across groups. A P-value <0.05 was considered statistically significant.

Results

Demographic Characteristics of Participants

Of the 408 healthcare workers enrolled, ages ranged from 19 to 99 years (mean 34.0 ± 8.6 years), with the largest proportion aged 20–30 years (40.9%), followed by 31–40 years (37.3%), 41–50 years (16.7%), and 51–60 years (5.1%) (Table 1). Years of professional experience ranged from 1 to 35 (mean 10.3 ± 8.1), with the largest group reporting 0–5 years of experience (37.7%), followed by 11–15 years (25.5%), 6–10 years (15.9%), more than 21 years (13.2%), and 16–20 years (7.6%). Physicians (38.5%) and nurses (30.1%) were the most represented professions, followed by pharmacists (18.1%) and dentists (13.2%). Most participants (83.8%) held permanent positions, with smaller proportions on contract (6.4%), volunteering (6.1%), or in other arrangements (3.7%). The sample comprised 219 females (53.7%) and 189 males (46.3%) (Figure 1).

Knowledge of Antimicrobial Resistance (AMR)

Knowledge of AMR varied among participants (Table 2). Most (82.4%) correctly identified prevention of post-operative infection as an appropriate use of antibiotics; however, misconceptions persisted, including the belief that antibiotics are effective against colds or flu (6.6%), acne (3.7%), or fever of any cause (7.4%). Only 31.6% of participants reported being "very familiar" with the concept of AMR, 52.2% "somewhat familiar," and 16.2% "not familiar." Most participants (72.8%) correctly defined AMR as the inability of drugs to kill the microorganisms they were designed to target, although 48.8% incorrectly identified the development of new antibiotics as a consequence of AMR. Just over half (52.2%) correctly recognized that antimicrobial overuse contributes to AMR by creating selective pressure that favors resistant organisms.

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Table 1. Demographic characteristics of study participants (N=408)

Demographic Variable	Category	Frequency (N)	Precentage (%)
A. Age (years)	20–30	167	40.9
	31–40	152	37.3
	41–50	68	16.7
	51–60	21	5.1
	Total	408	100
B. Years of experience	0–5	154	37.7
	6–10	65	15.9
	11–15	104	25.5
	16–20	31	7.6
	>21	54	13.2
	Total	408	100
C. Profession	Physician	157	38.5
	Pharmacist	74	18.1
	Dentist	54	13.2
	Nurse	123	30.1
	Total	408	100
D. State of employment	Permanent	342	83.8
	Contract	26	6.4
	Volunteer	25	6.1
	Other (specify)	15	3.7
	Total	408	100

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Table 2. Participants' understanding of antimicrobial resistance (AMR)

AMR Knowledge Domain	Specific Understanding / Belief	% of Participants
1. Appropriate antibiotic use	Correct: to prevent infections after surgery	82.4
	Incorrect: to treat colds or flu	6.6
	Incorrect: to treat acne	3.7
	Incorrect: to treat any fever	7.4
2. Familiarity with the AMR concept	Very familiar	31.6
	Somewhat familiar	52.2
	Not familiar	16.2
3. Correct definition of AMR	Correct: microorganisms can no longer be killed by drugs designed to kill them	72.8
4. Misconception about AMR's impact	Incorrect belief: development of new antibiotics is a consequence of AMR	48.8
5. Overuse contribution to AMR	Correct: overuse creates selective pressure for resistant bacteria to survive	52.2

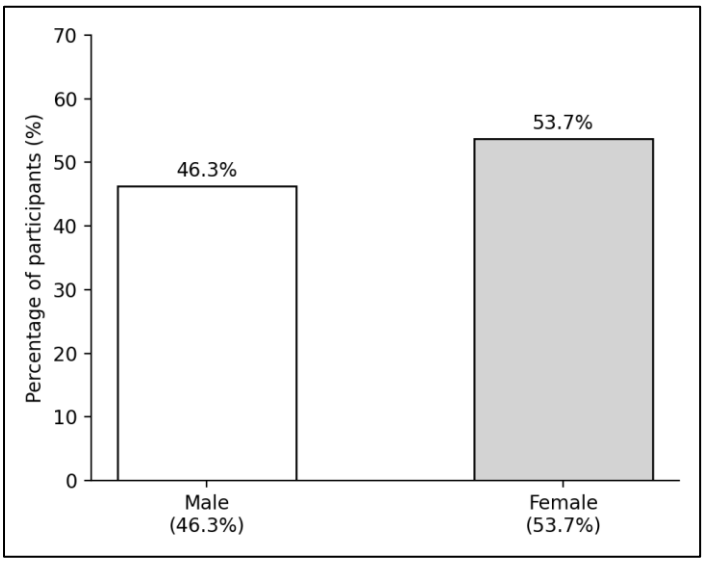

Figure 1. Distribution of gender among study participants (N=408)

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Self-Reported Practices Related to AMR

Self-reported practices also varied (Table 3). Only 29.2% of participants reported "always" following national or local antibiotic-prescribing guidelines, while 44.6% reported doing so "sometimes," 15.2% "rarely," and 11.0% "never." Most participants (75.2%) had encountered patients who self-medicated with antibiotics. While 59.1% reported routinely discussing appropriate antibiotic use with patients, 27.5% admitted to having prescribed antibiotics for a viral infection (e.g., cold or flu) at least occasionally, and 77.7% reported discussing alternative treatment options with patients requesting antibiotics. More than half (56.1%) reported not having access to AMR guidelines at their workplace, and 71.1% had never participated in AMR- or antimicrobial-stewardship-related training.

Table 3. Self-reported practices on antibiotic use and AMR among HCWs

Practice Area	Specific Finding	% of Participants
1. Following prescribing guidelines	Always follows guidelines	29.2
	Sometimes follows guidelines	44.6
	Rarely follows guidelines	15.2
	Never follows guidelines	11.0
2. Patient self-medication	Encountered patients who self-medicated with antibiotics	75.2
3. Discussing proper use	Routinely discusses proper antibiotic use with patients	59.1
4. Prescribing for viral infections	Admitted to prescribing antibiotics for a viral infection	27.5
5. Discussing alternative treatments	Discusses alternative treatments with patients requesting antibiotics	77.7
6. Access to AMR guidelines	Does not have access to AMR guidelines at the workplace	56.1
7. Participation in AMR education	Never participated in AMR/antibiotic-stewardship programs	71.1

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Comparison of Knowledge and Practices among Professions

Adherence to antibiotic-prescribing guidelines differed significantly by profession (P <0.001) (Table 4). Physicians reported the highest adherence, with 38.3% always and 49.0% sometimes following guidelines. Dentists most often reported following guidelines "sometimes" (59.3%), although their "always" rate (22.2%) was lower than that of physicians. Pharmacists showed moderate adherence (31.1% always, 41.9% sometimes), while 27.1% reported rarely or never following guidelines. Nurses showed the lowest adherence, with 46.4% reporting rarely or never following guidelines and only 19.5% reporting always doing so.

The frequency of discussing proper antibiotic use with patients also varied significantly by profession (P<0.001) (Table 5): pharmacists (73.0%), dentists (66.7%), and physicians (63.7%) reported the highest rates, compared with 41.5% among nurses.

Table 4. Distribution of adherence to antibiotic-prescribing guidelines by profession

Profession	Never (%)	Rarely (%)	Sometimes (%)	Always (%)	Total (%)	P value
Physician	5.1	7.6	49.0	38.3	100.0	<0.001
Pharmacist	12.2	14.9	41.9	31.1	100.0	
Dentist	13.0	5.6	59.3	22.2	100.0	
Nurse	17.1	29.3	34.1	19.5	100.0	
Overall	11.0	15.2	44.6	29.2	100.0	

Table 5. Frequency of discussing the importance of proper antibiotic use with patients, by profession

Profession	Yes (%)	No (%)	Sometimes (%)	P value
Physician	63.7	5.7	30.6	P<0.001
Pharmacist	73.0	5.4	21.6	
Dentist	66.7	3.7	29.6	
Nurse	41.5	22.0	36.6	
Overall	59.1	10.3	30.6	

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Prescribing antibiotics for viral infections differed significantly across professions (P <0.001) (Table 6). Nurses reported the highest rate of having prescribed antibiotics for viral infections (44.7%), more than twice the rate reported by physicians (20.4%) and pharmacists (21.6%).

Access to AMR guidelines at the workplace did not differ significantly across professions (P = 0.079) (Table 7); however, the majority of respondents overall (56.1%) reported lacking access to these guidelines, indicating a systemic barrier affecting antimicrobial stewardship regardless of profession.

Table 6. Frequency of prescribing antibiotics for viral infections (e.g., cold, flu) by profession

Profession	Yes (%)	No (%)	Rarely (%)	P value
Physician	20.4	52.9	26.8	<0.001
Pharmacist	21.6	55.4	23.0	
Dentist	16.7	70.4	13.0	
Nurse	44.7	33.3	22.0	
Overall	27.5	49.8	22.8	

Table 7. Access to AMR guidelines at the workplace by profession

Profession	Yes (%)	No (%)	P value
Physician	37.6	62.4	0.079
Pharmacist	44.6	55.4	
Dentist	40.7	59.3	
Nurse	52.8	47.2	
Overall	43.9	56.1	

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Perceptions of healthcare workers' contribution to the spread of AMR varied significantly by profession (P <0.001) (Table 8). Physicians were most likely to accept this responsibility (86.0%), while nurses were least likely (43.1%), with a substantial proportion of nurses uncertain or in disagreement.

Knowledge scores also differed significantly among professions (one-way ANOVA, P <0.001) (Table 9). Physicians recorded the highest mean knowledge score (4.65 ± 1.12), followed by dentists (3.80 ± 1.17) and pharmacists (3.70 ± 1.58); nurses recorded the lowest mean score (2.06 ± 1.19).

Table 8. Perception of healthcare workers' contribution to the spread of AMR, by profession

Profession	Yes (%)	No (%)	Not sure (%)	P value
Physician	86.0	5.1	8.9	<0.001
Pharmacist	73.0	12.2	14.9	
Dentist	72.2	14.8	13.0	
Nurse	43.1	30.1	26.8	
Overall	68.9	15.2	15.9	

Table 9. One-way ANOVA test results for knowledge score by profession

Profession	Mean Knowledge Score	SD	P value
Physician	4.65	1.12	<0.001
Dentist	3.80	1.17	
Pharmacist	3.70	1.58	
Nurse	2.06	1.19	
Overall	3.58	—	

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Discussion

This study offers insight into the knowledge, attitudes, and self-reported practices of healthcare workers in Erbil, Iraq, regarding antibiotic use, and highlights marked differences between professions. Physicians demonstrated the strongest knowledge of AMR, consistent with previous research linking higher education and specialized clinical experience to a better understanding of resistance mechanisms (10, 14). Even so, some physicians held misconceptions about appropriate antibiotic use, underscoring the need for ongoing education across all professional groups.

Nurses showed the lowest levels of knowledge and the least favorable practices: they were less likely to follow prescribing guidelines, more likely to prescribe antibiotics for viral infections that do not require them, and less likely to counsel patients on appropriate antibiotic use (19). Because nurses play a central role in patient care, these gaps could meaningfully affect antimicrobial stewardship and patient outcomes. This finding is consistent with other studies reporting that nurses tend to be less aware of AMR than physicians and pharmacists (20). Demographic and occupational factors such as gender, years of experience, and working hours have also been shown to influence knowledge levels; for example, one study found that male health workers with 6–10 years of experience had significantly higher AMR knowledge scores. (11)

Pharmacists and dentists demonstrated intermediate knowledge levels. Pharmacists' relatively stronger performance compared with nurses may reflect their specialized training in pharmacology, though their knowledge remained below that of physicians, suggesting scope for further training to expand their role in antibiotic stewardship.

Limited access to AMR guidelines emerged as a common barrier across professions. Without clear institutional guidance, healthcare workers may rely on personal experience or outdated information when making prescribing decisions, increasing the risk of inappropriate use. The World Health Organization has consistently emphasized that widespread education on AMR is essential for improving prescribing practices and patient outcomes (16). Similar barriers, particularly limited guideline access and inconsistent stewardship activity, have also been reported among community pharmacists in Erbil City, suggesting that this gap is a broader feature of the local healthcare system rather than one confined to a single profession (21).

Awareness of healthcare workers' own contribution to the spread of AMR also varied by profession, with physicians most aware and nurses least aware; this

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gap may influence each group's willingness to engage in antimicrobial-stewardship initiatives. A similar pattern, in which HCWs' awareness does not reliably translate into consistent day-to-day practice, has also been documented among healthcare workers in Erbil Teaching Hospitals in other domains, such as biomedical waste management, suggesting that the gap between knowledge and routine practice is a more general feature of the local hospital workforce rather than one specific to antibiotic use (22).

Overall, these findings are consistent with earlier research showing that healthcare workers frequently have knowledge gaps and do not always use antibiotics appropriately (5, 9, 15). The differences observed across professions indicate that stewardship interventions should be tailored to the specific knowledge and practice gaps of each professional group rather than applied uniformly.

Limitations

This study has several limitations. The use of convenience sampling may limit the generalizability of the findings to all healthcare workers in Erbil City. The cross-sectional design does not allow for causal inference. Because practices were self-reported, responses may be subject to social desirability bias, potentially overestimating guideline adherence and good practice. Finally, the study was conducted exclusively in public health facilities and may not generalize to private healthcare settings.

Conclusion

This study reveals substantial disparities in the self-reported knowledge and practice of antibiotic use among healthcare workers in Erbil, Iraq, with physicians reporting the strongest performance and nurses the weakest. A high proportion of participants reported poor practices, including low adherence to prescribing guidelines and inappropriate antibiotic use for viral infections, driven in part by limited access to AMR guidelines and inadequate training. These findings highlight an urgent need for profession-specific interventions to strengthen HCWs' knowledge and practice in Erbil. Healthcare institutions should ensure ready access to up-to-date AMR guidelines and ongoing antimicrobial-stewardship training to improve patient safety, optimize antibiotic use, and help curb the spread of AMR.

Competing interest

The authors declare that they have no competing interests.

References

1. Sultan I, Rahman S, Jan AT, Siddiqui MT, Mondal AH, Haq QMR. Antibiotics, resistome and resistance mechanisms: a bacterial perspective. Front Microbiol. 2018;9:2066. DOI: 10.3389/fmicb.2018.02066

https://doi.org/10.15218/zjms.2026.028

2. Belay WY, Getachew M, Tegegne BA, Teffera ZH, Dagne A, Zeleke TK, et al. Mechanism of antibacterial resistance, strategies and next-generation antimicrobials to contain antimicrobial resistance: A review. Front Pharmacol. 2024;15:1444781.
DOI: 10.3389/fphar.2024.1444781

3. Alsoubani M, Nadimpalli ML, Doron S. How Should Health Care Respond to Threats Antimicrobial Resistance Poses to Workers? AMA J Ethics. 2024;26(5):383-9.
DOI: 10.1001/amajethics.2024.383

4. Ananth S, Adeoti AO, Ray A, Middleton PG, Ekkelenkamp M, Thee S, et al. Healthcare worker views on antimicrobial resistance in chronic respiratory disease. Antimicrob Resist Infect Control. 2025;14(1):1-12. DOI: 10.1186/s13756-024-01254-8

5. De Vita E, Segala FV, Frallonardo L, Civile G, De Scisciolo D, Novara R, et al. Knowledge, Attitudes, and Practices toward Antimicrobial Resistance among Young Italian Nurses and Students: A Multicenter, Cross-Sectional Study. Ann Glob Health. 2024;90(1):46. DOI: 10.5334/aogh.4442

6. 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. DOI: 10.3389/fpubh.2022.790892

7. Alomari A, Alkhawaldeh A, Abunaser M, Dwairi M, Jaber M, Househ M. Self-medication with antibiotics in the Middle East: a systematic review of the literature. Int J Risk Saf Med. 2024;32(1):1-13. DOI: 10.3233/JRSM-230013

8. Islam T. A Superbug in Every Bite: Eliminating Antibiotic Overuse in US Livestock Production (Doctoral dissertation).

9. Osman EA, Omer SA, Elmubarak RM, Abdelnabi M, Abdelgadir S, Ahmed DG, et al. Antibiotic resistance in Sudan: assessing the knowledge and practices of healthcare workers in Khartoum. JAC Antimicrob Resist. 2024;6(2):dlae049. DOI: 10.1093/jacamr/dlae049

10. Chukwu EE, Oladele DA, Enwuru CA, Gogwan PL, Abuh D, Audu RA, et al. Antimicrobial resistance awareness and antibiotic prescribing behavior among healthcare workers in Nigeria: a national survey. BMC Infect Dis. 2021;21:1-12. DOI: 10.1186/s12879-020-05714-9

11. Rana S, Kaur KN, Narad P, Walia K, Saeed S, Chandra A, et al. Knowledge, attitudes and practices of antimicrobial resistance awareness among healthcare workers in India: a systematic review. Front Public Health. 2024;12:1433430. DOI: 10.3389/fpubh.2024.1433430

12. Rzewuska M, Rosińczuk J, Maziak M, Gryko M, Hryniewicz W, Gniadek A. Knowledge, attitudes and self-reported practices of hospital staff regarding

https://doi.org/10.15218/zjms.2026.028

antimicrobial stewardship. Antimicrob Resist Infect Control. 2020;9:1-9. DOI: 10.1186/s13756-020-00881-x

13. Sakeena MHF, Bennett AA, McLachlan AJ. Enhancing pharmacists' role in developing countries to overcome the challenge of antimicrobial resistance: a narrative review. Antimicrob Resist Infect Control. 2018;7:1-11. DOI: 10.1186/s13756-018-0382-7

14. Ashiru-Oredope D, John K, Sagar V, Eno U, Olaolu O, Hopkins S. Survey of Healthcare Workers' Knowledge, Attitudes and Behaviors on Antibiotics, Antibiotic Use and Antibiotic Resistance in the EU/EEA, 2019. Euro Surveill. 2021;26. DOI: 10.2807/1560-7917.ES.2021.26.11.2000422

15. Barchitta M, Sabbatucci M, Furiozzi F, Iannazzo S, Maugeri A, Maraglino F, et al. Knowledge, attitudes and behaviors on antibiotic use and resistance among healthcare workers in Italy, 2019: investigation by a clustering method. Antimicrob Resist Infect Control. 2021;10:1-10. DOI: 10.1186/s13756-021-00913-9

16. Lotfinejad N, Peters A, Tartari E, Fankhauser-Rodriguez C, Pires D, Pittet D. Hand hygiene in health care: 20 years of ongoing advances and perspectives. Lancet Infect Dis. 2021;21(8):e209-e221. DOI: 10.1016/S1473-3099(20)30637-5

17. Mudenda S, Chabalenge B, Daka V, Jere E, Sefah IA, Wesangula E, et al. Knowledge, awareness, and practices of healthcare workers regarding antimicrobial use, resistance, and stewardship in Zambia: a multi-facility cross-sectional study. JAC Antimicrob Resist. 2024;6(3):dlae076. DOI: 10.1093/jacamr/dlae076

18. Nukaly HY, Aljuhani RA, Alhartani MM, Alhindi YZ, Asif U, Alshanberi AM, Alsanosi SM. Knowledge of antibiotic use and resistance among medical students in Saudi Arabia. Adv Med Educ Pract. 2024;15:501-12. DOI: 10.2147/AMEP.S462490.

19. Tacconelli E, Sifakis F, Harbarth S, Schrijver R, van Mourik M, Voss A, et al. Surveillance for control of antimicrobial resistance. Lancet Infect Dis. 2018;18(3):e99-e106. DOI: 10.1016/S1473-3099(17)30667-2

20. Tembo N, Mudenda S, Banda M, Chileshe M, Matafwali S. Knowledge, attitudes and practices on antimicrobial resistance among pharmacy personnel and nurses at a tertiary hospital in Ndola, Zambia: implications for antimicrobial stewardship programmes. JAC Antimicrob Resist. 2022;4(5):dlac107.
DOI: 10.1093/jacamr/dlac107

21. Yassen AO, Bilal AD, Ismael BS, Al-Ani AHH. Perceptions and practices of community pharmacists towards antimicrobial stewardship program in Erbil City, Iraq: A cross-sectional study. Zanco J Med Sci. 2025:423-34. DOI: 10.15218/zjms.2025.045

https://doi.org/10.15218/zjms.2026.028

22. Bilbas JZA, Al-Najjar SMO, Bilbas OAH. Knowledge, Attitudes, and Practices About Biomedical Waste Management among Healthcare Workers in Erbil Teaching Hospitals. Adv Med J. 2025;10(2):31-41. DOI: 10.56056/amj.2025.340