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Antibiotic Prescribing Patterns and Their Associated Diagnoses and Microbiological Cultures in Primary Care Centers in Riyadh, Saudi Arabia: A Retrospective Cross-Sectional Study

Antibiotic Prescribing in Saudi Primary Care

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ABSTRACT:

Background: Primary care accounts for most antibiotic use, yet antibiotic prescribing in Saudi primary care has received less attention than hospital use. This study examined antibiotic prescribing patterns, associated diagnoses, and the use of microbiological cultures in primary care centers in Riyadh, Saudi Arabia.

Methods: A retrospective cross-sectional study of all antibiotic prescriptions issued between January and December 2022 at three primary care centers of the Ministry of National Guard Health Affairs. Data were extracted electronically from the health record, and adult (≥19 years) and pediatric (≤18 years) prescriptions were compared.

Results: A total of 33,750 prescriptions were issued to 25,258 patients during 32,043 visits; 56.1% were for adults and 43.9% for pediatric patients. Penicillins, macrolides, and lincosamides accounted for 75.3% of adult and 91.5% of pediatric prescriptions. Access antibiotics represented 71.7% and Watch antibiotics 28.3% of prescriptions. Upper respiratory tract infection was the most frequent recorded diagnosis (13.2% in adults; 38.7% in pediatrics), and 38.6% of prescriptions for it were macrolides. No infection diagnosis was recorded for 41.7% of adult and 20.0% of pediatric prescriptions. Monthly prescriptions were 73% higher in October–December than in January–September. Cultures were linked to 21.9% of prescriptions (33.1% in adults vs 7.7% in pediatrics); 22.3% were positive, and 17.0% of isolates with susceptibility results were resistant.

Conclusions: Although Access antibiotics exceeded the WHO 60% target, frequent macrolide use for upper respiratory tract infections and prescriptions without a documented infection identify priority targets for antimicrobial stewardship in primary care.

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INTRODUCTION

Antibiotic resistance has become a major global public health challenge and one of the most serious threats to modern therapeutic medicine [1]. The misuse and overuse of antibiotics in treating both human and animal diseases have probably accelerated the global emergence of new types of antibiotic resistance [2]. The increase in antimicrobial resistance has a considerable impact on healthcare costs and clinical outcomes [3].

In Saudi Arabia, as in the rest of the world, resistance in several pathogens of concern has increased [4]. The annual influx of millions of pilgrims to the holy mosques in Makkah poses an additional challenge for the spread of antibiotic resistance [5]. In 2018, Saudi Arabia began enforcing the prohibition of dispensing antibiotics without a prescription [6], which substantially reduced non-prescription dispensing in community pharmacies [7]. However, national antimicrobial utilization in community pharmacies dropped immediately after enforcement and then gradually returned to near pre-policy levels, which has been attributed partly to patients obtaining prescriptions through physician visits [8]. This places prescribers, particularly in easily accessible primary care services, at the center of antibiotic stewardship efforts.

Primary care physicians are the main prescribers of antibiotics [9, 10], and in low- and middle-income countries more than half of primary care patients receive antibiotics [11, 12]. In Saudi Arabia, antibiotic consumption has been described in hospitals [13, 14] and intensive care units [15, 16], whereas antibiotic prescribing in primary care has received less attention [17, 18], and the microbiological testing associated with prescriptions in this setting is rarely reported [17, 18]. Describing antibiotic prescribing in primary care is important for assessing inappropriate prescribing [19], identifying the required interventions [20, 21], and informing national antimicrobial stewardship programs [22]. The objectives of the current study were to examine antibiotic prescribing patterns in primary care, to describe the diagnoses associated with these prescriptions, and to describe the use and results of microbiological cultures, comparing adult and pediatric patients.

METHODS

Study design: A retrospective cross-sectional study was conducted at three large primary care centers in Riyadh, Saudi Arabia, using data extracted electronically from the health record for the period January to December 2022. The study is reported in accordance with the RECORD (REporting of studies Conducted using Observational Routinely-collected health Data) statement.

Setting: The three centers belong to the Ministry of National Guard Health Affairs (MNGHA): Iskan Yarmouk, Khashm Alan, and Um Alhamam clinics. They were randomly selected from the 13 MNGHA primary care centers in the Central Region. The centers provide free primary healthcare services to MNGHA personnel and their dependents within defined catchment areas, including family medicine, pediatrics, well-baby, obstetrics and gynecology, dentistry, ear, nose, and throat (ENT), ophthalmology, dermatology, psychiatry, health education and dietetics, and emergency services, supported by laboratory, radiology, and pharmacy services. According to the MNGHA statistics book for 2022, primary care centers in Riyadh provided more than one million visits, approximately two million laboratory tests, and 84,000 radiological investigations, and dispensed 2.5 million pharmacy items. The centers are accredited training sites for fifth-year medical students and the family medicine residency program.

Study population: All antibiotic prescriptions issued to patients of any age during the study period were included, including repeat visits and multiple prescriptions per visit. Patients aged 18 years or younger were classified as pediatric and those aged 19 years or older as adults. Prophylactic antibiotic prescriptions and other antimicrobials (antifungal and antiviral agents) were excluded. Duplicate records (same visit and same antibiotic prescription) were removed. The unit of analysis was the antibiotic prescription.

Data collection: All centers use the same electronic health record system (BestCare), from which data were extracted by King Abdullah International Medical Research Center (KAIMRC) staff according to the inclusion and exclusion criteria. Culture data were provided separately and linked to the corresponding prescriptions using patient identifiers and dates. The extracted data included demographic characteristics (age, gender, marital status, and nationality), prescription data (antibiotic, antibiotic class, route, duration, prescribing specialty, and recorded visit diagnosis), and culture data (performance, timing relative to the prescription, specimen type, result, isolated organism, and antimicrobial susceptibility). Antibiotics were classified according to the World Health Organization (WHO) Access, Watch, Reserve (AWaRe) classification [23]; antibiotics for external (topical, ophthalmic, and otic) use were classified using the same list. Recorded visit diagnoses were grouped into the clinical categories

shown in Table 2, and each prescription was classified as having or not having a recorded infection diagnosis. Antimicrobial susceptibility was recorded as reported by the hospital microbiology laboratory, and isolates reported as resistant were classified as resistant.

Statistical analysis: Categorical variables were presented as frequencies and percentages, and continuous variables as mean and standard deviation or median and interquartile range, according to their distribution. Data were presented separately for adult and pediatric prescriptions. Differences between the two groups were examined using Pearson's Chi-square test, or Fisher's exact test when expected cell counts were below five; for variables with many categories, each category was compared against all others. Prescription duration was compared using the Mann-Whitney U test. Monthly prescription counts were plotted to examine seasonal variation, and the proportion of prescriptions issued in the last quarter of the year (October–December) was compared between adults and pediatrics. All p-values were two-tailed, and $p<0.05$ was considered statistically significant. Analyses were performed using SPSS version 29.0 (IBM Corp, Armonk, NY, USA).

RESULTS

A total of 33,750 antibiotic prescriptions were issued during 2022 to 25,258 patients during 32,043 visits. Of these, 18,941 (56.1%) were issued to adults and 14,809 (43.9%) to pediatric patients. Prescriptions increased in the last quarter of the year (Figure 1): the average monthly number was 4,121 in October–December compared with 2,376 in January–September, an increase of 73%. The increase was larger in pediatric than in adult patients (126% versus 39%), and the proportion of prescriptions issued in the last quarter was higher in pediatric than in adult patients (43.0% versus 31.7%, $p<0.001$). Lower monthly counts were observed in April and July.

As shown in Table 1, the mean age was 39.7±15.4 years for adult prescriptions and 8.6±5.5 years for pediatric prescriptions. Most adult prescriptions were for patients aged 19–45 years (67.9%), and 64.2% of pediatric prescriptions were for patients aged 6–18 years. Most adult prescriptions were for women (76.2%), whereas pediatric prescriptions were evenly distributed by gender (49.2% male and 50.8% female). Khashm Alan clinic accounted for more adult prescriptions (48.7% versus 33.1%), and Iskan Yarmouk clinic for more pediatric prescriptions (55.6% versus 38.1%). The most frequent prescribing specialties for adults were family medicine (62.0%), the emergency department (10.7%), dentistry (9.2%), and obstetrics and gynecology (4.0%), while for pediatric patients they were family medicine (36.5%), the emergency department (27.4%), pediatrics (14.0%), and dentistry (4.6%). Emergency department prescriptions were considerably more frequent in pediatric than in adult patients (27.4% versus 10.7%, $p<0.001$).

Penicillins, macrolides, and lincosamides were the most frequently prescribed antibiotic classes in both groups, representing 75.3% of adult and 91.5% of pediatric prescriptions (Figure 2). Penicillins and macrolides were more frequent in pediatric patients (absolute differences of 10.0 and 6.5 percentage points, respectively), whereas cephalosporins and fluoroquinolones were more frequent in adults (absolute differences of 7.3 and 2.5 percentage points, respectively). As shown in Table 2, the most frequently prescribed antibiotics in adults were amoxicillin-clavulanate (30.3%), amoxicillin (14.8%), clindamycin (14.5%), azithromycin (11.7%), and cefuroxime (8.3%), and in pediatric patients amoxicillin-clavulanate (37.2%), azithromycin (21.3%), amoxicillin (17.9%), clindamycin (14.2%), and moxifloxacin (2.4%). Access antibiotics represented 70.2% of adult and 73.5% of pediatric prescriptions, Watch antibiotics 29.8% and 26.5%, respectively, and no Reserve antibiotics were prescribed. The median prescription duration was 7 days, and the route was oral in 83.8%, external (topical) in 15.6%, and parenteral in 0.6% of prescriptions.

The most frequent recorded diagnoses or visit reasons in adults were upper respiratory tract infection (13.2%), skin infection or disease (12.5%), dental infection or disease (10.1%), routine check-up or follow-up (9.4%), ENT infection or disease (8.7%), and urinary tract infection (7.6%). In pediatric patients, they were upper respiratory tract infection (38.7%), ENT infection or disease (17.4%), skin infection or disease (13.6%), routine check-up or follow-up (6.5%), dental infection or disease (5.1%), and pneumonia or lower respiratory tract infection (2.7%). Non-infectious conditions such as pregnancy (3.9%), dyslipidemia (3.5%), and diabetes (3.0%) were recorded as the visit diagnosis for a notable proportion of adult prescriptions. Overall, no infection diagnosis was recorded for 32.2% of prescriptions, more often in adults than in pediatric patients (41.7% versus 20.0%, $p<0.001$) (Table 2).

The antibiotic classes prescribed for each diagnosis are shown in Supplementary Table 1. Upper respiratory tract infections were treated mainly with penicillins (56.2%) and macrolides (38.6%), and macrolides accounted for 53.8% of prescriptions for

bronchospasm or cough. Penicillins accounted for 79.5% of prescriptions for ENT conditions and 97.7% of those for dental conditions, and lincosamides for 63.5% of prescriptions for skin conditions and 76.3% of dermatology prescriptions. Urinary tract infections were treated with other antibiotics, mainly nitrofurantoin (44.7%), penicillins (18.8%), cephalosporins (17.6%), and fluoroquinolones (17.3%). Fluoroquinolones accounted for 41.2% of prescriptions for eye infections or diseases.

As shown in Table 3, cultures were performed more frequently in relation to adult than pediatric prescriptions (33.1% versus 7.7%, $p<0.001$), and were more often obtained before the prescription in adults (57.8% versus 43.3%, $p<0.001$). The most frequent specimens were urine (82.7%), vaginal (9.4%), and throat (2.8%) in adults, and urine (69.7%), throat (9.5%), and stool (8.5%) in pediatric patients. Positive cultures were more frequent in adults than in pediatric patients (23.5% versus 16.0%, $p<0.001$). The most frequent organisms isolated in adults were Escherichia coli (33.7%), Streptococcus agalactiae (group B, 26.6%), Klebsiella spp. (8.3%), and Staphylococcus aureus (2.2%), and in pediatric patients Escherichia coli (36.6%), Streptococcus pyogenes (group A, 12.9%), Klebsiella spp. (5.9%), and Streptococcus agalactiae (group B, 5.4%). Among isolates with susceptibility results, resistance did not differ significantly between adult and pediatric patients (17.3% versus 14.5%, $p=0.421$).

DISCUSSION

This study examined antibiotic prescribing patterns, associated diagnoses, and microbiological cultures in primary care centers in Riyadh and compared adult and pediatric prescriptions. Previous studies have typically described antibiotic prescribing in primary care irrespective of age [11, 24, 25] or focused specifically on pediatric patients [18], and have rarely compared adult and pediatric patients [17]. The current study found important differences between the two groups in antibiotic classes, associated diagnoses, and culture practices, and identified specific targets for stewardship.

Penicillins, macrolides, and lincosamides were the most frequently prescribed antibiotics in both groups, with penicillins and macrolides more frequent in pediatric patients and cephalosporins and fluoroquinolones more frequent in adults. Similarly, previous studies have reported penicillins, including amoxicillin and amoxicillin-clavulanate, as the most frequently prescribed antibiotics in primary care, representing at least half of all prescriptions [24–27], and macrolides as the second or third most prescribed class, representing 10% to 20% of prescriptions [24–26]. As in previous studies, upper respiratory tract infection, skin conditions, and dental conditions were the most frequent diagnoses associated with prescriptions [17, 27]. The higher use of penicillins and macrolides in pediatric patients is consistent with the predominance of upper respiratory tract and ENT infections in this group [28], while the higher use of cephalosporins and fluoroquinolones in adults may be related to their use for urinary tract infections and to the use of cephalosporins in pregnancy.

Several findings point to potentially inappropriate prescribing. Upper respiratory tract infections, which are mostly viral and for which antibiotics are usually not recommended [23], were the most common diagnosis, accounting for nearly a quarter of all prescriptions and 38.7% of pediatric prescriptions. Moreover, macrolides, which belong to the Watch group, accounted for 38.6% of prescriptions for upper respiratory tract infections and more than half of those for bronchospasm or cough, whereas amoxicillin or penicillin is recommended when an antibiotic is indicated for streptococcal pharyngitis [23]. Fluoroquinolones and cephalosporins together accounted for about one third of prescriptions for urinary tract infections, although nitrofurantoin and other Access antibiotics are recommended first-line options for uncomplicated cystitis [23]. In addition, no infection diagnosis was recorded for 32.2% of prescriptions overall and for 41.7% of adult prescriptions, and routine check-up or follow-up, pregnancy, dyslipidemia, and diabetes were among the recorded visit reasons. This may partly reflect documentation practices, in which the main reason for the visit or a chronic condition was recorded rather than the treated infection; the number of prescriptions with a recorded diagnosis of pregnancy (749) was identical to the number issued by obstetrics and gynecology clinics, which supports this explanation. Comorbidity has also been associated with more frequent antibiotic prescribing in primary care [29]. Nevertheless, the absence of a documented indication for one in three prescriptions limits the ability to audit prescribing and is itself a target for improvement, for example through mandatory indication fields and audit and feedback [21].

Access antibiotics represented 71.7% of all prescriptions, exceeding the WHO target of at least 60% [23] and approaching the target of 70% adopted in the 2024 United Nations political declaration on antimicrobial resistance [30]. The proportion of Watch antibiotics (28.3%) was lower than previously reported in primary care in Saudi Arabia, especially in pediatric patients [17], and within the wide range of 10% to 90% reported in primary care in low- and middle-income countries [11]. However,

Watch antibiotics have a higher potential for selecting resistance [23], and these proportions included antibiotics for external use, such as ophthalmic fluoroquinolones and topical clindamycin; the AWaRe classification was designed primarily for systemic antibiotics, and the proportions should therefore be compared with other studies with caution.

Prescriptions were higher in the last quarter of the year (late autumn and early winter), particularly in pediatric patients. Similar seasonality has been reported previously and is probably related to the increase in respiratory and ENT infections during the colder months [25, 26]. The lower numbers in April and July coincided with Ramadan and the summer vacation period, respectively, when primary care attendance usually declines. Because the study covered a single year shortly after the relaxation of COVID-19 restrictions, these patterns should be confirmed over several years.

Most adult prescriptions were for women, which is consistent with previous reports of higher antibiotic prescribing among women, probably related to the higher incidence of urinary tract infections [25, 31], and with the inclusion of obstetrics and gynecology clinics. Because the study did not include the total number of patients or visits, these distributions reflect the composition of the population that received antibiotics and should not be interpreted as differences in prescribing rates by age or gender.

Microbiological cultures were linked to 21.9% of prescriptions. This proportion is likely lower than in hospital settings [32] but higher than reported previously in primary care [33, 34]. For example, a study of primary care patients in Denmark showed that microbiological cultures were performed for 5.4% of patients and group A streptococcal antigen tests for 3.4% [33], and a study from the Netherlands showed that only 2.9% of patients with exacerbations of chronic obstructive pulmonary disease received a sputum culture [34]. However, most cultures in the current study were urine cultures, and some urine and vaginal cultures probably reflected routine antenatal screening rather than diagnostic testing for the treated infection. In particular, Streptococcus agalactiae (group B) was isolated mainly from adult vaginal specimens and most likely represents colonization detected through antenatal screening rather than infection. In contrast, Streptococcus pyogenes (group A) was more common in pediatric patients, consistent with streptococcal pharyngitis. Notably, only 281 throat cultures were performed in relation to 8,234 prescriptions for upper respiratory tract infections, which suggests an opportunity to support prescribing decisions with throat cultures or point-of-care tests such as rapid streptococcal antigen detection [20, 35]. Resistance in 17.0% of isolates with susceptibility results further supports the need to expand antimicrobial stewardship activities in primary care [20–22].

The main strengths of this study are the large number of prescriptions and the complete electronic extraction of a full year of data, which allowed stratification by age group, antibiotic class, diagnosis, and specialty. The separate presentation of adult and pediatric data and the linkage of prescriptions with culture results address a relevant gap in primary care data. Several limitations should be acknowledged. First, the cross-sectional design does not allow causal inference. Second, the unit of analysis was the prescription, and patients with several prescriptions contributed more than once, which may affect the independence of observations. Third, the total numbers of patients and visits were not available, so prescribing rates could not be calculated. Fourth, the recorded visit diagnosis did not always reflect the indication for the antibiotic, and the appropriateness of individual prescriptions could not be assessed against clinical guidelines. Fifth, antibiotics for external use were analyzed together with systemic antibiotics. Finally, the study included three well-equipped centers within a single health system during one year, which may limit generalizability to other primary care settings.

CONCLUSIONS

Penicillins, macrolides, and lincosamides were the most frequently prescribed antibiotics in primary care, representing 75% of adult and 92% of pediatric prescriptions. Prescribing differed between adult and pediatric patients, largely reflecting age-related differences in common infections, and increased markedly in late autumn and early winter. Access antibiotics accounted for more than 70% of prescriptions; however, the frequent use of macrolides for upper respiratory tract infections, the use of fluoroquinolones and cephalosporins for urinary tract infections, and the absence of a documented infection for one in three prescriptions identify priority targets for improvement. Cultures were linked to 22% of prescriptions, but throat testing for respiratory infections was uncommon. Continued monitoring of antibiotic prescribing and the expansion of antimicrobial stewardship activities, including indication documentation, diagnostic testing, and audit and feedback, are needed in primary care settings.

DECLARATIONS

Ethics approval and consent to participate: The study was approved by the Institutional Review Board of King Abdullah International Medical Research Center (protocol reference number IRB/1506/24). The requirement for informed consent was waived because of the retrospective design and the use of de-identified data.

Consent for publication: Not applicable.

Availability of data and materials: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request and with the approval of the Institutional Review Board.

Competing interests: The authors declare no competing interests.

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Authors' contributions: SA: conceptualization, methodology, data analysis, and writing of the original draft. YA and AA: writing, critical review, and editing. All authors read and approved the final manuscript.

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Table 1. Demographic and visit characteristics of antibiotic prescriptions in three MNGHA primary care centers, Riyadh, 2022

	Adults N=18,941	**Pediatrics N=14,809**	**Total N=33,750**	**p-value**
Age (years), mean ± SD	39.7 ± 15.4	8.6 ± 5.5	26.0 ± 19.6	
Age group (years)				
≤5	–	5,307 (35.8%)	5,307 (15.7%)	
6–18	–	9,502 (64.2%)	9,502 (28.2%)	
19–45	12,870 (67.9%)	–	12,870 (38.1%)	
46–60	4,110 (21.7%)	–	4,110 (12.2%)	
>60	1,961 (10.4%)	–	1,961 (5.8%)	
Gender				<0.001
Male	4,504 (23.8%)	7,286 (49.2%)	11,790 (34.9%)	
Female	14,437 (76.2%)	7,523 (50.8%)	21,960 (65.1%)	
Nationality				<0.001
Saudi	18,226 (96.2%)	14,602 (98.6%)	32,828 (97.3%)	

	Adults N=18,941	Pediatrics N=14,809	Total N=33,750	p-value
Non-Saudi	715 (3.8%)	207 (1.4%)	922 (2.7%)	
Marital status†				<0.001
Single	4,510 (23.9%)	14,736 (99.6%)	19,246 (57.2%)	
Married	13,053 (69.2%)	56 (0.4%)	13,109 (38.9%)	
Divorced/widowed	1,306 (6.9%)	10 (0.1%)	1,316 (3.9%)	
Clinic				<0.001
Iskan Yarmouk	7,224 (38.1%)	8,236 (55.6%)	15,460 (45.8%)	
Khashm Alan	9,229 (48.7%)	4,900 (33.1%)	14,129 (41.9%)	
Um Alhamam	2,488 (13.1%)	1,673 (11.3%)	4,161 (12.3%)	
Specialty				
Family medicine	11,748 (62.0%)	5,409 (36.5%)	17,157 (50.8%)	<0.001
Emergency department	2,026 (10.7%)	4,054 (27.4%)	6,080 (18.0%)	<0.001
Dentistry	1,751 (9.2%)	684 (4.6%)	2,435 (7.2%)	<0.001
Pediatrics	0 (0.0%)	2,079 (14.0%)	2,079 (6.2%)	–
Obstetrics and gynecology	749 (4.0%)	0 (0.0%)	749 (2.2%)	–
Dermatology	317 (1.7%)	203 (1.4%)	520 (1.5%)	0.025
Ear, nose, and throat	88 (0.5%)	69 (0.5%)	157 (0.5%)	0.986
Others	2,262 (11.9%)	2,311 (15.6%)	4,573 (13.5%)	<0.001

Data are n (%) of antibiotic prescriptions unless otherwise indicated. p-values compare adult and pediatric prescriptions using the Chi-square test for each variable; for specialty, each category is compared with all others. –, not applicable (category defined by age group or specialty). †Marital status was missing for 72 adult and 7 pediatric prescriptions; percentages are of non-missing values. MNGHA, Ministry of National Guard Health Affairs; SD, standard deviation.

Table 2. Antibiotics prescribed and recorded visit diagnoses or reasons in three MNGHA primary care centers, Riyadh, 2022

	Adults N=18,941	Pediatrics N=14,809	Total N=33,750	p-value
Antibiotic (AWaRe group)				
Amoxicillin-clavulanate (A)	5,736 (30.3%)	5,509 (37.2%)	11,245 (33.3%)	<0.001

	Adults N=18,941	Pediatrics N=14,809	Total N=33,750	p-value
Amoxicillin (A)	2,808 (14.8%)	2,653 (17.9%)	5,461 (16.2%)	<0.001
Azithromycin (W)	2,208 (11.7%)	3,151 (21.3%)	5,359 (15.9%)	<0.001
Clindamycin (A)	2,744 (14.5%)	2,097 (14.2%)	4,841 (14.3%)	0.395
Cefuroxime (W)	1,576 (8.3%)	179 (1.2%)	1,755 (5.2%)	<0.001
Nitrofurantoin (A)	1,314 (6.9%)	56 (0.4%)	1,370 (4.1%)	<0.001
Doxycycline (A)	641 (3.4%)	328 (2.2%)	969 (2.9%)	<0.001
Clarithromycin (W)	761 (4.0%)	130 (0.9%)	891 (2.6%)	<0.001
Ciprofloxacin (W)	738 (3.9%)	29 (0.2%)	767 (2.3%)	<0.001
Moxifloxacin (W)	222 (1.2%)	361 (2.4%)	583 (1.7%)	<0.001
Sulfamethoxazole-trimethoprim (A)	2 (0.0%)	201 (1.4%)	203 (0.6%)	<0.001
Ceftriaxone (W)	124 (0.7%)	71 (0.5%)	195 (0.6%)	0.035
Cephalexin (A)	53 (0.3%)	43 (0.3%)	96 (0.3%)	0.857
Streptomycin (W)	14 (0.1%)	1 (0.0%)	15 (0.0%)	0.004
WHO AWaRe group				<0.001
Access	13,298 (70.2%)	10,887 (73.5%)	24,185 (71.7%)	
Watch	5,643 (29.8%)	3,922 (26.5%)	9,565 (28.3%)	
Reserve	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Route of administration‡				<0.001
Oral	15,990 (84.4%)	12,288 (83.0%)	28,278 (83.8%)	
Parenteral	138 (0.7%)	72 (0.5%)	210 (0.6%)	
External (topical)	2,813 (14.9%)	2,449 (16.5%)	5,262 (15.6%)	
Prescription duration (days), median (IQR)	7 (5–10)	7 (5–7)	7 (5–8)	<0.001
Visit diagnosis or reason				
Upper respiratory tract infection	2,505 (13.2%)	5,729 (38.7%)	8,234 (24.4%)	<0.001
Skin infection or disease	2,360 (12.5%)	2,017 (13.6%)	4,377 (13.0%)	0.002

	Adults N=18,941	Pediatrics N=14,809	Total N=33,750	p-value
ENT infection or disease	1,648 (8.7%)	2,580 (17.4%)	4,228 (12.5%)	<0.001
Routine check-up or follow-up	1,780 (9.4%)	965 (6.5%)	2,745 (8.1%)	<0.001
Dental infection or disease	1,909 (10.1%)	750 (5.1%)	2,659 (7.9%)	<0.001
Urinary tract infection	1,432 (7.6%)	272 (1.8%)	1,704 (5.0%)	<0.001
Gastrointestinal infection or disorder	1,234 (6.5%)	273 (1.8%)	1,507 (4.5%)	<0.001
Pregnancy	745 (3.9%)	4 (0.0%)	749 (2.2%)	<0.001
Bronchospasm or cough	380 (2.0%)	352 (2.4%)	732 (2.2%)	0.020
Pneumonia or lower respiratory tract infection	289 (1.5%)	407 (2.7%)	696 (2.1%)	<0.001
Dyslipidemia	659 (3.5%)	9 (0.1%)	668 (2.0%)	<0.001
Diabetes	575 (3.0%)	7 (0.0%)	582 (1.7%)	<0.001
Reproductive tract infection or disorder	442 (2.3%)	28 (0.2%)	470 (1.4%)	<0.001
Painful conditions	368 (1.9%)	82 (0.6%)	450 (1.3%)	<0.001
Injury or trauma	146 (0.8%)	297 (2.0%)	443 (1.3%)	<0.001
Eye infection or disease	231 (1.2%)	172 (1.2%)	403 (1.2%)	0.626
Others	2,238 (11.8%)	865 (5.8%)	3,103 (9.2%)	<0.001
Diagnosis of infection§				<0.001
No	7,891 (41.7%)	2,968 (20.0%)	10,859 (32.2%)	
Yes	11,050 (58.3%)	11,841 (80.0%)	22,891 (67.8%)	

Data are n (%) of antibiotic prescriptions unless otherwise indicated. For antibiotics and visit diagnoses, each category is compared with all others (Chi-square or Fisher's exact test); for other variables, a single Chi-square test is reported. (A), WHO Access group; (W), WHO Watch group. ‡External route includes topical, ophthalmic, and otic preparations. §Prescriptions with a recorded diagnosis of infection. ENT, ear, nose, and throat; IQR, interquartile range.

Table 3. Microbiological cultures related to antibiotic prescriptions in three MNGHA primary care centers, Riyadh, 2022

	Adults N=18,941	Pediatrics N=14,809	Total N=33,750	p-value
Culture performed				<0.001
No	12,673 (66.9%)	13,673 (92.3%)	26,346 (78.1%)	

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	Adults N=18,941	Pediatrics N=14,809	Total N=33,750	p-value
Yes	6,268 (33.1%)	1,136 (7.7%)	7,404 (21.9%)	
Culture timing¶				<0.001
Before prescription	3,626 (57.8%)	492 (43.3%)	4,118 (55.6%)	
After prescription	2,642 (42.2%)	644 (56.7%)	3,286 (44.4%)	
Specimen type¶				
Urine	5,185 (82.7%)	792 (69.7%)	5,977 (80.7%)	<0.001
Vaginal	592 (9.4%)	8 (0.7%)	600 (8.1%)	<0.001
Throat	173 (2.8%)	108 (9.5%)	281 (3.8%)	<0.001
Stool	119 (1.9%)	96 (8.5%)	215 (2.9%)	<0.001
Blood	54 (0.9%)	63 (5.5%)	117 (1.6%)	<0.001
Ear	55 (0.9%)	49 (4.3%)	104 (1.4%)	<0.001
Wound	46 (0.7%)	13 (1.1%)	59 (0.8%)	0.152
Others	44 (0.7%)	7 (0.6%)	51 (0.7%)	0.748
Culture result¶				<0.001
Negative	4,796 (76.5%)	954 (84.0%)	5,750 (77.7%)	
Positive	1,472 (23.5%)	182 (16.0%)	1,654 (22.3%)	
Isolated organism#				
Escherichia coli	496 (33.7%)	68 (36.6%)	564 (34.0%)	0.437
Streptococcus agalactiae (group B)	392 (26.6%)	10 (5.4%)	402 (24.2%)	<0.001
Klebsiella spp.	122 (8.3%)	11 (5.9%)	133 (8.0%)	0.261
Staphylococcus aureus	32 (2.2%)	7 (3.8%)	39 (2.4%)	0.194
Pseudomonas spp.	26 (1.8%)	5 (2.7%)	31 (1.9%)	0.383
Streptococcus pyogenes (group A)	3 (0.2%)	24 (12.9%)	27 (1.6%)	<0.001
Enterococcus spp.	19 (1.3%)	3 (1.6%)	22 (1.3%)	0.730
Proteus mirabilis	12 (0.8%)	5 (2.7%)	17 (1.0%)	0.034
MRSA	7 (0.5%)	5 (2.7%)	12 (0.7%)	0.007

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	Adults N=18,941	Pediatrics N=14,809	Total N=33,750	p-value
Neisseria gonorrhoeae	7 (0.5%)	0 (0.0%)	7 (0.4%)	1.000
Salmonella spp.	2 (0.1%)	5 (2.7%)	7 (0.4%)	<0.001
Other Gram-negative bacteria	277 (18.8%)	28 (15.1%)	305 (18.4%)	0.212
Fungi	20 (1.4%)	1 (0.5%)	21 (1.3%)	0.501
Others	57 (3.9%)	14 (7.5%)	71 (4.3%)	0.020
Antimicrobial susceptibility††				0.421
Susceptible	836 (82.7%)	112 (85.5%)	948 (83.0%)	
Resistant	175 (17.3%)	19 (14.5%)	194 (17.0%)	

Data are n (%). ¶Percentages among prescriptions with a culture (adults n=6,268; pediatrics n=1,136). #Percentages of isolates (adults n=1,472; pediatrics n=186). ††Among isolates with susceptibility results (adults n=1,011; pediatrics n=131). For specimen type and organism, each category is compared with all others (Chi-square or Fisher's exact test). MRSA, methicillin-resistant Staphylococcus aureus.

FIGURE LEGENDS

Figure 1. Monthly number of antibiotic prescriptions by patient group in three MNGHA primary care centers, Riyadh, January–December 2022 (N=33,750). The shaded area indicates October–December.

Figure 2. Distribution of antibiotic prescriptions by antibiotic class and patient group (N=33,750). Others include nitrofurantoin, doxycycline, sulfamethoxazole-trimethoprim, and streptomycin.

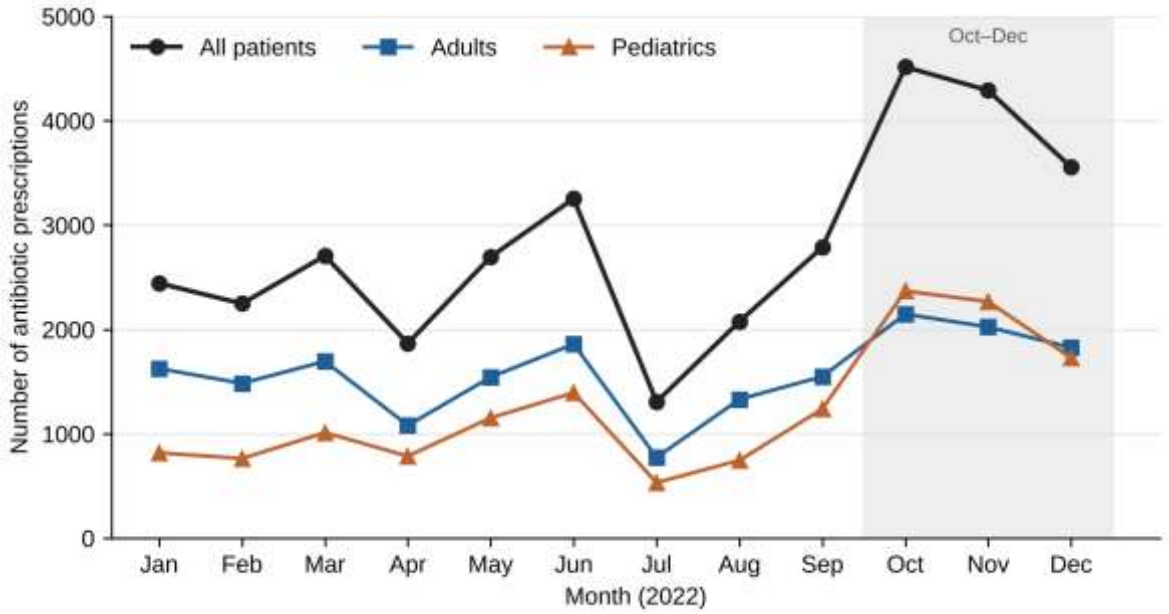

Figure 1

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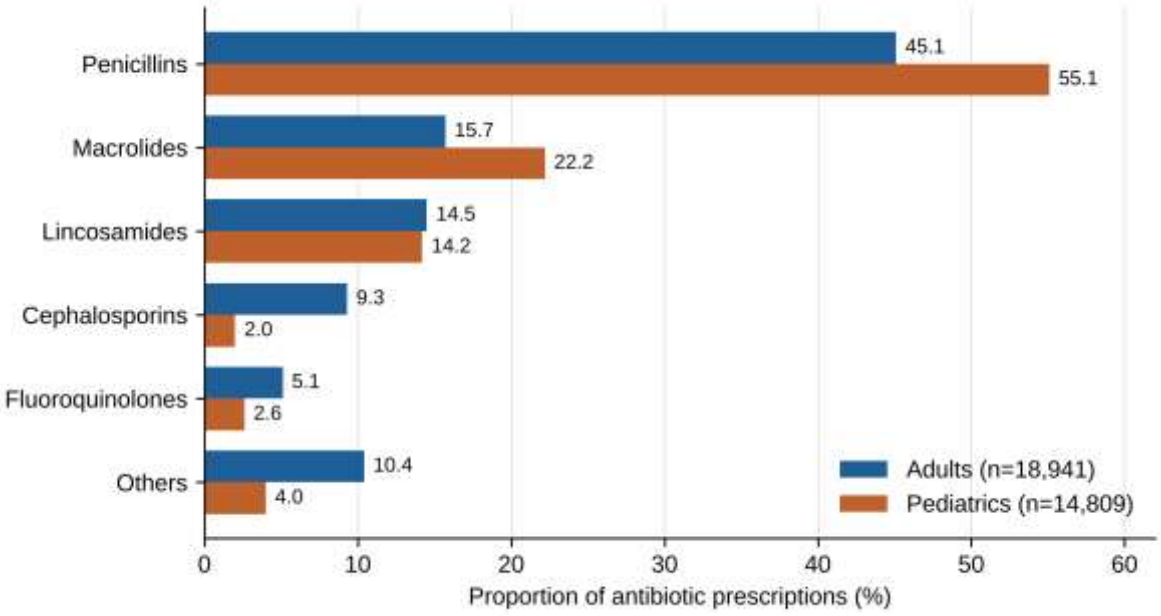

Figure 2