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Educational gaps in antimicrobial stewardship among Tunisian medical residents: a multicenter cross-sectional study

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Abstract

Background

Antimicrobial resistance (AMR) is a major global public health threat driven in part by inappropriate antibiotic prescribing. Medical residents play a central role in antimicrobial prescribing and represent an important target for antimicrobial stewardship (AMS) interventions. This study aimed to assess the knowledge, perceptions, attitudes, and self-reported practices related to antimicrobial prescribing and AMR among Tunisian medical residents.

Methods

We conducted a multicenter cross-sectional survey between June and December 2022 among medical residents practicing in three tertiary teaching hospitals in central Tunisia. A self-administered questionnaire adapted from previously published instruments assessed sociodemographic characteristics, antimicrobial prescribing knowledge, perceptions of factors influencing prescribing and AMR, and self-reported prescribing practices. Descriptive statistics were used to summarize the findings.

Results

A total of 337 medical residents participated, representing 48.4% of eligible residents. Most respondents were enrolled in medical specialties (68.5%), while only 27.0% had received antimicrobial prescribing training during the previous year. Knowledge gaps were identified in several key areas. Although most residents correctly recognized that antibiotics were not indicated for acute diarrhea (83.7%), only 52.2% appropriately rejected antibiotic use for upper respiratory tract infections. Less than half correctly identified antimicrobial dose adjustment requirements in severe renal impairment (40.0%), and 49.6% incorrectly considered methicillin-resistant *Staphylococcus aureus* susceptible to cephalosporins. Most participants perceived AMR as a major problem nationally (97.7%) and within their institutions (89.6%). Guideline availability (87.6%), colleagues' opinions (95.8%), infectious disease specialists (90.5%), and senior physicians (84.6%) were identified as major influences on prescribing decisions. More than one-third of residents (35.9%) reported prescribing antibiotics to more than one patient daily.

Conclusion

Tunisian medical residents demonstrated substantial awareness of AMR but exhibited important deficiencies in antimicrobial prescribing knowledge and limited exposure to formal AMS training. These findings highlight the need to strengthen antimicrobial stewardship education during residency, improve access to locally adapted prescribing guidelines, and promote multidisciplinary stewardship support to optimize antibiotic use and combat AMR in Tunisia.

INTRODUCTION

Antimicrobial resistance (AMR) is a major global public health challenge that threatens the effective prevention and treatment of infectious diseases worldwide (1). Inappropriate antibiotic use and suboptimal prescribing practices are recognized as major drivers of antimicrobial resistance and contribute to increased morbidity,

mortality, healthcare costs, and therapeutic failures (2–6). Strengthening antimicrobial stewardship strategies has therefore become a public health priority in many healthcare systems.

The World Health Organization has highlighted the urgent need for coordinated antimicrobial stewardship interventions, particularly in low- and middle-income countries where antibiotic regulation and stewardship resources remain limited (7, 8).

Tunisia is also facing increasing antimicrobial resistance challenges, with high levels of antibiotic consumption and rising resistance rates among several clinically important bacterial pathogens (9, 10). In response, Tunisia implemented a national action plan against antimicrobial resistance for the period 2019–2023, aligned with the One Health approach and focused on surveillance, infection prevention, rational antibiotic use, education, and public awareness (11).

Medical residents represent a key target population for antimicrobial stewardship interventions because they are frequently involved in frontline antibiotic prescribing in both hospital and outpatient settings. Inadequate knowledge, diagnostic uncertainty, and inappropriate prescribing behaviors among junior physicians may contribute to unnecessary antibiotic exposure and the emergence of antimicrobial resistance. Previous studies conducted in different countries have identified important gaps in antimicrobial prescribing knowledge, stewardship perceptions, and training among medical residents and junior physicians (12–14). Strengthening antimicrobial stewardship education during residency training may therefore play an important role in improving prescribing practices.

The present study aimed to assess the knowledge, attitudes, perceptions, and self-reported practices of Tunisian medical residents regarding antimicrobial prescribing and antimicrobial resistance in tertiary teaching hospitals in central Tunisia.

METHODS

Study design, period and setting

We conducted a cross-sectional study of all eligible medical residents over a 7-month period (from June 1st to December 31 st, 2022) in three large tertiary teaching hospitals belonging to the center of Tunisia, which were located in 2 different cities (Sousse and Kairouan).

Sahloul University Hospital, a 690-bed university teaching hospital in Sousse, Tunisia with a total number of 237 residents assigned to this facility during the study period. Farhat Hached University Hospital, a 694-bed university teaching hospital in Sousse, Tunisia with a total number of 319 residents assigned to this facility during the study period.

The Ibn Al Jazzar University Hospital in Kairouan, a 574-bed university teaching hospital in Kairouan, Tunisia with a total number of 140 residents assigned to this facility during the study period.

Study population

The term “resident” referred to doctors after qualification from medical school who were still in their training years for a specialty.

Participants eligible for the survey included all residents prescribing antibiotics in their clinical practice at the Farhat Hached and Sahloul university hospitals in Sousse, Ibn El Jazzar university hospital in Kairouan and in the Sousse primary health care centers.

Participants were recruited using a non-probability sampling method.

Medical residents from: Medical imaging, Nuclear medicine, Occupational Medicine, Community and Preventive Medicine, Forensic medicine, Medical biology, Physiology and functional investigations, Psychiatry, Paedo-psychiatry, Histo-embryology and Biochemistry were not included as they do not routinely prescribe antibiotics.

Instrument

In order to achieve the study objectives, we used a self-administered questionnaire in French, inspired by questionnaires used in the literature. In the absence of a validated measurement instrument, we adapted the questionnaire designed by Pulcini et al (12) and García et al (13).

The questionnaire was distributed in paper format and was submitted in a pilot test to ten residents in May 2022, to check the clarity of the questions and to reword two questions to make them more comprehensible.

Knowledge was measured using ten questions, divided into three case-based questions addressed the choice of antimicrobials and five questions on the properties of ATBs and two questions on bacterial resistance to antibiotics.

Declared practices were determinate using three questions relating to the antimicrobial prescribing of medical residents.

Eight questions were asked related to perceptions of factors influencing antimicrobial prescribing and antimicrobial resistance.

We also asked for information about participants’ gender, age, clinical specialty, years of clinical experience and training on antibiotics in the past year.

Statistical analysis

The data collected was entered and analyzed using SPSS version 27.0 statistical software (SPSS: Statistical Package for the Social Sciences). Qualitative variables were summarized as absolute frequencies (n) and relative frequencies (%). The normality of the distribution was tested by the Kolmogorov-Smirnov test. Quantitative variables with a normal distribution were expressed as means ± standard deviation.

Ethical considerations

Ethical approval

was obtained from the Ethics Committee of the Faculty of Medicine of Sousse (reference: CEFMSo_0165_2025), which covers all participating study sites.

The committee reviewed the study protocol after completion of data collection and confirmed that, given the anonymous and non-interventional design, the study posed minimal risk to participants.

The committee approved the study and the consent procedure: participants received an information sheet explaining the study objectives, and verbal consent was obtained prior to questionnaire completion. Informed consent was obtained verbally and documented by the investigators; voluntary completion and submission of the anonymous questionnaire were considered evidence of consent. Data were collected anonymously, and no identifiable personal information was recorded.

RESULTS

Sociodemographic and academic characteristics of respondents

A total of 337 medical residents filled in the questionnaire, corresponding to 48.4% of all targeted residents, with almost half (44.5%) from Farhat Hached University Hospital, a quarter (25.2%) from Ibn Jazzar University Hospital and a quarter (24.6%) from Sahloul University Hospital. Medical specialties accounted for the majority of respondents (68.5%). Less than one-third of respondents (27%) had attended training on antibiotic prescription last year. Table I gives an overview of demographic and academic characteristics of participants.

Medical residents' knowledge on AM prescription

The residents were asked if antibiotic prescription was justified in two clinical scenarios encountered frequently in routine ambulatory settings: acute diarrhea and upper respiratory tract infections.

Most respondents did not justify use of antibiotics for acute diarrhea (n = 282, 83.7%) and only half of them for upper respiratory tract infections (n = 176, 52.2%).

The need to reduce the dose of AM in a patient with severe renal failure was assessed by presenting two clinical cases. Less than half of the respondents (40%) correctly identified the need to reduce the dose of antibiotics in case of severe renal failure. The majority of respondents incorrectly indicated a dose adjustment for the 2 cases (n = 144, 42.7%).

In addition, most participants (79.5%) correctly answered that metronidazole is active against anaerobes but less than half (n = 153, 45.4%) correctly answered that ceftriaxone is the most effective drug to cross the blood-brain barrier. Almost half of the participants (49.6%) answered incorrectly that *Methicillin-Resistant Staphylococcus aureus* (MRSA) is susceptible to cefalotin, cefuroxime or ceftriaxone.

More details about antibiotic prescribing knowledge among respondents are shown in table II.

Medical residents' perceived factors influencing antibiotic prescribing and antimicrobial resistance

Participants mostly considered that antimicrobial resistance was a significant problem at national level (97.7%), at their institution (89.6%), and for their daily practice (78.6%).

Immunocompromised patient conditions (86.4%) and outpatient expectations and preferences (84.4%) were the most patient-related factors perceived as influencing antibiotic prescribing.

Colleagues (95.8%), infectiologists (90.5%) and seniors (84.6%) opinions were the most physician-related factors perceived as influencing antibiotic prescribing. However, guidelines availability (87.6%) was the most health system-related factors perceived as influencing antibiotic prescribing according to Tunisian medical residents (Table III).

Poor hand hygiene by healthcare providers (37.7%) and excessive use of antibiotics in animal husbandry (52.8%) were the least perceived factors contributing to antimicrobial resistance.

Medical residents' practices regarding antibiotic prescription

Almost a third (35.9%) of medical residents usually prescribes antibiotics to more than one patient a day. However, 22.3% of respondents prescribe an average of one to 2 patients per week. More than half of medical residents (56.10%) occasionally consulted a senior doctor for advice before prescribing antibiotics, 11.3% did so systematically before prescribing and 3.6% never consulted a senior doctor for advice before prescribing.

More than half of respondents (63.5%) felt that their opinion on antibiotic prescribing was in line with that of their senior (Table IV).

DISCUSSION

This multicenter study provides updated data on Tunisian medical residents' knowledge, attitudes, and practices regarding antimicrobial prescribing and antimicrobial resistance. Our findings revealed important gaps in antimicrobial prescribing knowledge, particularly regarding upper respiratory tract infections, antimicrobial dose adjustment in renal impairment, and MRSA. In addition, only a minority of participants reported recent training in antimicrobial prescribing. These findings highlight substantial opportunities for strengthening antimicrobial stewardship education among junior physicians in Tunisian teaching hospitals.

To our knowledge, this is one of the few studies exploring antimicrobial prescribing perceptions and practices among medical residents in Tunisia. Compared with previous local data (15), our study provides a broader multicenter overview involving several tertiary teaching hospitals and may contribute to informing locally adapted antimicrobial stewardship interventions.

Only one-quarter of participants reported having received recent training in antimicrobial prescribing, a proportion substantially lower than that reported in studies conducted in high-income countries (12). This limited exposure to antimicrobial stewardship education may partly explain the knowledge gaps identified in our study. Previous studies have shown that targeted educational interventions can improve prescribing practices and reduce inappropriate antibiotic use, particularly in resource-limited settings (16,17). Strengthening structured antimicrobial stewardship training during residency may therefore represent an important strategy to improve prescribing quality and support national efforts to combat antimicrobial resistance in Tunisia.

Residents' practices

More than half of the surveyed residents reported prescribing antibiotics on a daily basis, reflecting the central role of junior physicians in antimicrobial use within teaching hospitals. Similar findings have been reported in other low- and middle-income settings, where high antibiotic prescribing frequency may be related to limited stewardship resources, diagnostic uncertainty, and heavy clinical workload (17). Given the important contribution of prescribing pressure to antimicrobial resistance, these findings further support the need for targeted stewardship interventions among medical residents.

Residents' knowledge

Most participants correctly recognized that antibiotics were not indicated for acute diarrhea. However, nearly half still considered antibiotic treatment appropriate for upper respiratory tract infections, despite the predominantly viral etiology of these conditions. Similar findings have been reported in several international studies and suggest persistent misconceptions regarding appropriate antibiotic use for common community-acquired infections (13). Inappropriate prescribing for upper respiratory tract infections remains an important contributor to unnecessary antibiotic exposure and may promote the emergence of antimicrobial resistance.

Almost half of participants demonstrated inadequate knowledge regarding MRSA susceptibility patterns. This finding is concerning given the major clinical and epidemiological importance of MRSA in both hospital and community settings. Similar deficiencies have been reported in other low-resource settings (18-20), suggesting that knowledge gaps related to resistant pathogens remain common among junior physicians. Improving education on antimicrobial spectra and resistance mechanisms should therefore be considered a priority within residency training programs.

Our findings also revealed insufficient knowledge regarding antimicrobial dose adjustment in patients with renal impairment. Inappropriate dosing in this population may increase the risk of toxicity, treatment failure, and selection of resistant organisms. Similar difficulties have been described among medical trainees in other countries and may reflect insufficient practical training in antimicrobial pharmacology during undergraduate and postgraduate education (21). Integrating antimicrobial dosing principles into stewardship education programs may help address this gap.

Medical residents' perceptions

While most residents perceived antimicrobial resistance as a major national public health issue, fewer considered it a significant problem in their own daily clinical practice. Similar findings have been observed in previous international studies and may reflect a tendency among clinicians to perceive antimicrobial resistance as a distant or collective problem rather than an immediate consequence of individual prescribing behavior (12,17). This perception gap may represent an important barrier to effective antimicrobial stewardship implementation.

***Perceptions of factors influencing antimicrobial prescribing**

Several patient-, physician-, and health system-related factors may influence antimicrobial prescribing behaviors among junior physicians.

Patient related factors:

Our findings suggest that patient expectations and preferences, particularly in outpatient settings, may substantially influence antibiotic prescribing among medical residents. Similar observations have been reported in previous studies, where physicians practicing primary care or ambulatory medicine were more likely to prescribe antibiotics in response to perceived patient expectations and diagnostic uncertainty (22-24). Time constraints during consultations, fear of patient dissatisfaction, and concern about missing bacterial infections may further contribute to inappropriate prescribing behaviors (25,26). In addition, some physicians may underestimate the contribution of outpatient antibiotic prescribing to antimicrobial resistance, thereby reducing their perception of individual responsibility in stewardship efforts (27,28). These findings highlight the importance of communication skills training and behavioral stewardship interventions aimed at supporting clinicians in managing patient expectations while promoting appropriate antibiotic use.

Physician-relatedfactors

Our results suggest that antimicrobial prescribing decisions among Tunisian residents are strongly influenced by colleagues, infectious diseases specialists, and senior physicians. Previous studies have shown that prescribing behaviors are shaped not only by clinical knowledge but also by hierarchical relationships, local prescribing culture, and perceived social expectations within healthcare teams (29-31). Junior physicians may therefore experience difficulty challenging inappropriate prescribing practices, particularly in settings where antimicrobial stewardship programs remain insufficiently structured (32-34). These findings highlight the importance of multidisciplinary stewardship approaches involving senior clinicians, infectious diseases specialists, and pharmacists.

Health system-related factors

The availability of clinical guidelines and local protocols was perceived by participants as one of the main factors influencing antimicrobial prescribing. This finding highlights the importance of accessible and context-adapted prescribing tools in supporting appropriate antibiotic use among junior physicians. Similar observations have been reported in other low- and middle-income settings (17,20,35), where the lack of local stewardship guidance may contribute to variability and inappropriate prescribing practices. Strengthening the dissemination and implementation of locally adapted antimicrobial prescribing guidelines may therefore represent an important component of stewardship interventions in Tunisian hospitals.

***Factors contributing to antimicrobial resistance**

A substantial proportion of participants did not perceive poor hand hygiene as an important contributor to antimicrobial resistance. This finding suggests that antimicrobial resistance may still be primarily viewed as a prescribing issue rather than a broader infection prevention and control challenge (12,20). However, inadequate hand hygiene contributes to the transmission of resistant microorganisms within healthcare settings and remains a key component of antimicrobial resistance prevention strategies (36). Strengthening awareness regarding the relationship between infection prevention practices and antimicrobial resistance should therefore be integrated into antimicrobial stewardship education programs.

Strengths and limitations

This study has several strengths, including its multicenter design, relatively large sample size, and focus on medical residents from different teaching hospitals, providing updated insights into antimicrobial stewardship

perceptions in Tunisia.

Nevertheless, this study also has several limitations. First, the use of convenience sampling may limit the generalizability of our findings to all Tunisian medical residents. Second, the cross-sectional design relied on self-reported practices and perceptions, which may have introduced recall bias and social desirability bias. In addition, because questionnaires were not completed under direct supervision, some participants may have consulted external resources before answering knowledge-related questions. Finally, this study focused exclusively on medical residents and did not include senior physicians, whose prescribing practices and supervision may substantially influence junior doctors' prescribing behaviors.

In conclusion, this study identified important gaps in antimicrobial prescribing knowledge and stewardship-related perceptions among Tunisian medical residents. Despite a high level of awareness regarding antimicrobial resistance as a public health problem, deficiencies persisted in several key areas of antimicrobial prescribing practice. These findings highlight the need for strengthened antimicrobial stewardship education, improved access to local prescribing guidelines, and greater multidisciplinary support within teaching hospitals. Developing locally adapted stewardship interventions targeting junior physicians may contribute to more appropriate antibiotic use and help address the growing burden of antimicrobial resistance in Tunisia.

Declarations

Authors' contributions:

OE suggested research question, wrote this manuscript and submitted it for publication.

SZ conducted the fieldwork, administered the questionnaire, and collected the study data.

ND designed the statistical analysis plan.

NO, AA and SC performed the statistical analysis and contributed to data interpretation.

MA, WH and MM reviewed the manuscript.

All authors critically revised and approved the final manuscript prior to submission.

Data availability

Zenodo: Antimicrobial Resistance and Prescribing: Knowledge, Attitudes, and Practices Among Tunisian Medical

Residents. https://doi.org/10.5281/zenodo.17349214 .

Underlying data

This project contains the following underlying data: BASE SPSS ATB.sav

Data are available under the terms of the Creative Commons Zero "No rights reserved" data waiver (CC BY 4.0 Public domain dedication).

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References

1. Aslam B, Wang W, Arshad MI, Khurshid M, Muzammil S, Rasool MH, et al. Antibiotic resistance: a rundown of a global crisis. Infect Drug Resist. 2018;11:1645–58.
2. Antibiotic resistance threats in the United States, Prevention (U.S.); National Center for Emerging Zoonotic and Infectious Diseases (U.S.). 2019. Centers for Disease Control and. Division of Healthcare Quality Promotion. Antibiotic Resistance Coordination and Strategy Unit. 2019. Available online:https://stacks.cdc.gov/view/cdc/82532
3. Lemaoui CE, Layaida H, Badi A, Foud N. Stratégies actuelles de lutte contre la résistance aux antibiotiques. J Anti Infectieux. 2017;19(1):12–9.
4. World Health Organization Regional Office for Europe and European Centre for Disease Prevention and Control. Antimicrobial resistance surveillance in Europe 2022–2020 data. Copenhagen: WHO Regional Office for Europe; 2022. - eng.pdf?sequence = 1&isAllowed = y. https://iris.who.int/bitstream/handle/10665/351141/9789289056687.
5. Taylor J, Hafner M, Yerushalmi E, Smith R, Bellasio J, Vardavas R et al. Estimating the economic costs of antimicrobial resistance: Model and Results. RAND Corporation. 2014. Available online: https://www.rand.org/pubs/research_reports/RR911.html
6. Review on Antimicrobial Resistance. Antimicrobial Resistance: Tackling a Crisis for the Health and Wealth of Nations. 2014. Available at:https://amr- review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of %20nations_1.pdf.
7. Organisation mondiale de la santé. Premier rapport de l'OMS sur la résistance aux antibiotiques: une menace grave d'ampleur mondiale. Available online: https://www.who.int/fr/news/item/30-04-2014-who-s-first-global-report-on- antibiotic-resistance-reveals-serious-worldwide-threat-to-public-health
8. Salam MA, Al-Amin MY, Salam MT, Pawar JS, Akhter N, Rabaan AA, Alqumber MAA. Antimicrobial Resistance: A Growing Serious Threat for Global Public Health. Healthc (Basel). 2023;11(13):1946.
9. Klein EY, Van Boeckel TP, Martinez EM, Pant S, Gandra S, Levin SA, et al. Global increase and geographic convergence in antibiotic consumption between 2000 and 2015. Proc Natl Acad Sci U S A. 2018;115(15):E3463–70.
10. de Société T. Pathologie Infectieuse.L'antibio-résistance en Tunisie LART données 2015–2017. Available online: https://www.infectiologie.org.tn/resistance.php
11. Ministère, de la Santé. Ministère de l'Agriculture, des Resources Hydrauliques et de la Pêche. Plan d'Action National de lutte contre la résistance aux antimicrobiens en Tunisie 2019–2023. République Tunisienne - Ministère de la santé (2019). Available online: https://www.reactgroup.org/wp-content/uploads/2022/01/Tunisia.pdf
12. Pulcini C, Williams F, Molinari N, Davey P, Nathwani D. Junior doctors' knowledge and perceptions of antibiotic resistance and prescribing: a survey in France and Scotland. Clin Microbiol Infect. 2011;17(1):80–

7.
13. García C, Llamocca LP, García K, Jiménez A, Samalvides F, Gotuzzo E, et al. Knowledge, attitudes and practice survey about antimicrobial resistance and prescribing among physicians in a hospital setting in Lima, Peru. BMC Clin Pharmacol. 2011;11:18.
14. Huong Thi LV, Thuy Thi TP, Yen Hai D, Quan Anh T, Hong Khanh N, Tu Thi CN, et al. Antibiotic prescribing practices of medical doctors in a resource-limited setting and the influence of individual perceptions and stewardship support: a survey in three tertiary hospitals in Vietnam. JAC Antimicrob Resist. 2024;6(2). 10.1093/jacamr/dlae064.
15. Ben Rejeb M, Marzougui L, Ben Fradj M, Bouallègue O, Said-Latiri H. Résistance bactérienne et prescription antibiotique: perceptions, attitudes et connaissances d'un échantillon de médecins hospitaliers. Étude au CHU Sahloul – Sousse – Tunisie. Rev Epidemiol Sante Publique. 2014;62(S5):S230–1.
16. Taborda JCM, Montaño Guzmán JCM, Higuita-Gutiérrez LF. Understanding antibiotic knowledge, attitudes, and practices: a cross-sectional study in physicians from a Colombian region, 2023. BMC Med Educ. 2024;24:380.
17. Chaw PS, Schlinkmann KM, Raupach-Rosin H, Karch A, Pletz MW, Huebner J. Knowledge, attitude and practice of Gambian health practitioners towards antibiotic prescribing and microbiological testing: a cross-sectional survey. Trans R Soc Trop Med Hyg. 2017;111(3):117–24.
18. Guo Y, Song G, Sun M, Wang J, Wang Y. Prevalence and Therapies of Antibiotic- Resistance in *Staphylococcus aureus*. Front Cell Infect Microbiol. 2020;10:107.
19. Rhim H, Ben Trad R, Haddad O, Kadri Y, Mastouri M. Comparative study of multidrug-resistant bacterial infections in hospitals and community settings in the region of Monastir - Tunisia. Tunis Med. 2022;100(5):390–5.
20. Thriemer K, Katuala Y, Batoko B, Alworonga J-P, Devlieger H, Van Geet C, et al. Antibiotic Prescribing in DR Congo: A Knowledge, Attitude and Practice Survey among Medical Doctors and Students. PLoS ONE. 2013;8(2):e55495.
21. Deskur-Smielecka E, Kotlinska-Lemieszek A, Kropinska S, Wieczorowska-Tobis K. Medical Students' and Internal Medicine Trainees' Knowledge of Drug Prescribing Recommendations in Older Patients with Impaired Kidney Function. Clin Interv Aging. 2020;15:53–60.
22. Md Rezal RS, Hassali MA, Alrasheedy AA, Saleem F, Md Yusof FA, Godman B. Physicians' knowledge, perceptions and behaviour towards antibiotic prescribing: a systematic review of the literature. Expert Rev Anti Infect Ther. 2015;13(5):665–80.
23. Butler CC, Rollnick S, Pill R, Maggs-Rapport F, Stott N. Understanding the culture of prescribing: qualitative study of general practitioners' and patients' perceptions of antibiotics for sore throats. BMJ. 1998;317(7159):637–42.
24. Wester CW, Durairaj L, Evans AT, Schwartz DN, Husain S, Martinez E. Antibiotic resistance: a survey of physician perceptions. Arch Intern Med. 2002;162(19):2210–6.
25. Mohan S, Dharamraj K, Dindial R, Mathur D, Parmasad V, Ramdhanie J, et al. Physician behaviour for antimicrobial prescribing for paediatric upper respiratory tract infections: a survey in general practice in Trinidad, West Indies. Ann Clin Microbiol Antimicrob. 2004;3:11.
26. Grossman Z, del Torso S, Hadjipanayis A, van Esso D, Drabik A, Sharland M. Antibiotic prescribing for upper respiratory infections: European primary paediatricians' knowledge, attitudes and practice. Acta Paediatr.

2012;101(9):935–40.
27. Béjean S, Peyron C, Urbinelli R. Variations in activity and practice patterns: a French study for GPs. Eur J Health Econ. 2007;8(3):225–36.
28. Tähtinen PA, Boonacker CWB, Rovers MM, Schilder AGM, Huovinen P, Liuksila PR, et al. Parental experiences and attitudes regarding the management of acute otitis media–a comparative questionnaire between Finland and The Netherlands. Fam Pract. 2009;26(6):488–92.
29. Mattick K, Kelly N, Rees C. A window into the lives of junior doctors: narrative interviews exploring antimicrobial prescribing experiences. J Antimicrob Chemother. 2014;69(8):2274–83.
30. Eyer MM, Läng M, Aujesky D, Marschall J. Overtreatment of asymptomatic bacteriuria: a qualitative study. J Hosp Infect. 2016;93(3):297–303.
31. Broom A, Broom J, Kirby E. Cultures of resistance? A Bourdieusian analysis of doctors' antibiotic prescribing. Soc Sci Med. 2014;110:81–8.
32. Pulcini C, Botelho-Nevers E, Dyar OJ, Harbarth S. The impact of infectious disease specialists on antibiotic prescribing in hospitals. Clin Microbiol Infect. 2014;20(10):963–72.
33. Cunha CB. Antimicrobial Stewardship Programs: Principles and Practice. Med Clin North Am. 2018;102(5):797–803.
34. Baadani AM, Baig K, Alfahad WA, Aldalbahi S, Omrani AS. Physicians' knowledge, perceptions, and attitudes toward antimicrobial prescribing in Riyadh, Saudi Arabia. Saudi Med J. 2015;36(5):613.
35. Pittet D, Boyce JM. Hand hygiene and patient care: pursuing the Semmelweis legacy. Lancet Infect Dis. 2001;1:9–20.
36. Hasan MM, Rana MM, Tithy TA. Antibiotics in a Changing World: Resistance, Ecology, and Public Health Conundrums. Med Sci Forum. 2023;24(1):19.

Tables

Table I: Demographic and academic characteristics of participants (N=337)

Characteristics	n (%)
Gender	
Male	109 (32.3)
Female	228 (67.7)
Age in years	
<28	150 (44.5)
28-30	128 (44.2)
>30	31 (11.3)
Specialty	
Medical specialties	259 (76.8)
Surgical specialties	52 (15.4)
Critical care/anesthesiology	26 (7.7)
Year of residency training	
First	120 (35.6)
Second	103 (30.6)
Third	72 (21.4)
Fourth	42 (12.5)
Health institutions	
Farhat Hached University Hospital	150 (44.5)
Sahloul University Hospital	93 (27.6)
Ibn Al Jazzar University Hospital	94 (27.9)
Attending training on antibiotic prescription last year	
Yes	91 (27.0)
No	240 (71.2)
Don’t know	6 (1.8)
Total	**337 (100%)**

Table II: Medical residents’ knowledge regarding antibiotic prescription (N=337)

Questions	n (%)
Treatment of non-febrilediarrhea	
Rehydration only*	**282(83.7)**
Bactrim or ciprofloxacin	55(16.3)
Treatment of a (IVAS)	
No indication for antibiotictherapy*	**176(52.2)**
Amoxicillin VO	124(36.8)
Augmention VO	27(8.0)
Bactrim VO	10(3.0)
Adapting antibiotic therapy in cases of renal failure	
Patient A	42(12.5)
Patient B*	**136 (40.4)**
Patient A and B	144 (42.7)
Neither patient A nor patient B	15 (4.5)
Authorised antibiotic therapy during pregnancy	
Amoxicillin*	**264(78.3)**
Ciprofloxacin	59(17.5)
Gentamicin	14(4.2)
The antibiotic with the best activity against anaerobes	
Metronidazole*	**268(79.5)**
Bactrim	42(12.5)
Ciprofloxacin	27(8.0)
MRSA-sensitive antibiotics	
Cefalutin	30(8.9)
Cefuroxime	35(10.4)
Ceftriaxone	102(30.3)
None of theseantibiotics*	**170(50.4)**
The most effective drug for crossing the blood-brain barrier	
Vancomycin	170(50.4)
Ceftriaxone*	**153(45.4)**
Clindamycin	14(4.2)
Inappropriate prescribing of antibiotics is associated with adverse effects	

Agreed*	**308(91.4)**
Neutral	5(1.5)
No agreement	24(7.1)

*: Correct answer

Table III: Perceptions of factors influencing antibiotic prescribing and antimicrobial resistance (N=337)

Perceptions related to	n (%)
Factors influencing antibiotic prescribing	
Patient-related factors	
Outpatient expectations and preferences	284 (84.4)
Inpatient expectations and preferences	154 (45.7)
Patients with low income	234 (69.4)
Presence of fever or leukocytosis even with negative microbiological analysis	182 (45.0)
Immunocompromised conditions	291(86.4)
Clostridium difficile colitis risk	163(48.4)
Physician-related factors	
Fear of missing an infection	259 (76.2)
Complacency	129 (38.2)
Senior advice	285 (84.6)
Colleague advice	323 (95.8)
Infectiologist advice	305 (90.5)
Pharmacist advice	145 (43.0)
Health system-related factors	
Antibiotic availability	165 (48.9)
Guidelines availability	295 (87.6)
Local protocols availability	207 (61.5)
Cost of the drug for the institution	174 (51,7)
Pharmaceutical representatives influence	192 (56.9)
Factors contributing to antimicrobial resistance	
Infection control practices related factors	
Poor hand hygiene by healthcare providers	127 (37.7)
Prescription practices related factors	
Overprescription of antibiotics	335 (99.4)
Extended duration of antibiotics	295 (87.7)
Too low dose of antibiotics	258 (76.5)
Extended use of broad spectrum antibiotics	330 (97.9)
Excessive use of antibiotics in animal husbandry	178 (52.8)
Population practices related factors	

Self-medication	329 (97.7)

Table IV: Medical residents' practices regarding antibiotic prescription (N=337)

Questions	n (%)
Antibiotic prescribing frequency	
>1 patient per day	121(35.9)
1 Patient per day	66(19.6)
1 to 2 patients per week	75(22.3)
3 to 5 patients per week	37(11.0)
>5 patients per week	27(8.0)
1 patient per month	11(3.3)
Consulting a second medical opinion	
Never	12 (3.6)
Sometimes	189 (56.1)
Often	98 (29.1)
Always	38 (11.3)
Concordance between resident's opinion and senior's opinion regarding antibiotic prescription	
Never	1 (0.3)
Sometimes	84 (24.9)
Often	214 (63.5)
Always	38 (11.3)