

The Evolution of Antibiotic Prescribing Practices in Family Medicine An Exploratory Study Amidst Rising Antimicrobial Resistance

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Abstract:

Background: Antimicrobial resistance (AMR) represents a growing global health threat, with inappropriate antibiotic prescribing practices contributing significantly to its development. Family physicians play a crucial role in combating AMR through judicious antibiotic use. This study aimed to explore the evolution of antibiotic prescribing practices among family physicians in primary health care settings in Al-Ahsa, Saudi Arabia.

Methods: A cross-sectional study was conducted using a structured questionnaire administered to 50 randomly selected family physicians from primary health care centers in Al-Ahsa. The questionnaire assessed antibiotic prescribing patterns, awareness and understanding of AMR, factors influencing prescribing decisions, and compliance with antibiotic stewardship programs. Descriptive statistics, chi-square tests, and logistic regression analyses were performed to analyze the data.

Results: The study revealed variations in antibiotic prescribing patterns across different types of infections, with penicillins commonly prescribed for respiratory infections and cephalosporins for urinary tract infections. Most physicians recognized AMR as a significant public health threat (90%) and considered AMR risks in their prescribing decisions (80%). Factors significantly associated with higher antibiotic prescribing rates included patient expectations (OR=2.5, p=0.006), peer practices/prescribing norms (OR=2.0, p=0.022), fear of clinical complications (OR=3.0, p=0.002), and previous experience with patient outcomes (OR=2.8, p=0.004). Adherence to guidelines and protocols was associated with lower prescribing rates (OR=0.5, p=0.017). Compliance with antibiotic stewardship programs varied, with high awareness (78%) but lower engagement in peer discussions (44%) and feedback on prescribing patterns (40%).

Conclusion: The study highlights the need for continued education, strengthening of antibiotic stewardship programs, addressing patient expectations, promoting public awareness, ongoing monitoring, and multidisciplinary collaboration to combat AMR effectively in primary health care settings.

Keywords: Antibiotic prescribing practices, antimicrobial resistance, family medicine, primary health care, antibiotic stewardship.

Introduction:

Family medicine serves as a cornerstone of primary health care, distinguished by its comprehensive approach to medical treatment across all ages, genders, diseases, and parts of the body [1,2]. As a primary care specialty, family medicine is uniquely positioned to address a wide range of health issues, offering continuous and holistic care that spans the

lifetime of an individual [3]. This broad mandate not only enables family practitioners to establish enduring relationships with patients but also places them at the forefront of preventive care and health maintenance [4]. The pivotal role of family medicine is further underscored by its capacity to manage both acute and chronic conditions, seamlessly integrating health promotion, disease prevention, and patient

education into daily practice [5]. By serving as the first point of contact in the healthcare system, family medicine practitioners play a crucial role in guiding patient care pathways, making timely referrals, and coordinating care with specialists, thereby optimizing health outcomes and enhancing the efficiency of the healthcare system as a whole [6].

Antibiotics are an essential component of the family medicine toolkit, pivotal for their efficacy in combating bacterial infections that patients commonly encounter, such as strep throat, urinary tract infections, and some forms of pneumonia. In family medicine, the ability to quickly and effectively treat these infections is crucial not only for the immediate health and well-being of the individual patient but also for the broader community [7]. By promptly addressing bacterial infections, family practitioners play a vital role in preventing the escalation of symptoms and reducing the potential for severe health complications [8]. Moreover, effective antibiotic use in outpatient settings like family medicine clinics can significantly deter the transmission of infectious diseases, especially in densely populated or communal living environments where the spread of bacteria can be swift and widespread [9]. This role is particularly critical in safeguarding vulnerable populations, including the elderly, young children, and those with compromised immune systems, underscoring the importance of judicious antibiotic use [10].

However, the role of antibiotics in family medicine extends beyond the mere treatment of infections; it also encompasses a larger public health responsibility [11]. The judicious prescribing of antibiotics by family practitioners is vital to mitigate the development and spread of antimicrobial resistance (AMR) [10]. Over-prescription or inappropriate use of antibiotics can lead to bacteria evolving resistance mechanisms, rendering standard treatments ineffective and leading to harder-to-treat infections [12,13]. Therefore, family physicians are often at the forefront of efforts to educate patients about the importance of proper antibiotic use and adherence to prescribed treatments [14]. This educational role is essential in fostering an understanding among patients that antibiotics are not a panacea for all ailments, particularly viral infections like the common cold or flu, and should

only be used when necessary and effective [15]. Through careful assessment and diagnosis, family practitioners ensure that antibiotics are prescribed only when absolutely indicated, thereby balancing patient care with the necessity to preserve the efficacy of these crucial drugs for future generations [16].

Antimicrobial resistance (AMR) represents a critical and growing challenge in the field of healthcare, defined as the ability of microorganisms—including bacteria, viruses, fungi, and parasites—to resist the effects of medications that were once effective in treating infections caused by them [17]. This resistance emerges primarily through the genetic adaptation of these organisms in response to their exposure to antimicrobial drugs such as antibiotics, antivirals, antifungals, and antiparasitics [18]. As these microorganisms evolve, infections become more difficult to manage and control, leading to increased risk of disease spread, prolonged illness, higher healthcare costs, and greater mortality rates [19]. The development of AMR is a natural phenomenon, but it has been significantly accelerated by human activities, particularly the inappropriate use of these drugs in clinical and agricultural settings [20].

The impact of AMR is profound and far-reaching, affecting individuals and healthcare systems worldwide. According to the World Health Organization, AMR is one of the top ten global public health threats facing humanity [21]. It is responsible for approximately 700,000 deaths annually, a number projected to soar to 10 million deaths per year by 2050 if no effective actions are taken. In countries across all income levels, resistant infections now compromise the ability to perform routine surgeries and provide effective chemotherapy, as the risk of untreatable infections becomes more common [22]. Locally, every community faces the challenges of AMR differently, depending on factors such as healthcare practices, availability of antibiotics, and public health policies. In some regions, common pathogens have already become resistant to multiple drugs, which is a dire situation comparable to returning to the pre-antibiotic era [23].

The rise in AMR can be attributed to several factors, with the overuse and misuse of antibiotics in healthcare settings being the most significant [20]. In family medicine, where the pressure to satisfy patient expectations for quick remedies is high, antibiotics may be prescribed unnecessarily for viral infections such as colds and flu, against which these drugs have no effect [24]. Additionally, improper prescribing practices, such as the use of incorrect dosages or durations for antibiotic treatments, further exacerbate the problem. The consequences of these practices in family medicine are severe [25]. Practitioners are increasingly facing scenarios where standard antibiotic treatments fail, leading to more complex and prolonged patient care strategies [26]. This not only complicates the therapeutic landscape but also burdens the healthcare system with higher costs and worse health outcomes [27]. Moreover, the erosion of effective antibiotic therapy undermines the cornerstone of modern medical practices, including the management of infections in vulnerable populations and the performance of routine and complex surgeries [28].

Methods

Setting

The study was conducted in primary health care (PHC) centers located in Al-Ahsa, Saudi Arabia. Al-Ahsa, a region known for its expansive date palm groves and being one of the largest oases in the world, is also a significant healthcare hub with a network of PHC centers serving its diverse population. These centers were chosen due to their crucial role in delivering primary health services and their accessibility to a wide demographic, making them ideal locations for studying antibiotic prescribing practices.

Design

A cross-sectional study design was utilized to examine the evolution of antibiotic prescribing practices among family physicians in the selected PHC centers in Al-Ahsa. This design was chosen because it allowed for the collection and analysis of data from a representative sample of physicians at a single point in time, providing a snapshot of current practices and attitudes towards antibiotic use. The time frame for the data collection was set during the

months of January and February 2023, which provided a sufficient window to gather comprehensive data while minimizing the influence of seasonal variations in disease prevalence and antibiotic use.

Sample and Sampling

Sample Definition

The sample for this study consisted of family physicians working in primary health care (PHC) centers across Al-Ahsa, Saudi Arabia. These individuals were targeted as they represent the frontline healthcare providers who frequently make decisions about antibiotic prescribing, and their practices directly influence the dynamics of antimicrobial resistance within the community. The study aimed to include a diverse group of physicians in terms of age, gender, years of experience, and the type of PHC center (urban vs rural) they practiced in, to ensure a comprehensive analysis of prescribing behaviors.

Sampling Method

A stratified random sampling method was employed to select participants for this study. This approach was chosen to ensure that the sample accurately reflected the distribution of family physicians across different types of PHC centers in Al-Ahsa. Each PHC center in the region was first categorized as either urban or rural based on its geographical location and the population it serves. This stratification was crucial as it acknowledged the potential differences in prescribing practices that might arise from the varying patient demographics and resource availability between urban and rural settings.

Sample Size Determination

To determine the appropriate sample size for the study, a power analysis was conducted prior to the commencement of data collection. The analysis took into account the expected effect size, the alpha error (probability of type I error), and the power (probability of detecting an effect if there is one, probability of type II error). Based on a confidence level of 95% and a power of 80%, the calculation suggested that a sample of 50 physicians would be

sufficient to detect significant differences in prescribing practices.

Participant Selection

From the comprehensive list of PHC centers operating in Al-Ahsa, 30 centers were randomly selected to participate in the study. Within each selected center, the total number of practicing family physicians was identified, and physicians were randomly selected using a computer-generated list of random numbers. This random selection was proportionate to the size of the physician staff at each center to maintain representativeness.

Inclusion and Exclusion Criteria

Inclusion criteria specified that participants must be licensed family physicians actively practicing and prescribing antibiotics at one of the selected PHC centers. Physicians were excluded from the study if they were on leave (e.g., maternity, study, or long-term sick leave) during the period of data collection, as their prescribing practices might not reflect their usual clinical behavior.

Recruitment

Physicians who met the inclusion criteria were contacted by phone or email, where the study's purpose, nature, and requirements were explained. Interested physicians were then provided with a consent form detailing the study's aims, the voluntary nature of their participation, and the confidentiality with which their responses would be treated. Upon receiving written consent, participants were scheduled for an interview session to complete the questionnaire.

Data Collection Tools

For this study, the primary tool used for data collection was a structured questionnaire developed to investigate the antibiotic prescribing practices among family physicians in primary health care centers in Al-Ahsa, Saudi Arabia. The development of the questionnaire involved several key steps to ensure it accurately captured the necessary information while being easy to understand and complete by the participants.

Design of the Questionnaire

The questionnaire was designed to gather comprehensive data on various aspects of antibiotic prescribing. It included sections on:

- **Demographic Information:** Collecting basic information about the physicians such as age, gender, years of experience, and educational background.
- **Prescribing Practices:** Questions related to the frequency of antibiotic prescriptions, the types of antibiotics commonly prescribed, and the conditions for which they are prescribed.
- **Knowledge and Attitudes towards AMR:** Assessing physicians' understanding of antimicrobial resistance, their sources of information about AMR, and their perceptions of the impact of their prescribing habits on AMR.
- **Influence of Guidelines and Training:** Investigating whether the physicians follow national or international guidelines in their prescribing practices, and the role of ongoing training and education in shaping their approaches to antibiotic use.

Validation and Reliability Testing

Before the questionnaire was deployed, it underwent a validation process:

- **Expert Review:** The questionnaire was reviewed by a panel of experts in family medicine and pharmacology to ensure that the content was medically and scientifically accurate.
- **Pilot Testing:** A pilot test was conducted with a small group of family physicians who were not part of the main study. This helped in identifying any ambiguous questions and assessing the questionnaire's clarity and the time required to complete it.

Administration of the Questionnaire

The finalized questionnaire was administered face-to-face by trained research assistants. This method was chosen to:

- **Maximize Response Rates:** Direct interaction was anticipated to enhance participation rates and encourage complete responses.

- **Ensure Clarity:** Face-to-face **administration** allowed assistants to clarify any doubts the participants might have about the questions, ensuring the accuracy of the data collected.
- **Verify Identity and Eligibility:** This approach ensured that the questionnaire was filled out by the intended participant who met the study's inclusion criteria.

Ethical Considerations

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of the local health authority in Al-Ahsa, Saudi Arabia, ensuring that all research activities adhered to national and international guidelines for ethical research involving human participants. Informed consent was a cornerstone of the data collection process. All participating family physicians were provided with detailed information about the purpose of the study, the nature of the data collection, their right to withdraw at any time without penalty, and the measures taken to ensure confidentiality and anonymity of their responses. To protect privacy, all questionnaires were coded, and no personal identifiers were included in any of the study documentation or reports. Additionally, the study's findings are to be used exclusively for academic and policy-making purposes, aimed at improving antibiotic prescribing practices and not for commercial benefit.

Data Analysis

The statistical analysis of the collected data was conducted using SPSS software, version 26. Initially, descriptive statistics such as means, standard deviations, and frequency distributions were calculated to summarize the demographic

characteristics of the participating family physicians and their antibiotic prescribing patterns. To explore relationships between categorical variables, such as age, gender, years of practice, and various prescribing behaviors, chi-square tests were employed. Additionally, logistic regression analyses were performed to identify factors that significantly influenced antibiotic prescribing decisions, adjusting for potential confounders like physician's experience and the type of health care setting (urban vs rural). The level of significance for all statistical tests was set at $p < 0.05$. This approach allowed for a thorough evaluation of the data, providing insights into the factors that drive antibiotic prescribing practices among family physicians in Al-Ahsa, and identifying potential targets for interventions to improve prescribing behavior.

Results:

The demographic characteristics of the 50 participating physicians in our study are outlined in Table 1. The age distribution shows a predominant grouping between 35 and 44 years (36%), followed closely by the 45-54 age group (30%), indicating a mid-career professional demographic. Only a smaller fraction (10%) of participants were above 55 years. Regarding gender, the majority of the physicians were male (64%), while females constituted 36% of the sample. In terms of professional experience, 34% of the physicians had been practicing for 5-10 years, and a similar proportion (30%) had 11-20 years of experience, suggesting a moderately experienced cohort. The educational background of the participants revealed that 60% held a Bachelor of Medicine, 30% had a Master's Degree, and a smaller group (10%) had attained a Doctorate or higher.

Table 1: Demographic Characteristics of Participating Physicians

Characteristic	Total (N=50)	Percentage (%)
Age		
25-34 years	12	24%
35-44 years	18	36%
45-54 years	15	30%
55+ years	5	10%
Gender		
Male	32	64%
Female	18	36%

Years of Practice		
Less than 5 years	8	16%
5-10 years	17	34%
11-20 years	15	30%
More than 20 years	10	20%
Educational Background		
Bachelor of Medicine	30	60%
Master's Degree	15	30%
Doctorate or higher	5	10%

Analysis of antibiotic prescribing practices among family physicians revealed distinct preferences for different types of infections (Table 2). Penicillins were most commonly prescribed for respiratory infections, noted in 22 of the 50 cases, reflecting their continued prominence in treating these conditions. Conversely, cephalosporins were predominantly used for urinary tract infections, with 18 out of 50 prescriptions, underscoring their efficacy and preference in urinary pathogen management. Macrolides, while generally less frequently prescribed, were still notably used for 15 respiratory cases, indicating their selective use likely driven by specific clinical criteria.

Fluoroquinolones showed a broader spectrum of use across different infections, particularly notable in urinary tract (15 cases) and other infections (10 cases), highlighting their versatility but also raising concerns regarding their role in the development of resistance. Tetracyclines were primarily prescribed for skin infections, utilized in 11 out of 17 cases, suggesting a targeted approach for dermatological conditions. Sulfonamides and other antibiotics, such as metronidazole, had more limited but focused applications, often reserved for specific conditions that align with their pharmacological profiles

Table 2: Antibiotic Prescribing Practices

Antibiotic Type	Prescribed for Respiratory Infections (N=50)	Prescribed for Urinary Tract Infections (N=50)	Prescribed for Skin Infections (N=50)	Other Infections (N=50)	Total Prescriptions
Penicillins	22	5	8	2	37
Cephalosporins	10	18	7	6	41
Macrolides	15	3	2	4	24
Fluoroquinolones	5	15	5	10	35
Tetracyclines	3	2	11	1	17
Sulfonamides	2	10	3	2	17
Others (e.g., Metronidazole)	1	1	4	8	14

The responses detailed in Table 3 illuminate the awareness and understanding of antimicrobial resistance (AMR) among family physicians in Al-Ahsa, as well as their engagement with AMR-related issues. A substantial majority of the participants (70%) reported being well-informed about AMR, and a similar proportion (60%) understood the clinical implications, which highlights a good

baseline knowledge level within the group. Impressively, 90% of the physicians recognized AMR as a significant public health threat, and 80% actively considered AMR risks in their prescribing decisions, suggesting a high level of risk perception and conscientious practice.

However, there are areas that may benefit from further development, as only 50% of the respondents regularly updated their AMR knowledge through professional training, indicating a potential gap in ongoing education. While 76% relied on clinical guidelines, which is positive, there remains room for improvement in ensuring all physicians have regular

access to and utilize these guidelines. The sense of responsibility towards controlling AMR was notably high, with 84% feeling accountable, yet active participation in AMR discussions or training was lower (64%), suggesting opportunities to enhance engagement through more structured or frequent educational programs.

Table 3: Awareness and understanding of AMR Among Physicians

Question/Statement	Agree (N, %)	Neutral (N, %)	Disagree (N, %)	Total Responses
General Knowledge				
I am well-informed about the issues surrounding AMR.	35 (70%)	10 (20%)	5 (10%)	50
I understand the clinical implications of AMR.	30 (60%)	15 (30%)	5 (10%)	50
Risk Perception				
I believe AMR is a significant threat to public health.	45 (90%)	3 (6%)	2 (4%)	50
AMR risks are frequently considered in my prescribing decisions.	40 (80%)	5 (10%)	5 (10%)	50
Sources of Information				
I regularly update my knowledge on AMR through professional training.	25 (50%)	20 (40%)	5 (10%)	50
I rely on clinical guidelines to inform my prescribing practices.	38 (76%)	7 (14%)	5 (10%)	50
Responsibility and Action				
I feel responsible for controlling AMR in my practice.	42 (84%)	6 (12%)	2 (4%)	50
I actively participate in discussions or training on AMR.	32 (64%)	10 (20%)	8 (16%)	50

The data presented in Table 4 illustrate the distribution of factors influencing antibiotic prescribing decisions among 50 family physicians. The most significant factors affecting prescribing decisions include "Previous Experience with Patient Outcomes" and "Guidelines and Protocols," with 54% and 58% of respondents citing these as major influences, respectively. This suggests that personal clinical experiences and formal guidelines play crucial roles in shaping antibiotic use practices. Conversely, "Peer Practices/Prescribing Norms" and

"Access to Diagnostic Tools" were less frequently reported as major influences, cited by only 22% and 32% of physicians respectively, indicating a moderate to low impact on decision-making. Factors like "Patient Expectations" and "Fear of Clinical Complications" also notably impacted prescribing behavior, with nearly half of the participants identifying these as major influences, highlighting the complexities that clinicians face in balancing clinical judgement with patient management and safety concerns.

Table 4: Factors Influencing Antibiotic Prescribing Decisions

Factor	Major Influence (N, %)	Moderate Influence (N, %)	Minor Influence (N, %)	No Influence (N, %)	Total Responses
Patient Expectations	21 (42%)	14 (28%)	11 (22%)	4 (8%)	50
Diagnostic Uncertainty	24 (48%)	13 (26%)	9 (18%)	4 (8%)	50
Time Pressure in Consultations	17 (34%)	19 (38%)	8 (16%)	6 (12%)	50
Peer Practices/Prescribing Norms	11 (22%)	19 (38%)	14 (28%)	6 (12%)	50
Guidelines and Protocols	29 (58%)	11 (22%)	6 (12%)	4 (8%)	50
Fear of Clinical Complications	23 (46%)	17 (34%)	6 (12%)	4 (8%)	50
Access to Diagnostic Tools	16 (32%)	23 (46%)	7 (14%)	4 (8%)	50
Previous Experience with Patient Outcomes	27 (54%)	12 (24%)	6 (12%)	5 (10%)	50

Table 5 presents data on the compliance of family physicians with various aspects of antibiotic stewardship programs within primary health care settings in Al-Ahsa, Saudi Arabia. The results indicate a high level of awareness of local antibiotic stewardship programs, with 78% of physicians reporting full compliance. However, there is variability in compliance across other factors. Participation in training sessions and adherence to

prescribing guidelines show moderate levels of full compliance at 58% and 52% respectively. The engagement in peer discussions and the use of decision support tools are less prevalent, with only 44% and 34% of physicians fully complying. Notably, feedback on prescribing patterns displays the lowest full compliance rate at 40%, with an equal percentage of physicians being only partially compliant and a significant 20% not compliant at all.

Table 5: Compliance with Antibiotic Stewardship Programs

Compliance Factor	Fully Compliant (N, %)	Partially Compliant (N, %)	Non-Compliant (N, %)	Total Responses
Awareness of Local Antibiotic Stewardship Programs	39 (78%)	9 (18%)	2 (4%)	50
Participation in Training Sessions	29 (58%)	16 (32%)	5 (10%)	50
Adherence to Prescribing Guidelines	26 (52%)	19 (38%)	5 (10%)	50
Regular Review of Antibiotic Use	27 (54%)	18 (36%)	5 (10%)	50
Engagement in Peer Discussions on Antibiotic Use	22 (44%)	23 (46%)	5 (10%)	50
Use of Decision Support Tools	17 (34%)	28 (56%)	5 (10%)	50

Feedback on Prescribing Patterns	20 (40%)	20 (40%)	10 (20%)	50
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The statistical analysis presented in Table 6 reveals several key factors associated with high antibiotic prescribing rates among physicians. Factors such as patient expectations, peer practices/prescribing norms, fear of clinical complications, and previous experience with patient outcomes showed significant associations with higher prescribing rates, as indicated by odds ratios greater than 1 and p-values less than 0.05. Specifically, the fear of clinical complications had the strongest association with high prescribing rates (OR=3.0, 95% CI 1.5-6.0, p=0.002), suggesting that physicians are more likely

to prescribe antibiotics when concerned about potential adverse outcomes. Conversely, adherence to guidelines and protocols was significantly associated with lower prescribing rates (OR=0.5, 95% CI 0.3-0.9, p=0.017), indicating that when physicians follow established guidelines, antibiotic usage decreases. Factors such as diagnostic uncertainty and access to diagnostic tools, although they had odds ratios indicating a potential increase in prescribing, were not statistically significant, suggesting that other unmeasured factors might influence these relationships.

Table 6: Statistical Analysis of Factors Associated with High Antibiotic Prescribing Rates

Factor	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Patient Expectations	2.5	1.3 - 4.7	0.006
Diagnostic Uncertainty	1.8	0.9 - 3.5	0.088
Time Pressure in Consultations	1.4	0.7 - 2.8	0.320
Peer Practices/Prescribing Norms	2.0	1.1 - 3.6	0.022
Guidelines and Protocols	0.5	0.3 - 0.9	0.017
Fear of Clinical Complications	3.0	1.5 - 6.0	0.002
Access to Diagnostic Tools	1.2	0.6 - 2.4	0.600
Previous Experience with Patient Outcomes	2.8	1.4 - 5.7	0.004

Discussion:

The findings of this exploratory study offer valuable insights into the evolution of antibiotic prescribing practices among family physicians in primary health care settings in Al-Ahsa, Saudi Arabia. The results shed light on the factors influencing prescribing decisions, the awareness and understanding of antimicrobial resistance (AMR), and the compliance with antibiotic stewardship programs.

One of the notable findings is the variation in antibiotic prescribing patterns observed across different types of infections. Penicillins were the preferred choice for respiratory infections, while cephalosporins were more commonly prescribed for urinary tract infections. This pattern aligns with established guidelines and reflects the tailored approach adopted by family physicians in selecting appropriate antibiotics based on the suspected site of

infection [29]. However, the substantial use of fluoroquinolones across a broad range of infections warrants further examination, as the widespread and indiscriminate use of these broad-spectrum antibiotics can contribute to the development of antimicrobial resistance [30].

The study revealed a generally high level of awareness and understanding of AMR among family physicians in Al-Ahsa. The majority of participants recognized AMR as a significant public health threat and considered AMR risks in their prescribing decisions. This finding is encouraging, as recognizing the gravity of the AMR crisis is a crucial first step towards implementing measures to mitigate its impact [31]. However, the study also highlighted areas for improvement, such as the need for more regular participation in AMR-related training programs and more consistent utilization of clinical

guidelines. Ongoing education and adherence to evidence-based guidelines are critical for ensuring that physicians remain up-to-date with the latest developments in AMR and implement best practices in antibiotic prescribing [32].

The analysis of factors influencing antibiotic prescribing decisions revealed a complex interplay of clinical, patient-related, and system-level factors. Previous experience with patient outcomes and adherence to guidelines and protocols emerged as the most significant influences, underscoring the importance of evidence-based decision-making and the value of clinical experience [33]. Notably, patient expectations and fear of clinical complications were also identified as major factors, suggesting that physicians may sometimes feel compelled to prescribe antibiotics due to patient demands or concerns about potential complications [34]. This finding aligns with previous research highlighting the challenges faced by physicians in managing patient expectations and balancing the need for effective treatment with the responsible use of antibiotics [35].

Interestingly, peer practices and prescribing norms were not reported as major influences, which could indicate a shift towards more individualized decision-making based on clinical evidence rather than conformity with peer practices [36]. However, this finding should be interpreted with caution, as social desirability bias may have influenced responses, and further exploration of peer influence through qualitative methods may provide additional insights.

The statistical analysis revealed significant associations between various factors and high antibiotic prescribing rates. Patient expectations, peer practices/prescribing norms, fear of clinical complications, and previous experience with patient outcomes were all positively associated with higher prescribing rates. These findings align with existing literature, which has consistently identified patient demands, peer influence, and defensive medical practices as drivers of inappropriate antibiotic prescribing [37]. Conversely, adherence to guidelines and protocols was associated with lower

prescribing rates, reinforcing the importance of evidence-based practices in promoting judicious antibiotic use [38].

The study's findings on compliance with antibiotic stewardship programs highlighted areas of strength and areas for improvement. While awareness of local stewardship programs was high, compliance varied across different aspects. Participation in training sessions and adherence to prescribing guidelines showed moderate levels of full compliance, suggesting the need for more robust implementation and monitoring mechanisms [39]. The lower levels of engagement in peer discussions, use of decision support tools, and feedback on prescribing patterns indicate potential gaps in the implementation of stewardship programs and a need for more comprehensive strategies to promote evidence-based prescribing [40].

The implications of this study are multifaceted and significant for improving antibiotic prescribing practices and combating the threat of AMR in primary health care settings. First, the findings underscore the importance of continued education and training for family physicians, with a focus on the latest developments in AMR, evidence-based prescribing guidelines, and strategies for managing patient expectations. Regular training programs and knowledge-sharing platforms can help bridge the gap between theoretical knowledge and practical implementation, leading to more judicious antibiotic use [41].

Second, the study highlights the need for strengthening antibiotic stewardship programs in primary health care settings. While awareness of these programs was high, compliance varied, indicating potential barriers or challenges in implementation. A comprehensive review of existing stewardship programs, along with input from frontline physicians, could identify areas for improvement and facilitate the development of more effective strategies tailored to the specific needs and challenges of primary care settings [42].

Third, the study emphasizes the importance of addressing patient expectations and promoting

public awareness about the responsible use of antibiotics. Collaborative efforts between healthcare providers, public health agencies, and community organizations can help educate patients about the potential risks of inappropriate antibiotic use and the importance of adhering to prescribed treatment regimens [43]. Empowering patients with accurate information can help mitigate the pressure on physicians to prescribe antibiotics unnecessarily and foster a more collaborative approach to healthcare decision-making [44].

Furthermore, the findings underscore the need for ongoing monitoring and evaluation of antibiotic prescribing practices. Regular audits and feedback mechanisms can provide valuable insights into prescribing patterns, identify areas of concern, and inform targeted interventions to promote more judicious use of antibiotics [45]. Additionally, the integration of decision support tools, such as electronic prescribing systems or clinical decision aids, can assist physicians in making evidence-based prescribing decisions and reducing the risk of inappropriate antibiotic use [46].

Lastly, the study reinforces the importance of multidisciplinary collaboration and a coordinated approach to combating AMR. Effective strategies require the involvement of various stakeholders, including healthcare providers, policymakers, researchers, and the broader community. Collaborative efforts can facilitate the development of comprehensive policies, promote the implementation of best practices, and foster a culture of responsible antibiotic use across all levels of the healthcare system [47].

Conclusion:

This exploratory study has shed light on the evolution of antibiotic prescribing practices among family physicians in primary health care settings in Al-Ahsa, Saudi Arabia. The findings reveal a generally high level of awareness and understanding of AMR, but also highlight areas for improvement, such as the need for more regular participation in AMR-related training programs and more consistent utilization of clinical guidelines.

The study identified various factors influencing antibiotic prescribing decisions, with previous experience with patient outcomes, adherence to guidelines and protocols, patient expectations, and fear of clinical complications emerging as significant influences. These findings underscore the complex interplay of clinical, patient-related, and system-level factors that shape prescribing practices.

While compliance with antibiotic stewardship programs was generally high in terms of awareness, there was variability across different aspects, such as participation in training sessions, adherence to prescribing guidelines, and engagement in peer discussions. This suggests opportunities for enhancing the implementation and monitoring of stewardship programs to promote more judicious antibiotic use.

The implications of this study are far-reaching, emphasizing the need for continued education and training, strengthening of antibiotic stewardship programs, addressing patient expectations, promoting public awareness, ongoing monitoring and evaluation, and multidisciplinary collaboration to combat the threat of AMR effectively.

By addressing the factors influencing antibiotic prescribing practices, implementing robust stewardship programs, and fostering a culture of responsible antibiotic use, primary health care settings can play a vital role in mitigating the development and spread of antimicrobial resistance, ultimately safeguarding the efficacy of these life-saving medications for future generations.

References:

1. The Future of Family Medicine: A Collaborative Project of the Family Medicine Community. *Ann Fam Med*. 2004, 2:S3–32. 10.1370/afm.130
2. Ohta R, Sano C: Implementation of the Principles of Family Medicine in Modern Family Medicine Education Needing System-Specific Approaches. *Cureus*. Published Online First: 6 November 2022. 10.7759/cureus.31177
3. Kumar R: Frequently asked questions about family medicine in India. *J Fam Med Prim Care*. 2016, 5:3. 10.4103/2249-4863.184615

4. Simon M, Baur C, Guastello S, et al.: Patient and Family Engaged Care: An Essential Element of Health Equity. *NAM Perspect*. Published Online First: 13 July 2020. 10.31478/202007a
5. Wagner EH: The role of patient care teams in chronic disease management. *BMJ*. 2000, 320:569–72. 10.1136/bmj.320.7234.569
6. Amjad A, Kordel P, Fernandes G: A Review on Innovation in Healthcare Sector (Telehealth) through Artificial Intelligence. *Sustainability*. 2023, 15:6655. 10.3390/su15086655
7. Lutfiyya MN, Henley E, Chang LF, Reyburn SW: Diagnosis and treatment of community-acquired pneumonia. *Am Fam Physician*. 2006, 73:442–50.
8. Haque M, McKimm J, Sartelli M, et al.: Strategies to Prevent Healthcare-Associated Infections: A Narrative Overview. *Risk Manag Healthc Policy*. 2020, Volume 13:1765–80. 10.2147/RMHP.S269315
9. Muteeb G, Rehman MT, Shahwan M, Aatif M: Origin of Antibiotics and Antibiotic Resistance, and Their Impacts on Drug Development: A Narrative Review. *Pharmaceuticals*. 2023, 16:1615. 10.3390/ph16111615
10. Llor C, Bjerrum L: Antimicrobial resistance: risk associated with antibiotic overuse and initiatives to reduce the problem. *Ther Adv Drug Saf*. 2014, 5:229–41. 10.1177/2042098614554919
11. Wall S: Prevention of antibiotic resistance – an epidemiological scoping review to identify research categories and knowledge gaps. *Glob Health Action*. 2019, 12:1756191. 10.1080/16549716.2020.1756191
12. Chinemerem Nwobodo D, Ugwu MC, Oliseloke Anie C, Al-Ouqaili MTS, Chinedu Ikem J, Victor Chigozie U, Saki M: Antibiotic resistance: The challenges and some emerging strategies for tackling a global menace. *J Clin Lab Anal*. 2022, 36:. 10.1002/jcla.24655
13. Uddin TM, Chakraborty AJ, Khusro A, et al.: Antibiotic resistance in microbes: History, mechanisms, therapeutic strategies and future prospects. *J Infect Public Health*. 2021, 14:1750–66. 10.1016/j.jiph.2021.10.020
14. Bergsholm YKR, Feiring M, Charnock C, Holm LB, Krogstad T: Exploring patients' adherence to antibiotics by understanding their health knowledge and relational communication in encounters with pharmacists and physicians. *Explor Res Clin Soc Pharm*. 2023, 12:100372. 10.1016/j.rcsop.2023.100372
15. Voidăzan S, Moldovan G, Voidăzan L, Zazgyva A, Moldovan H: Knowledge, Attitudes And Practices Regarding The Use Of Antibiotics. Study On The General Population Of Mureş County, Romania. *Infect Drug Resist*. 2019, Volume 12:3385–96. 10.2147/IDR.S214574
16. Dadgostar P: Antimicrobial Resistance: Implications and Costs. *Infect Drug Resist*. 2019, Volume 12:3903–10. 10.2147/IDR.S234610
17. Tang KWK, Millar BC, Moore JE: Antimicrobial Resistance (AMR). *Br J Biomed Sci*. 2023, 80:. 10.3389/bjbs.2023.11387
18. Murugaiyan J, Kumar PA, Rao GS, et al.: Progress in Alternative Strategies to Combat Antimicrobial Resistance: Focus on Antibiotics. *Antibiotics*. 2022, 11:200. 10.3390/antibiotics11020200
19. Almansour AM, Alhadlaq MA, Alzahrani KO, Mukhtar LE, Alharbi AL, Alajel SM: The Silent Threat: Antimicrobial-Resistant Pathogens in Food-Producing Animals and Their Impact on Public Health. *Microorganisms*. 2023, 11:2127. 10.3390/microorganisms11092127
20. 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. *Healthcare*. 2023, 11:1946. 10.3390/healthcare11131946
21. Prestinaci F, Pezzotti P, Pantosti A: Antimicrobial resistance: a global multifaceted phenomenon. *Pathog Glob Health*. 2015, 109:309–18. 10.1179/2047773215Y.0000000030
22. Pulingam T, Parumasivam T, Gazzali AM, et al.: Antimicrobial resistance: Prevalence, economic burden, mechanisms of resistance and strategies to overcome. *Eur J Pharm Sci*. 2022, 170:106103. 10.1016/j.ejps.2021.106103
23. Ayukekbong JA, Ntemgwa M, Atabe AN: The threat of antimicrobial resistance in developing countries: causes and control strategies. *Antimicrob Resist Infect Control*. 2017, 6:47. 10.1186/s13756-017-0208-x
24. Thakolkaran N, Shetty Av, D'Souza NR, Shetty A: Antibiotic prescribing knowledge,

- attitudes, and practice among physicians in teaching hospitals in South India. *J Fam Med Prim Care*. 2017, 6:526. 10.4103/2249-4863.222057
25. Nemr N, Kishk RM, Elsaid NMAB, Louis N, Fahmy E, Khattab S: Knowledge, attitude, and practice (KAP) of antimicrobial prescription and its resistance among health care providers in the COVID-19 era: A cross sectional study. *PLoS One*. 2023, 18:e0289711. 10.1371/journal.pone.0289711
26. Littmann J, Viens AM, Silva DS: The Super-Wicked Problem of Antimicrobial Resistance. 2020. 421–43.10.1007/978-3-030-27874-8_26
27. Byrne MK, Miellet S, McGlenn A, Fish J, Meedy S, Reynolds N, van Oijen AM: The drivers of antibiotic use and misuse: the development and investigation of a theory driven community measure. *BMC Public Health*. 2019, 19:1425. 10.1186/s12889-019-7796-8
28. Dhole S, Mahakalkar C, Kshirsagar S, Bhargava A: Antibiotic Prophylaxis in Surgery: Current Insights and Future Directions for Surgical Site Infection Prevention. *Cureus*. Published Online First: 28 October 2023. 10.7759/cureus.47858
29. Ting JY, Autmizguine J, Dunn MS, et al.: Practice Summary of Antimicrobial Therapy for Commonly Encountered Conditions in the Neonatal Intensive Care Unit: A Canadian Perspective. *Front Pediatr*. 2022, 10:10.3389/fped.2022.894005
30. Čizman M, Plankar Srovin T: Antibiotic consumption and resistance of gram-negative pathogens (collateral damage). *GMS Infect Dis*. 2018, 6:Doc05. 10.3205/id000040
31. Baraka MA, Alboghdadly A, Alshawwa S, et al.: 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, 10:878. 10.3390/antibiotics10070878
32. Tao Y, Wang Y, Zhang Y, Han Y, Feng J, Cheng H, Lin L: A qualitative study of the factors impacting implementation of the national action plan to contain antimicrobial resistance (2016–2020) in medical institutions. *BMC Health Serv Res*. 2024, 24:120. 10.1186/s12913-023-10404-y
33. Kasse GE, Humphries J, Cosh SM, Islam MS: Factors contributing to the variation in antibiotic prescribing among primary health care physicians: a systematic review. *BMC Prim Care*. 2024, 25:8. 10.1186/s12875-023-02223-1
34. AbdEl-Aty MA, Amin MT, Ahmed SM, Elsedfy GO, El-Gazzar AF: Exploring factors for antibiotic over-prescription in children with acute upper respiratory tract infections in Assiut, Egypt: a qualitative study. *Antimicrob Resist Infect Control*. 2024, 13:2. 10.1186/s13756-023-01357-2
35. Acampora M, Guasconi M, Schirotti C, et al.: Uncovering doctors' perceived barriers and facilitators of antibiotic prescribing behaviours: a qualitative study using the theoretical domains framework. *Acta Biomed*. 2023, 94:e2023265. 10.23750/abm.v94i6.15232
36. SOUMERAI SB, McLAUGHLIN TJ, AVORN J: Improving Drug Prescribing in Primary Care: A Critical Analysis of the Experimental Literature. *Milbank Q*. 2005, 83:10.1111/j.1468-0009.2005.00435.x
37. Sijbom M, Büchner FL, Saadah NH, Numans ME, de Boer MGJ: Determinants of inappropriate antibiotic prescription in primary care in developed countries with general practitioners as gatekeepers: a systematic review and construction of a framework. *BMJ Open*. 2023, 13:e065006. 10.1136/bmjopen-2022-065006
38. Giamarellou H, Galani L, Karavasilis T, Ioannidis K, Karaikos I: Antimicrobial Stewardship in the Hospital Setting: A Narrative Review. *Antibiotics*. 2023, 12:1557. 10.3390/antibiotics12101557
39. Barlam TF, Cosgrove SE, Abbo LM, et al.: Implementing an Antibiotic Stewardship Program: Guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. *Clin Infect Dis*. 2016, 62:e51–77. 10.1093/cid/ciw118
40. Suttels V, Van Singer M, Clack LC, Plüss-Suard C, Niquille A, Mueller Y, Boillat Blanco N: Factors Influencing the Implementation of Antimicrobial Stewardship in Primary Care: A Narrative Review. *Antibiotics*. 2022, 12:30. 10.3390/antibiotics12010030
41. Alam M, Saleem Z, Haseeb A, et al.:

- Tackling antimicrobial resistance in primary care facilities across Pakistan: Current challenges and implications for the future. *J Infect Public Health*. 2023, 16:97–110. 10.1016/j.jiph.2023.10.046
42. Alqahtani NS, Bilal MM, Al Margan AM, Albaghran FA, Al Sharyan AM, Alyami ASM: Assessment of Physicians' Practice in Implementing Antibiotic Stewardship Program in Najran City, Saudi Arabia: A Cross-Sectional Study. *Pharmacy*. 2024, 12:24. 10.3390/pharmacy12010024
43. Adebisi YA: Balancing the risks and benefits of antibiotic use in a globalized world: the ethics of antimicrobial resistance. *Global Health*. 2023, 19:27. 10.1186/s12992-023-00930-z
44. Ghiga I, Pitchforth E, Stålsby Lundborg C, Machowska A: Family doctors' roles and perceptions on antibiotic consumption and antibiotic resistance in Romania: a qualitative study. *BMC Prim Care*. 2023, 24:93. 10.1186/s12875-023-02047-z
45. Nsojo A, George L, Mwasomola D, Tawete J, Mbotwa CH, Mweya CN, Mwakyula I: Prescribing patterns of antimicrobials according to the WHO AWaRe classification at a tertiary referral hospital in the southern highlands of Tanzania. *Infect Prev Pract*. 2024, 6:100347. 10.1016/j.infpip.2024.100347
46. Shahmoradi L, Safdari R, Ahmadi H, Zahmatkeshan M: Clinical decision support systems-based interventions to improve medication outcomes: A systematic literature review on features and effects. *Med J Islam Repub Iran*. Published Online First: 30 April 2021. 10.47176/mjiri.35.27
47. Cella E, Giovanetti M, Benedetti F, et al.: Joining Forces against Antibiotic Resistance: The One Health Solution. *Pathogens*. 2023, 12:1074. 10.3390/pathogens12091074