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ORIGINAL ARTICLE

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Determinants of Antibiotic Prescribing for Upper Respiratory Tract Infections in Sana'a City, Yemen

Abdulrazzaq Y. Al-Khazzan[1*], Doa'a A. Ibrahim[1], Abdulsalam M. Halboup[1,2], Sabariah N. Harun[2], Shatha Al Dhubai[1], Noor Hayal[1], Hajer Alhazwarah[1], Aisha Shaaban[1], Afraa Alsabri[1], Soha Al-Thalje[1], Abdullah A. Areqi[3], Ammar A. S. Jaber[4]

[1]Department of Clinical Pharmacy and Pharmacy Practice, Faculty of Pharmacy, University of Science and Technology, Sana'a, Yemen

[2]Discipline of Clinical Pharmacy, School of Pharmaceutical Sciences, Universiti Sains Malaysia, Penang, Malaysia

[3]Department of Pharmacology, Faculty of Pharmacy, University of Science and Technology, Hodeidah, Yemen

[4]Department of Clinical Pharmacy & Pharmacotherapeutics, Dubai Pharmacy College for Girls, Dubai, UAE

*** Corresponding author: Email:** abdulrazzagy@ust.edu.ye

ABSTRACT

Background: Antibiotics are frequently overprescribed for upper respiratory tract infections (URTIs) in outpatient settings, especially in regions with fragile health systems. Therefore, the present study assessed the patterns and predictors of antibiotic prescribing for URTIs in Sana'a city, Yemen.

Methods: A cross-sectional study was conducted among 453 conveniently sampled patients with URTIs in the pediatric and ear, nose and throat (ENT) clinics in six public and private referral hospitals in Sana'a from July to September 2019. Demographic characteristics of patients and physicians, as well as data on the likely types of URTIs and prescribed antibiotics, were collected using a validated questionnaire. The data were then analyzed using univariate and multivariable binary logistic regression, with a significance level of less than 0.05.

Results: Of 453 patients with URTIs, 429 (94.7%) received antibiotics in the pediatric and ENT outpatient clinics of the study hospitals. More than half of antibiotic prescriptions were prescribed by physicians who were male (54.7%), experienced for 15 years or fewer (53.2%), and pediatricians (51.2%). On the other hand, most prescriptions (73.7%) were prescribed by physicians aged ≤45 years. Penicillins were the most frequently prescribed antibiotics (44.3%), followed by macrolides (25.9%), and cephalosporins (17.2%). However, antifolates (0.9%) and fluoroquinolones (11.7%) were the least frequently prescribed. Amoxicillin-clavulanate (38.9%) was the most frequently prescribed antibiotic for URTIs, followed by azithromycin (16.1%), clarithromycin (9.8%), and cefdinir (5.7%). In

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multivariable analysis, female physicians were more likely to prescribe antibiotics than males (AOR = 4.5, 95% CI: 1.49–13.33; *P* = 0.007), while ENT specialists were less likely compared to pediatricians (AOR = 0.2, 95% CI: 0.07–0.84; *P* = 0.025).

Conclusion: The rate of prescribing antibiotics for URTIs among outpatients in Sana'a is high, with a high proportion of inappropriate prescriptions for infections that are unlikely to be bacterial. Penicillins, particularly amoxicillin-clavulanate, are most often prescribed. Various factors related to patients and physicians can influence physicians' prescribing behavior, emphasizing the need for targeted interventions to rationalize antibiotic prescribing for treating URTIs. Further research is needed to address antibiotic prescribing patterns in the clinical context.

Keywords: Antibiotic prescription ▪ Upper respiratory tract infection ▪ Yemen

1. Introduction

Antibiotic resistance poses a significant global threat to human health and remains a public health problem. Overuse and misuse of antibiotics contribute significantly to the emergence of antibiotic-resistant bacteria, which are difficult to treat and are associated with high mortality, morbidity, prolonged hospital stays, and increased healthcare resource consumption.[1,2] The burden of this resistance is higher in developing countries due to higher prescription rates and easier access to antibiotics without requiring a prescription.[3]

Upper respiratory tract infections (URTIs) account for the majority of antibiotic prescriptions, with more frequent visits compared to other types of infection.[4,5] Antibiotics are often prescribed for unconfirmed conditions, such as pharyngitis and acute otitis media (AOM), or for conditions with no evidence of benefit, like the common cold.[6–8] Similar patterns of inappropriate antibiotic prescriptions for URTIs have been reported in several countries.[9–11]

Discrepancies in antibiotic prescribing may be attributed to several factors. Studies have shown that patient-related factors, such as gender, disease severity, comorbidities and satisfaction, influence prescribing of antibiotics.[12,13] On the other hand, the prescribing behavior of physicians is influenced by knowledge and trust in current guidelines, personal experience, fear of complications, and availability of antibiotics.[14,15]

In Yemen, earlier studies have found high antibiotic prescribing rates, particularly for URTIs.[16,17] However, there is a lack of published studies on antibiotic prescribing for URTIs in Sana'a city. Therefore, this study aimed to assess the patterns and determinants influencing antibiotic prescribing for treating outpatients with URTIs in Sana'a city.

2. Methods

2.1. Study design, population and setting

This cross-sectional study was conducted among patients with URTIs who attended the pediatric ENT outpatient clinics in six hospitals in Sana'a from July to September 2019. The study included three public hospitals (Al-Jomhori Teaching Hospital, Al-Sabean Maternal Hospital, and Kuwait University Hospital) and three private hospitals (Azal Hospital, C-Plus Hospital, and University of Science and Technology Hospital). These hospitals were selected as major referral hospitals to ensure a representative sample from diverse healthcare facilities. Patients of both genders and any age group were included if presenting with URTIs. Those diagnosed with lower respiratory tract infections were excluded.

2.2. Study tool and data collection

A validated questionnaire, which was adapted from previously published studies,[12,19] was used to collect data. The questionnaire was reviewed by six experts in community medicine, pharmacology, pharmacy practice, clinical pharmacy, and research methodol-

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ogy, where it was modified based on the feedback they provided.

The questionnaire included questions about the demographic data of both patients and physicians, the most likely type of URTI based on clinical symptoms, and the antibiotics prescribed. Data were collected by five trained sixth-year PharmD students from the University of Science and Technology, who visited physicians' clinics and interviewed patients.

The likelihood of bacterial infections was categorized into "likely bacterial infection" and "unlikely bacterial infection" based on URTI diagnosis. "Likely bacterial infection" included URTIs with bacterial or viral etiologies, such as pharyngotonsillitis, bronchitis, AOM, and sinusitis. However, "unlikely bacterial infection" covered URTIs with only viral etiologies, such as the common cold, flu, allergic rhinitis, and laryngitis.

2.3. Sample size and sampling strategy

According to the Daniel sample size formula,[18] with an assumed response distribution of 50%, a confidence level of 95% and an accepted margin error of 5%, the minimum sample size was estimated at 384 patients. The sample size was increased to 452, accounting for an expected non-response rate of 15%. Patients from the six study hospitals were selected using a convenience sampling technique until the required sample size was achieved.

2.4. Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 21.0 (IBM Corp., Armonk, NY, USA). The association between the dependent variable (antibiotic prescribing) and the likelihood of bacterial URTIs was assessed using the chi-square test. Univariate analysis was used to test the factors associated with antibiotic prescribing, along with the odds ratio (OR) and 95% confidence interval (CI) of the association. Variables with a *P*-value of <0.25 in univariate analysis were included in a multivariable binary logistic regression model to identify independent predictors of antibiotic prescribing for URTIs. Adjusted ORs (AORs) and their corresponding 95% CIs of predictors were reported. The statistical significance was set at a *P* value <0.05.

3. Results

3.1. Characteristics of the study population

Table 1 shows that more than half of patients with URTIs were females (52.3%) and aged younger than 18 years (62%). On the other hand, most physicians were males (68.7%), aged ≤45 (87.5%), and were pediatricians (56.2%).

Table 1: Characteristics of patients and physicians*

Characteristics	*n* (%)
Patients	
Gender	
Female	237 (52.3)
Male	216 (47.7)
Age (years)	
<18	281 (62.0)
≥18	172 (38.0)
Physicians	
Gender	
Female	5 (31.3)
Male	11 (68.7)
Age (years)	
≤45	14 (87.5)
>45	2 (12.5)
Years of practice	
≤15	9 (56.2)
>15	7 (43.8)
Specialty	
Pediatrics	9 (56.2)
ENT	7 (43.8)

*The total number of patients was 453, and the total number of physicians was 16. ENT, ear, nose, and throat.

3.2. Distribution of URTIs

Pharyngotonsillitis (43%) was the most frequent URTI diagnosed in outpatient clinics, followed by AOM (14.3%) and bronchitis (9.9%). However, mixed infections were observed among 4.6% of cases (Figure 1).

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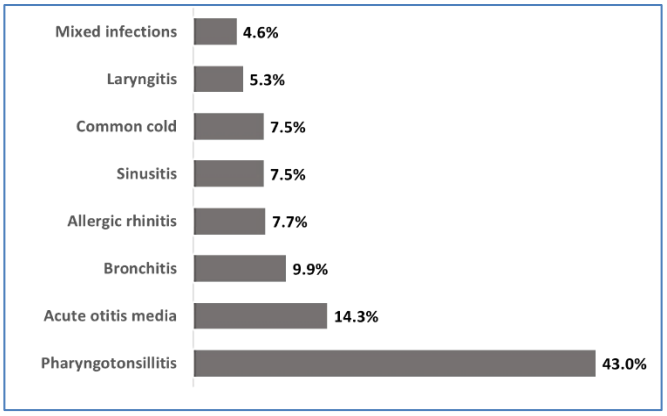

Figure 1: Distribution of URTIs among patients

3.3. Antibiotic prescriptions according to physicians' characteristics

Of 453 patients with URTIs, 429 (94.7%) received antibiotics in the pediatric and ENT outpatient clinics of the study hospitals. Table 2 shows that more than half of antibiotic prescriptions were prescribed by male physicians (54.7%), those having ≤15 years of experience (53.2%), and pediatricians (51.2%). On the other hand, most prescriptions (73.7%) were prescribed by physicians aged ≤45 years.

Table 2: Prescription according to physicians' characteristics*

Physicians' characteristics	Prescriptions *n* (%)
Gender	
Male	248 (54.7)
Female	205 (45.3)
Age (years)	
≤45	334 (73.7)
>45	119 (26.3)
Years of experience	
≤15	241 (53.2)
>15	212 (46.8)
Specialty	
Pediatrics	232 (51.2)
ENT	221 (49.8)

*The total number of prescriptions was 453. ENT, ear, nose, and throat,

3.4. Classes and types of antibiotics prescribed

Penicillins were the most frequently prescribed antibiotics (44.3%), followed by macrolides (25.9%) and cephalosporins (17.2%). However, antifolates (0.9%) and fluoroquinolones were the least prescribed (11.7%) (Table 3).

Table 3: Classes of antibiotics prescribed for URTIs in Sana'a city, Yemen*

Antibiotics	*n* (%)
Penicillins	190 (44.3)
Macrolides	111 (25.9)
Cephalosporins	74 (17.2)
Fluoroquinolones	50 (11.7)
Antifolates	4 (0.9)

*The total number of patients receiving antibiotics was 429.

Table 4 shows that amoxicillin-clavulanate (38.9%) was the most frequently prescribed antibiotic for URTIs, followed by azithromycin (16.1%), clarithromycin (9.8%), and cefdinir (5.7%).

Table 4: Types of antibiotics prescribed for URTs in Sana'a city, Yemen*

Antibiotics	*n* (%)
Penicillins	
Amoxicillin/clavulanate	167 (38.9)
Amoxicillin	23 (5.4)
Macrolides	
Azithromycin	69 (16.1)
Clarithromycin	42 (9.8)
Cephalosporins	
Cefdinir	22 (5.1)
Cefuroxime	18 (4.2)
Cefixime	19 (4.4)
Ceftriaxone	11 (2.6)
Cefpodoxime	1 (0.2)
Cefaclor	2 (0.5)
Cefotaxime	1 (0.2)
Quinolones	
Moxifloxacin	29 (6.8)
Ciprofloxacin	11 (2.6)
Levofloxacin	10 (2.3)
Antifolate	
Cotrimoxazole	4 (0.9)

*The total number of patients receiving antibiotics was 429.

3.5. Association between antibiotic prescribing and likelihood of bacterial URTIs

Table 5 shows a statistically significant association between antibiotic prescribing and the likelihood of bacterial URTI (P <0.001).

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Table 5: Association between antibiotic prescribing and likelihood of bacterial URTIs in Sana'a city, Yemen

Antibiotic prescription	Likelihood of bacterial infections *n* (%)			*P*-value
	Yes	No	Total	
Yes	381 (**84.1**)	48 (**10.6**)	429 (**94.7**)	<0.001
No	3 (**0.7**)	21 (**4.6**)	24 (**5.3**)	
Total	384 (**70.7**)	69 (**15.2**)	453 (**100.0**)	

3.6. Factors associated with antibiotic prescriptions for URTIs

Table 6 shows a significant association between patient age and the likelihood of antibiotic prescribing for URTIs, with patients aged ≥18 years being less likely to receive antibiotics than patients aged <18 years (OR = 0.4, 95% CI: 0.18–0.87; *P* = 0.021). In terms of physician-related factors, female physicians were significantly more likely to prescribe antibiotics compared to male physicians (OR = 5.4, 95% CI: 1.85–15.98; *P* = 0.002). On the other hand, ENT specialists were significantly less likely to prescribe antibiotics than pediatricians (OR = 0.2, 95% CI: 0.07–0.54; *P* = 0.001).

In the multivariable analysis, female physicians were significantly more likely to prescribe antibiotics than their male counterparts (AOR = 4.5, 95% CI: 1.49–13.33; *P* = 0.007). Similarly, ENT specialists were less likely to prescribe antibiotics than pediatricians (AOR = 0.2, 95% CI: 0.07–0.84; *P* = 0.025).

Table 6: Factors associated with antibiotic prescriptions for URTIs in Sana'a city, Yemen

	N	Antibiotic prescription *n* (%)	Univariate analysis OR (95% CI)	*P*-value	Multivariable analysis AOR (95% CI)	*P*-value
Patient's gender						
Female	215	202 (**47.1**)	Reference			
Male	238	227 (**52.9**)	**1.4** (0.65–3.09)	0.387		
Patient's age						
<18	282	272 (**63.4**)	Reference		Reference	
≥18	171	157 (**36.6**)	**0.4** (0.18–0.87)	0.021	**1.0** (0.36–2.67)	0.973
Physicians' gender						
Male	248	228 (**53.1**)	Reference		Reference	
Female	205	201 (**46.9**)	**5.4** (1.85–15.98)	0.002	**4.5** (1.49–13.33)	0.007
Physician's age						
≤45	334	321 (**74.8**)	Reference			
> 45	119	108 (**25.2**)	**0.7** (0.28–1.56)	0.348		
Years of practice						
≤15	241	226 (**52.7**)	Reference			
>15	212	203 (**47.3**)	**1.0** (0.43–2.08)	0.899		
Specialty						
Pediatrics	232	228 (**53.3**)	Reference		Reference	
ENT	221	201 (**46.7**)	**0.2** (0.07–0.54)	0.001	**0.2** (0.07–0.84)	0.025

N, Number of URTIs; *n*, number of antibiotic-treated infections; URTIs, upper respiratory tract infections; OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval; ENT, ear, nose, and throat.

4. Discussion

This study revealed a high rate of antibiotic prescribing for URTIs among outpatients in Sana'a, especially among pediatric patients. The most commonly prescribed antibiotics included penicillins, macrolides and cephalosporins. In particular, amoxicillin-clavulanate and azithromycin were the most frequently prescribed antibiotics by physicians. Moreover, a significant association was found between antibiotic prescribing and the likelihood of bacterial infections. Female physicians and pediatricians showed significantly higher rates of prescribing antibiotics for URTIs compared to their counterparts. The high rate of antibiotic prescribing in this study indicates a concerning trend toward overprescription of anti-

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biotics. Given that most URTIs are viral and self-limiting, most antibiotics prescribed in this study were likely unnecessary.[29] The inappropriate use of antibiotics is a common problem, with studies showing that 20–50% of antibiotic prescriptions are not based on clinical necessity.[17, 33] This inappropriate use not only contributes to increased antimicrobial resistance but also increases the risk of adverse effects, such as *Clostridium difficile* infections and raises healthcare costs.[18]

In the present study, 94.7% of patients received antibiotic prescriptions, aligning with a finding among outpatients in the governorate of Aden.[16] In contrast, lower rates of antibiotic prescription were reported in China (83.7%), Namibia (78%), Tanzania (66.7%) and Jordan (61%).[9,12,19,20] On the other hand, the higher likelihood of antibiotic prescribing by pediatricians in the present study is consistent with that reported in Nigeria, where physicians in pediatric departments were found to prescribe antibiotics more frequently than in other specialties.[34]

The higher likelihood of younger patients being prescribed antibiotics in the present study is consistent with a finding from Jordan, where children with URTIs were more likely to be prescribed antibiotics than adults.[19] However, the present study did not find that patient age have a significant influence on physicians' decisions regarding prescribing antibiotics. In contrast, patient age and illness were significant predictors of antibiotic prescribing in Katutura, Namibia.[9] The lack of association between patient gender and antibiotic prescribing in the present study is consistent with findings from Jordan and Namibia.[9,19]

The Centers for Disease Control and Prevention (CDC) estimates that over half of all antibiotics are inappropriately prescribed each year, primarily for viral infections.[21] Improper prescriptions have negative consequences on bacterial resistance and are associated with adverse outcomes such as *C. difficile* infection. URTIs are a major contributor to unnecessary antibiotic prescriptions, with at least 50% of these being considered unnecessary.[4]

In the present study, antibiotics were most frequently prescribed for patients with pharyngotonsillitis, followed by AOM and bronchitis. This finding is consistent with a similar pattern in Spain.[22] The more frequent use of amoxicillin-clavulanate compared to amoxicillin alone in the present study may indicate awareness of bacterial resistance. This pattern is consistent with that reported in several other countries.[10,12,22–24] For instance, amoxicillin, cotrimoxazole and amoxicillin-clavulanate accounted for 85% of prescribed antibiotics in Sweden.[25] However, macrolides were the most frequently prescribed antibiotics for URTIs in Malaysia.[26] These antibiotics are often prescribed because of their fewer side effects and shorter treatment duration, although their overuse may lead to resistance.[26] Furthermore, the treatment duration with macrolide may be inadequate, as formulations often offer a three-day regimen of tablets instead of the recommended five days.[27]

Guidelines recommend against the use of antibiotics for viral infections,[30,31] and in this study, antibiotic prescribing for conditions with an underlying viral etiology was considered inappropriate. However, conditions like pharyngotonsillitis, AOM, bronchitis and sinusitis may have both viral and bacterial causes.[32] In such cases, physicians' discretion in prescribing antibiotics could be accepted since there are no specific criteria to determine the microbial etiology.[32] It is noteworthy that the reliance on clinical diagnosis in the present study aligns with a study conducted in Qatar.[11]

The significant association of the physician's gender and specialty with antibiotic prescribing is consistent with a study conducted in Jordan.[19] Con-

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sistent with a study conducted in Sweden,[25] female physicians in our study prescribed antibiotics more frequently than their male counterparts. Several factors for noncompliance with prescribing guidelines have been identified in the United States, including doubts about the effectiveness of treatment, concerns about patient satisfaction, and fear of complications.[28] A Tanzanian study found that disease severity influenced prescribing rates.[12] However, our study did not assess the association of disease severity or comorbidity with antibiotic prescribing. Therefore, there is a need for educational interventions to rationalize antibiotic prescribing, where such interventions have proven effective in reducing antibiotic prescribing.[26,27]

This study provides valuable insights into antibiotic prescribing patterns for URTIs in Yemen, backed by a robust sample size. Nonetheless, the use of convenience sampling could potentially compromise the representativeness of the sample. Moreover, the absence of criteria to assess diagnosis and severity, along with the restriction of the study to outpatient settings in Sana'a, may limit the generalizability of its findings. Another limitation is that the study did not examine patient demands, which could be a key determinant of physicians' antibiotic prescribing behavior.

5. Conclusion

The rate of prescribing antibiotics for URTIs among outpatients in Sana'a is high, with a high proportion of inappropriate prescriptions for infections that are unlikely to be bacterial. Penicillins, particularly amoxicillin-clavulanate, are most often prescribed. Various factors related to patients and physicians can influence physicians' prescribing behavior, emphasizing the need for targeted interventions to rationalize antibiotic prescribing for treating URTIs. Further research is needed to address antibiotic prescribing patterns in the clinical context.

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Ethical approval and consent

The Ethics Committee of the University of Science and Technology, Sana'a, Yemen, approved the study (Ethical Clearance No.: EAC/UST 182). Participants were briefed on the study's goals and data confidentiality and provided verbal informed consent to participate. The study protocol conformed to the principles outlined in the Declaration of Helsinki.

Conflict of Interest

The authors declare no conflict of interest associated with this article.

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