Antibiotic Prescribing Pattern; Errors Perspective in Primary Health Care Centers in Riyadh City, Saudi Arabia

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ABSTRACT

Objectives: To explore the medication error in prescribing antibiotics in primary health care centers in Riyadh City, Saudi Arabia. **Methods:** It is a retrospective analysis of antibiotics prescribing errors of randomly selected twenty-five primary health care centers in Riyadh city. One month's prescription had been reviewed. The expert pharmacist revised the prescription and documented the errors. The medication error form of MOH had been used to document the errors. **Results:** During the study period, 18,031 prescriptions were recorded in all the included study settings. Of the total prescriptions, 3,879 (21.51%) contained antibiotics and were included in the current study. Of the total prescriptions, 1388 (35.78%) prescriptions detected medication errors were analyzed in the current study. The most errors detected in the prescription were height not written 1388 (100%), followed by diagnosis not found 535 (38.54%), and body weight not written 492 (35.45%). The antibiotics errors occurred with pediatrics and adolescents < or = 20 years 673 (50.08%) and adults > 20 years with 671(49.92%) with statically significant differences between all medication error types within pediatrics and adults (p=0.000). The errors identified mainly were related to inappropriate drug selection that occurred in 748 (53.9%) of the prescriptions, followed by low therapeutic dose 277 (20.0%) and dose frequency 175 (12.6%), with statistically significant differences between all types (p=0.000). The most Medications with errors were Amoxicillin 576 (41.5%), Amoxicillin/clavulanate 277 (28.1%), Fucidic Acid 123 (8.9%), and Azithromycin 116 (8.4%). **Conclusion:** One-third of primary healthcare centers prescriptions contained antibiotics and had at least one error. The most errors related to demographic information and most prescribed antibiotics at primary healthcare centers. Targeting electronic prescribing systems and implementing stewardship antimicrobial programs at primary healthcare centers are highly suggested.
Keywords: Medication error, Prescribing , Antibiotics, Primary health care center, Riyadh, Saudi Arabia.

INTRODUCTION

Drug-related problems are a significant negative feedback of drug therapy.[1-6] It might affect the patient clinically and economically in the health care system.[1-11] Drug-related problems consist of eight problems based on the American Society of Health Care Pharmacists in the United States of America.[12,13] Medication errors are a severe concern of drug-related problems.[14,15] The error might occur when prescribing, dispensing, and administering medication. Prescribing errors are a significant concern today, clinically and economically. Meta-analysis studies and others explored the high percentage of prescribing errors and emphasized the importance of healthcare centers.[16-24] Antibiotic was the most implicated prescribing error at primary healthcare centers.[25,26] Thus, various studies highlighted antibiotic prescribing errors at healthcare facilities.[27-32]

The pattern errors of antibiotic prescriptions are crucial to understanding the problem's magnitude and factors that might affect the mistakes and recommend preventive measures in future Primary health centers. The Primary Health Center (PHC) is accountable for treating and preventing diseases and is therefore treated as the base of the health care system. Thus, by determining medication errors in primary health centers and avoiding or reducing them, the healthcare system can improve health outcomes and decrease hospitalizations and costs.[25] The pharmacist's role in improving clinical and economic outcomes by avoiding medication errors is well-established locally.

Antibiotics are frequently used in health service settings and should be utilized rationally to provide optimum benefits.[33] Many studies stated that the overuse or misuse of Antibiotics might modify their efficacy of antibiotics.[34] Antibiotics fail when prescribed for diseases not indicated or at low regimens.[35] Detailed data on antibiotic use must be obtained to inhibit overprescribing or misuse of antibiotics.[36] Unfortunately, very few studies investigated the issue of Antibiotic prescribing errors in PHCs in Saudi Arabia. The authors were unfamiliar with previous studies on antibiotic prescription errors at the primary healthcare center in Riyadh city or locally or in Gulf and Arabic countries about the topic. Therefore, the current study was conducted at a randomized selected primary healthcare center in Riyadh City to determine the pattern of antibiotic prescription errors.

METHODS

The study was a retrospective analysis of the antibiotic prescribing Errors in primary health care centers in Riyadh city. Riyadh City is served by almost 120 Primary Healthcare Centers (PHC) distributed across five health sectors. The study sample consisted of Antibiotic prescriptions. For this study, we selected 25 PHCs from a random

sample. These centers were typical of those across the city, offering services to a large population relatively representative of Riyadh City. The scope of primary health care services is explained in a previous study.[37] The target population was all patients attending primary care centers. Antibiotic prescriptions given a month were recorded by a medication error form, certified by the general administration of pharmaceutical care from the Ministry of Health, as discussed before.[38] That is to determine the medication error rate in antibiotic prescriptions in PHCs and the types of medication errors. The qualified pharmacists recorded the details in the medication error form, which consisted of information about the patient's age, gender, nationality, allergy, medication name, dosage form, type of error, and the specialty of prescribers. Data collection was performed every day except for weekends. Permission to conduct the research was obtained from the general administration for analyses and studies at the Ministry of Health (1440-1033702). A letter of approval was sent to the health sectors. Data was collected for one month through December 2018. The Statistical Package of the Social Sciences version 20 software analyzed the data. Descriptive statistics were used to calculate frequencies and percentages. Chi-Square was used to determine the difference between categorical variables. A *p*-value of 0.005 was set as statistical significance at a 95% confidence interval. The STROBE (Strengthening the reporting of observational studies in epidemiology statement: guidelines for reporting observational studies) guided the reporting of the current study.[39-40]

RESULTS

During the study period, 18,031 prescriptions were recorded in all the included study settings. Of the total prescriptions, 3,879 (21.51%) contained antibiotics and were included in the current study. Of the total prescriptions, 1388 (35.78%) prescriptions detected medication errors were analyzed in the current study. The description of patients with prescriptions containing antibiotics medication errors is shown in Table 1. The proportion of male patients was 648 (46.7%), while 740 (53.3%) were females, with statistically significant differences between them (p=0.001), while there are non-statistically significant differences between pediatrics (< or = 15 Years) and adults (> 15 years) ((p=0.575). The nationality distribution for 1270 (91.49%) patients was Saudi nationality with statistically significant differences between non-Saudi nationality (p=0.000), while there are non-statistically significant differences between pediatrics (< or = 15 Years) and adults (> 15 years) ((p=0.575) ((p=239)). The patients' mean age (SD) recorded was 24.61 (19.92), and the weight was 10.54 KG (19.33). The patients' mean age (SD) recorded was 24.61 +/- (19.92), with the average age for pediatrics was 6.56 +/- (3.88), and for adults was 39.74 +/- (14.66), with statistically significant differences between pediatrics and adults (p=0.000). The number of medications per prescription was 2.77 within (1-6) per prescription, with a higher number of medications in pediatrics prescriptions with statistically significant differences between pediatrics and adults (p=0.000). The number of Antibiotics per prescription was 1.07 within (1-3) per prescription, with a higher number of antibiotics in adult

Table 1: Demographic data of prescriptions with errors.

	< or = 15 Years		> 15 years		Total		All ages		
Gender	**Response Count**	**Response Percent**	**Response Count**	**Response Percent**		**p-value (X2)**	**Response Count**	**Response Percent**	**p-value (X2)**
Male	292	21.7	337	25.1	629	0.575	648	46.7	0.001
Female	321	23.9	394	29.3	715		740	53.3	
Total	613		731		1344		1388		
Nationality							**Response Count**	**Response Percent**	
Saudi	567	42.2	663	49.3	114	0.239	1270	91.49	0.000
Non-Saudi	46	3.4	68	5.1	1230		118	8.51	
Total	613		731		1344		1388		
Others	**Response Count**	**Mean**	**SD**	**Response Count**	**Mean +/- SD**	**p-value (X2)**	**Response Count**	**Mean**	**SD**
Age	613	6.56	3.88	731	39.74 +/- 14.66	0.000	1344	24.61	19.92
Number of medications per prescription	613	2.91	0.803	731	2.65 +/- 0.99	0.000	1388	2.77	(1-6) range
Number of Antibiotics per prescription	613	1.03	0.169	731	1.10 +/- 0.29	0.000	1388	1.07	(1-3) range
Number of Non-Antibiotics per prescription	613	1.89	0.816	731	1.55 +/- 0.99	0.000	1388	1.70	(0-5) range
Type of patient character-istics errors	**Response Count**	**Response Percent**	**Response Count**	**Response Percent**		**p-value (X2)**	**Response Count**	**Response Percent**	
Height	613	45.5	731	54.4	1344	0.000	1388	100.00	
No diagnosis	217	16.1	304	22.6	525	0.013	535	38.54	
Body Weight (not written)	104	13.5	388	50.3	492	0.000	492	35.45	
Age (not written)	44	3.3	0	0	44	0.000	44	3.17	
Gender	0	0	0	0	0	>0.05	0	0.00	
Nationality	0	0	0	0	0	>0.05	0	0.00	

prescriptions with statistically significant differences between pediatrics and adults (p=0.000). The Number of Non-Antibiotics per prescription was 1.7 within (0-5) medications per prescription, with a higher number of non-antibiotic medications in pediatric prescriptions with statistically significant differences between pediatrics and adults (p=0.000). The most documented diagnosis was Upper respiratory tract infection 216 (15.6%) and Tonsillitis 88 (6.3%) in pediatrics and adults, as explored in Table 2.

Table 2: Diagnosis of prescriptions with errors.

Diagnosis	Frequency	Percentages
No diagnosis	535	38.5
URTI	216	15.6
Tonsillitis	88	6.3
Cough	56	4.0
Pharyngitis	53	3.8
Otitis Media	52	3.7
Tooth infection	41	3.0
Dental pain	29	2.1
Burn	28	2.0
UTI	26	1.9
Bronchial Asthma	26	1.9
Fever	21	1.5
Bronchitis	20	1.4
DM	18	1.3
Bacterial vaginosis	17	1.2
Dermatitis	15	1.1
Conjunctivitis	13	.9
Common cold	13	.9
HTN	12	.9
Sinusitis	11	.8
Others	98	7.06
Total	1388	100

Patient characteristics errors

The most errors with patient characteristics were height not written in 1388 (100%) antibiotics prescriptions and diagnosis not written 535 (38.54%), followed by body weight not written 492 (35.45%) and age not written 44 (3.17%). The adult prescription had higher errors than pediatrics, with statistically significant differences between pediatrics (< or = 15 Years) and adults (> 15 years) ((p=0.000). The adult's prescriptions had more errors with writing height 731 (54.4%), body weight 388 (50.3%), and the diagnosis 304 (22.6%) than pediatrics prescriptions with statistically significant differences between pediatrics and adults (p<0.01). In contrast, the pediatrics prescription had more errors in writing age 44 (3.3%) than adults, with statistically significant differences between pediatrics and adults (p<0.000). However, there were no errors with writing gender or nationalities among pediatrics and adults, with non-statistically significant differences between pediatrics and adults (p>0.5), as explored in Table 2.

Antibiotics errors

The most type of route of administration errors thought orally 1197 (86.2%) with statically significant differences among them (p=0.000). The adult prescription had higher errors than pediatrics, with statistically significant differences between pediatrics (< or = 15 Years) and adults (> 15 years) ((p=0.000). The most errors in medications were with oral antibiotics 1197 (86.2%), with suspension 550 (39.6%), tablet 319 (23.0%), and capsule 310 (22.3%). The pediatrics prescription had higher errors with suspension and with tablets and capsules in adults prescriptions with statistically significant differences between pediatrics (< or = 15 Years) and adults (> 15 years) ((p=0.000). The most antibiotics prescribed errors as generic were 937 (67.5%), with non-statistically significant differences between pediatrics and adults (p=0.081). The majority of antibiotics were treatment was 1346 (97.6%), and they were Bactericidal 1211(87.2%), with statically significant differences between them (p=0.000), with statistically significant differences between pediatrics and adults prescriptions (p=<0.05) as declared in Table 3.

Table 3: Antibiotics errors.

	< or = 15 Years		> 15 years				All ages		p-value
Rout of administrations	Response Count	Response Percent	Response Count	Response Percent	Total	p-value (X2)	Response Count	Response Percent	
Oral	579	43.1	583	43.4	1152	0.000	1197	86.2	0.000
Eye/Ear/Nose	16	1.2	44	3.3	60		66	4.8	
Topical skin	18	1.3	104	7.7	122		125	9.0	
Total	613		731				1388	100.0	
Dosage Form									
Suspension	524	39	12	0.9	536	0.000	550	39.6	0.000
Tablet	10	0.7	298	22.2	308		319	23.0	
Capsule	31	2.3	269	20	300		310	22.3	
Ointment	22	1.6	118	8.9	141		146	10.5	
Drops (nose, ear, eye)	14	1.0	33	2.5	47		51	3.7	
Syrup	10	0.7	0	0	10		10	0.7	
Cream	2	0.1	0	0	2		2	0.1	
Total	613		731		1344		1388	100	

continued...

Table 3: Cont'd.

The drug was written as generic or trade.									
Generic	395	29.4	504	37.5	899	0.081	937	67.5	0.000
Trade	218	16.2	227	16.9	445		451	32.5	
Toatl	613		731		1344		1388	100.0	
The drug was written as treatment or prophylaxis.							**Response Count**	**Response Percent**	
Treatment	596	44.7	705	52.8	1302	0.005	1346	97.6	0.000
Prophylaxis	7	0.5	26	1.9	33		33	2.4	
Total	604		731		1335		1379	100.0	
The drug was written as Bactericidal or Bacteriostatic.							**Response Count**	**Response Percent**	
Bactericidal	524	39	656	48.8	1180	0.018	1211	87.2	0.000
Bacteriostatic	89	6.6	75	5.6	164		177	12.8	
Total	613		731		1344		1388	100.0	
Type of Medication Errors							**Frequency**	**Percentages**	
Inappropriate drug choice	173	12.9	561	41.7	734	0.000	748	53.9	0.000
Low dose	259	19.3	18	1.3	277		277	20.0	
Dose frequency	78	5.8	94	7.0	172		175	12.6	
High dose	69	5.1	1	0.1	70		71	5.1	
Treatment duration	28	2.1	21	1.6	49		54	3.9	
Other medication errors	6	0.4	19	1.4	25		46	3.3	
Inappropriate dosage form	0	0	14	1.0	14		14	1.0	
Medication strength	0	0	2	0.1	2		2	.1	
Inappropriate route of administration	0	0	1	0.1	1		1	.1	
Total	613		731		1344		1388	100.0	
Antibiotics Names							**Frequency**	**Percentages**	
Amoxicillin	310	23.1	248	18.5	558	0.000	576	41.5	
Amoxicillin/clavulanate	168	12.5	219	16.3	387		390	28.1	
Fucidic Acid	14	1	106	7.9	120		123	8.9	
Azithromycin	65	4.8	42	3.1	107		116	8.4	
Gentamicin	17	1.3	40	3	57		61	4.4	
Bactrim	25	1.9	19	1.4	44		45	3.2	
metronidazole	6	0.4	31	2.3	37		38	2.7	
Ciprofloxacin	0	0	11	0.8	11		13	.9	
Tetracycline	5	0.4	5	0.4	10		12	.9	
Doxycycline	1	0.1	5	0.4	6		7	.5	
Clarithromycin	0	0	3	0.2	3		3	.2	
Flamazine	2	0.1	0	0	2		2	.1	
chloramphenicol	0	0	1	0.1	1		1	.1	
Erythromycin	0	0	1	0.1	1		1	.1	
Total	613		731		1344		1388	100	

The errors identified mainly were related to inappropriate drug selection that occurred in 748 (53.9%) of the prescriptions, followed by low therapeutic dose 277 (20.0%) and dose frequency 175 (12.6%) statically significant differences between all types (p=0.000). The most Medications with errors were Amoxicillin 576 (41.5%), Amoxicillin/clavulanate 277 (28.1%), Fucidic Acid 123 (8.9%), and Azithromycin 116 (8.4%) as demonstrated in Table 5. The antibiotics errors occurred with pediatrics < or = 15 years 613 (45.61%) and adults > 15 years with 731(54.39%), with statically significant differences between all medication error types within pediatrics and adults (p=0.000). The Inappropriate drug choice

561 (40.7%) and dose frequency errors 94 (7%) mainly occurred in adults with statically significant differences among all types of medication errors and age levels(p=0.000). In contrast, low dosing 259 (19.3%) and Inappropriate drug choice 173 (12.9%) mainly occurred in < or = 15 with statically significant differences among all types of medication errors and age levels (p=0.000) as explored in Table 3.

Prescriber errors

The number of prescribers who prescribed the antibiotics in this study was general practitioners (GPs) 943 (68.01%), specialists 439 (31.67%), with statically significant differences between them (p=0.000). The general practitioners had higher errors with adult prescriptions 539 (40.2%), while the specialty had more errors with pediatric prescriptions, with statistically significant differences between pediatrics and adult prescriptions (p=0.000). The most prescriber's specialty committed errors were general physician, 478 (49.43%); family medicine, 370 (38.26%); and dentists 48 (4.76%) statically significant differences among all specialties (p=0.000). The general practitioners and dentists had higher errors with adult prescriptions 321 (35.4%) and 27 (3%), respectively, while family medicine had more errors with pediatric prescriptions 207 (22.8%), with statistically significant differences between pediatric and adult prescriptions (p=0.000) as explored in Table 4.

Table 4: Prescriber errors.

	< or = 15 Years		> 15 years				All prescriptions		p-value
Rank of Prescriber	**Response Count**	**Response Percent**	**Response Count**	**Response Percent**	**Total**	**p-value (X2)**	**Response Count**	**Response Percent**	
General Practitioner	373	27.8	539	40.2	912	0.000	943	68.01	0.000
Specialist	239	17.8	187	13.9	426		439	31.67	
Other	0	0	4	0.3	4		4	0.32	
Total	612		730				1386		
Specialty of Prescriber									
General Physician	133	14.6	321	35.4	454	0.000	478	49.43	0.000
Family medicine	207	22.8	151	16.6	358		370	38.26	
Dentist	19	2.1	27	3.0	46		46	4.76	
Other	0	0	4	0.4	4		26	2.69	
Pediatric	12	1.3	10	1.1	22		22	2.28	
Internal medicine	8	0.9	7	0.8	15		16	1.65	
Gynecologist/ Obstetrician	2	0.2	7	0.8	9		9	0.93	
Total	381		527		908		967		

Table 5: The antibiotic prescription among prescribers ranking vs. demographic information.

Rank of prescriber	Type of Medication error										p-value
	Age		Gender		Nationality		Weight*	Height	Diagnosis*	Total	
	Count	Percent	Female	Male	Saudi	Non-Saudi					
GPs	31	70.5%	0(0%)	0(0%)	0(0%)	0(0%)	335 (68.1%)	943 (68.01%)	385 (71.96%)	1,694 (69.05%)	0.000*
Specialists	13	29.5%	0 (0%)	0 (0%)	0 (0%)	0 (0%)	153 (31.1%)	439 (31.67%)	150 (28.04%)	755 (30.77%)	
Others	0	0.00%	0(0%)	0(0%)	0(0%)	0(0%)	4 (0.8%)	4 (0.32%)	0 (0%)	4 (0.18%)	
Total	44	100.00%	0(0%)	0(0%)	0(0%)	0(0%)	492 (100%)	1388 (100%)	535(100%)	2,453	

Table 6: The antibiotic prescription among prescriber's specialty vs. vs. demographic information.

Specialty of prescriber		Type of Medication error						p-value
	Age*	Diagnosis*	Gender	Nationality	Height*	Weight*	Total	
General Physician	24 (64.84%)	253(47.29%)	0(0.0%)	0(0.0%)	478 (49.43%)	328 (66.66%)	1,083 (32%)	0.000*
Family medicine	12 (32.24%)	122 (22.8%)	0(0.0%)	0(0.0%)	470 (38.26%)	144 (29.26%)	748 (22.16%)	
Internal medicine	1(2.7%)	8(1.5%)	0(0.0%)	0(0.0%)	16 (1.65%)	0 (0.0%)	25 (0.74%)	
Gynecologist	0(0.0%)	2(0.37%)	0(0.0%)	0(0.0%)	9 (0.93%)	0 (0.0%)	11 (0.32%)	
Dentists	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	46 (4.76%)	20 (4.06%)	66 (1.95%)	
Pediatrics	37 (100%)	535(100%)	0(0.0%)	0(0.0%)	22 (2.28%)	492 (100%)	1086 (32.19%)	
Others	0(0.0%)	8(1.5%)	0(0.0%)	0(0.0%)	26 (2.28%)	0 (0.0%)	34 (1%)	
Total	37 (100%)	535 (57.0%)	0(0.0%)	0(0.0%)	1388 (100%)	492 (100%)	3,374	

The general practitioner 1,694 (69.05%), and specialist physicians 755 (30.77%), had the most demographic errors, with height, diagnosis, and body weight not documented, with statistically significant differences between them (p=0.000). All specialties with the most errors in demographic information were height, body weight, diagnosis, and age, emphasizing that the pediatric physician had the highest error, 1086 (32.19%), followed by general physicians 1,083 (32%) and family medicine 748 (22.16%), with statistically significant differences (p=0.000), as in Tables 5 and 6. Most antibiotic errors were done by general physician 943 (76.93%) and specialists 439 (31.63%). The most common types of medication errors were inappropriate drug choice error type 320(66.9%) and low dosing 58(12.1%) by General Physicians. In contrast, the family physician had more errors with inappropriate drug choice error type 162(43.8%) and 75(20.3%) dosing frequency. However, the dentist had an inappropriate drug choice error type 22 (47.8%) and duration of treatment 13(28.3%). There were statically significant variations among physician's specialties and types of mediation errors with statistically significant differences (p=0.000), as declared in Tables 7 and 8.

Factor associated with antibiotic error

Logistic regression multinominal analysis declared that The odds of antibiotics prescribing errors (Inappropriate drug choices) were seven times higher with the bactericidal antibiotics (OR = 7, 95% CI = 1.144–6.109, p-value = 0.000) compared to Bacteriostatic, other factors statistically significant differences (p>0.05). In antibiotics prescription (High doses), the odds of errors were 414 times higher with age < or = 15 years (OR = 414.385, 95% CI = 11.244–15,271.363, p-value = 0.001) compared to age > 15 years, other factors statistically significant differences (p>0.05). The odds ratio of antibiotics prescribing errors (low doses) the odds of errors were 31 times higher with age < or = 15 years (OR = 31.206, 95% CI = 2.296–424.185, p-value = 0.010) compared to age > 15 years, other factors statistically significant differences (p>0.05). All factors had non-statistically significant differences in the Medication strength of antibiotics prescribing errors (p>0.05). The odds of antibiotics prescribing errors (Dose frequency) were 3.5 times higher with the bactericidal antibiotics (OR = 3.561, 95% CI = 1.100–11.528, p-value = 0.034) compared to Bacteriostatic, other factors statistically

Table 7: The antibiotic prescription among prescribers ranking vs. type of medication errors.

Rank of prescriber	Type of Medication error										p-value
	Inappropriate drug choice	High dose	Low dose	Medication strength	Dose frequency	Treatment duration	Inappropriate dosage form	Inappropriate route of administration	Other medication errors	Total	
GPs	538 (57.1%)	26 (2.8%)	191 (20.3%)	0 (0%)	97 (10.3%)	44 (4.7%)	10 (1.1%)	1 (0.1%)	36 (3.8%)	943 (100.0%)	0.000
Specialists	204 (46.5%)	45 (10.3%)	86 (19.6%)	2 (0.5%)	78 (17.8%)	10 (2.3%)	4 (0.9%)	0 (0%)	10 (2.3%)	439 (100.0%)	
Others	4 (100.0%)	0 (0%)	0 (0%)	0 (0%)	0 (0.0%	0 (0.0%)	0 (0%)	0 (0%)	0 (0%)	4 (100.0%)	
Total	748 (53.9%)	71 (5.1%)	277 (20.0%)	2 (0.1%)	175 (12.6%)	54 (3.9%)	14 (1.0%)	1 (0.1%)	46 (3.3%)	1388 (100%)	

Table 8: The antibiotic prescription among prescriber's specialty vs types of medication errors.

Specialty of prescriber	Type of Medication error										p-value
	Inappropriate drug choice	High dose	Low dose	Medication strength	Dose frequency	Treatment duration	Inappropriate dosage form	Inappropriate route of administration	Other medication errors	Total	
General Physician	320 (66.9%)	11 (2.3%)	58 (12.1%)	0 (0.0%)	33 (6.9%)	12 (2.5%)	8 (1.7%)	0 (0.0%)	36 (7.5%)	478 (100.0%)	0.000
Family medicine	162 (43.8%)	45 (12.2%)	64 (17.3%)	2 (0.5%)	75 (20.3%)	10 (2.7%)	2 (0.5%)	0 (0.0%)	10 (2.7%)	370 (100.0%)	
Internal medicine	9 (56.3%)	0 (0.0%)	5 (31.3%)	0 (0.0%)	1 (6.3%)	0 (0.0%)	1 (8.3%)	0 (0.0%)	0 (0.0%)	16 (100%)	
Gynaecologist	7 (77.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (22.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	9 (100.0%)	
Dentists	22 (47.8%)	4 (8.7%)	5 (10.9%)	0 (0.0%)	1 (2.2%)	13 (28.3%)	1 (2.2%)	0 (0.0%)	0 (0.0%)	46 (100.0%)	
Pediatrics	15 (68.2%)	0 (0.0%)	7 (31.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	22 (100.0%)	
Others	4 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4 (100.0%)	
Total	539 (57.0%)	60 (6.3%)	139 (14.7%)	2 (0.2%)	112 (11.9%)	35 (3.7%)	12 (1.3%)	0 (0.0%)	46 (4.9%)	945 (100%)	

Table 9: Logistic regression analysis of factors associated with Antibiotics prescribing errors.

		Characteristics		Odd ratio (OR)	CI 95%		P-value
1	Inappropriate drug choices	Type of antibiotics	Bactericidal	7.000	2.409	20.345	0.000
			Bacteriostatic				
		All other factors; gender, nationality, age levels, dosage form, route of administration, drug names, prescribing goals, rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					
2	High doses	Age	< or = 15 years	414.385	11.244	15271.363	0.001
			> 15 years				
		All other factors; gender, nationality, dosage form, route of administration, drug names, type of antibiotics prescribing goals, rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					
3	Low doses	Age	< or = 15 years	31.206	2.296	424.185	0.010
			> 15 years				
		Type of antibiotics	Bactericidal	6.059	1.666	22.031	0.006
			Bacteriostatic				
		All other factors; gender, nationality, dosage form, route of administration, drug names, type of antibiotics, prescribing goals, rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					
3	Medication strength	All other factors; gender, nationality, age levels, dosage form, route of administration, drug names, type of antibiotics, prescribing goals, the rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					
4	Dose frequency	Type of antibiotics	Bactericidal	3.561	1.100	11.528	0.034
			Bacteriostatic				
		All other factors; gender, nationality, age levels, dosage form, route of administration, drug names, prescribing goals, rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					
5	Treatment duration	Dosage form	Drops (nose, ear, eye)	3 B	0.202 B	4.9 B	0.000
		All other factors: gender, nationality, age levels, non-drops (nose, ear, eye) dosage form, route of administration, drug names, type of antibiotics, prescribing goals, rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					
6	Inappropriate dosage form	All other factors; gender, nationality, age levels, dosage form, route of administration, drug names, type of antibiotics, prescribing goals, the rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					
7	number of antibiotics per prescription	All other factors; gender, nationality, age levels, dosage form, route of administration, drug names, type of antibiotics, prescribing goals, the rank of prescribers, prescriber specialties, and number of antibiotics per prescription were non-statistically significant differences (p>0.05).					

significant differences (p>0.05). The odds of antibiotics prescribing errors (Treatment duration) were 3 B times higher with the Drops (nose, ear, eye) (OR = 3 B, 95% CI = 0.202 B–4.9 B, p-value = 0.034) compared to other dosage forms of antibiotics, other factors statistically significant differences (p>0.05). Inappropriate dosage forms and number of antibiotics per prescription are not associated with antibiotics prescribing errors, with non-statistically significant differences (p>0.05), as illustrated in Table 9.

DISCUSSION

National medication safety is one of the critical programs established at the Ministry of Health hospital.[41,42] The proposed problem is preventing drug-related problems with an emphasis on medication errors. Thus, the program's impact is well documented clinically and economically at international and local levels.[43-47] The pharmacist plays an essential role in the program and prevents medication errors and related issues. Various medications implicated in medication errors, such as cardiovascular medication, electrolytes, and Total parenteral components, with emphasis on antibiotics.[48-53] Various studies revealed antibiotic prescribing errors. Most studies were done in the hospital and emphasized pediatrics.[25-28] The prescribing errors at primary healthcare centers are well documented locally. However, the zooming for prescription-contained antibiotics was not found locally. Thus, the required investigation on primary healthcare centers to explore the situation compared to hospitals. The current study was done at randomized selected primary healthcare centers with revised one-month regular non-electronic prescriptions. On those prescriptions, they choose the prescriptions containing antibiotics that had been prescribed and reviewed by the clinical pharmacist for antibiotic prescription errors. Those errors were in the demographics information errors and medication errors, as revealed in the discussion. The total number of prescriptions was reasonable compared to previous studies and almost better or resembles others.[25–28] The prevalence of errors in antibiotic prescribing was lower than previously in some studies, which has been related to the number of prescribing medications being low or different settings like hospitals or emergency departments setting which had a higher prevalence of medication errors or the antibiotic policy was poorly implemented.[19,25-28,30] In contrast, the percentage of errors was higher than in one study that used electronic prescribing.[29]

The study showed that most of the prescribing was for females, related to primary healthcare visiting, which is most suitable for females to visit the center beside their home, and non-significant between pediatrics and adults like previous study.[19] Most patients were female, resembling

some studies and differences from others related to various research settings.[25-28] Despite the majority of our study sample being female, there was a non-significant between pediatrics and adults in gender, which revealed that antibiotic errors might have occurred in both genders without differences.

Furthermore, most subjects were Saudi, which is expected because of the illegality process for Saudi and non-Saudi working at government agencies. There was a non-significant between pediatrics and adults in nationality, which declared equal occurrences of antibiotic errors in different nationalities. Most previous studies did not explore their nationality,[25-28] which was challenging to compare with previous studies. The primary pediatric age was around six years, while adults were around 40. That expected those age might exposed to viral infection and visit the nearest ambulatory care clinic. The pediatric prescription received higher antibiotics than adults without apparent reason. That is expected because most pediatric diagnostics cases were upper respiratory tract infections and more prescribed antibiotics.

Antibiotic prescribing errors might be divided into various types, including patient characteristics errors, antibiotic errors, and prescriber errors. In the patient characteristics errors, some elements were not found in the prescription, such as height, followed by diagnostic missed in one-third or prescribing and body weight not included in one-third of the primary healthcare sample emphasizing for adults prescriptions like previous study.[26] The pediatric prescription had more errors in writing age than the adult prescription, with statistically significant differences. That is related to not using an electronic prescription, which found lower antibiotics prescribing errors in a previous study).[29] In addition, the patient demographics information is critical, especially for pediatrics, because almost half of pediatric errors emphasize ages less than or equal to 15 years, which requires the body to calculate the appropriate dosing. Thus, most antibiotic errors were low dosing in the study because there was no information on patients to calculate the appropriate dosage.

Antibiotic errors are mostly found with oral route and dosage forms because most primary healthcare centers do not have emergency departments, and Parenteral medicine is unavailable. If there are any emergency cases, they should be transferred to the hospitals. Most errors occurred with an adult were tablets, while in pediatrics, it was a suspension that was expected because each dosage form required based on age level, either adults or pediatrics.

Most antibiotics had errors in using generic names, and for treatment, that is expected because the long duration of treatment might additionally be another error. The adult's prescription had more errors in the treatment than pediatrics, incorrect mistakes in the management period, and more extended time than pediatrics. However, there were no differences between pediatrics and adults in writing trade or generic because the prescriber did not differ in both populations with writing antibiotics. The most common antibiotic error was an inappropriate drug of choice in adults and a low dose in pediatrics. That was expected because one-third of prescriptions missed the diagnosis and body weight to revise the diagnosis and calculate the appropriate dosing for an antibiotic. Electronic prescription is the best choice to solve those problems).[29] Besides, the implementation of medication safety programs in the primary health care center. Most antibiotics had errors, such as Amoxicillin and Amoxicillin/clavulanate, that were expected because most of the diagnostic in adults and pediatrics was upper respiratory tract infections, and those medications are commonly used in practice.

Most patient characteristic errors come from general physicians, which is expected because new staff need an orientation program of medication safety lectures. Unfortunately, most errors are made by pediatrics and general physicians. Thus, special attention should be given to physician prescribers for introductory medication safety lectures to prevent future medication errors. Most prescribers had errors in general practitioner followed by the specialist emphasizing general physician and family medicine that's most of the diseases they can be treated by then and sometimes need to prescribe the antibiotic. The general physician had more errors with adult prescriptions, while the family physician had more errors with pediatrics, which might be related to insufficient knowledge of pediatrics and not being treated by specialized pediatrics.

The most common antibiotic errors were inappropriate drug choices, insufficient doses, and frequent dosing, resembling previous studies.[19,27,30,54] The current differed from the previous study, which used electronic prescriptions[29] such as wrong quantities, wrong doses, and duplicated antibiotics.[29] That is expected because the essential information on the patient's character and the diagnosis was not found. Most of The physician's specialties had the same type of committing antibiotic errors with the inappropriate drug of choice and low doses. However, the dentist had a second significant type, and it was the treatment duration that was related to antibiotic policy that was not implemented at primary health care centers. The medication errors are undoubtedly due to the lack of scientific efficiency of prescribers, insufficient education, updates and training, and limited experience. In addition, Heavy patient loads and work pressure due to inadequate staffing may also be tentative reasons for the error. However, many primary health centers in Riyadh city suggested otherwise. Most antibiotics with errors were Amoxicillin and Amoxicillin/Clavulanate, classified as penicillin groups like previous studies in hospital settings.[26,29,54] That is expected because the primary healthcare center is the first, quickest, and easiest healthcare service patients can contact if they suffer from infectious diseases. The antibiotic classes as penicillin differed from previous studies,[27] in which many errors with Cephalosporins might related to more complications and properly used penicillin before visiting the emergency section.

Several factors might associated with increased or reduced antibiotic prescription errors. Most factors, such as In the current study, age levels, dosage form, route of administration, drug names, prescribing goals, the rank of prescribers, prescriber specialties, and number of antibiotics per prescription, did not affect the type of most antibiotics prescribed errors. However, inappropriate drug choices might be affected by the type of antibiotics, bactericidal or bacteriostatic, related to choosing appropriate antibiotics for each diagnosis; that factor might be affected because the antimicrobial stewardship program was not implemented at primary healthcare centers. The high or low-dose errors might increase with pediatrics due to special attention in dosing calculations without writing the patient's body weight. There are more pediatric antibiotic errors in treatment duration with eye, ear, and nose dosage form errors because they need special attention for the dosage form and dosing calculation, particular administrations, storage conditions after opening the drops, and specialist consultations. The Inappropriate dosage form errors and number of antibiotics per prescription will not affect the errors that might related to a few medications per prescription. The medication errors are undoubtedly due to the lack of scientific efficiency of prescribers, insufficient education, updates and training, and limited experience. In addition, Heavy patient loads and work pressure due to inadequate staffing may also be tentative reasons for the error. However, the large number of primary health centers in Riyadh suggests otherwise. That differed from previous studies due to different site study settings and different types of analysis, in which our study had more detail with each type of antibiotic error.[27,54]

LIMITATIONS

The study had various advantages, including an appropriate sample size better than most previous studies, and the demographic information in gender, nationality, and diagnosis almost resemble adults and pediatrics. The study explored a clear picture of antibiotic prescribing errors in pediatrics and adults and the factors associated with errors. However, the study has various limitations, including using a manual, not computerized, or alerting system in detecting antibiotic errors. Various factors were missed, such as height, body weight, and diagnosis, which were difficult to compare.

CONCLUSION

This study demonstrated a high prevalence of medication errors related to antibiotics. Improving how we prescribe and use antibiotics is critically effective in treating common infections and protecting patients from adverse drug reactions. The antibiotic errors revealed the absence of antimicrobial stewardship programs at primary healthcare centers. The antibiotics prescribing errors might lead to over or under-use antibiotic use and might lead to antibiotic resistance. Targeting to implement antibiotic guidelines emphasizing education and training is highly recommended.

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CONFLICT OF INTEREST

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CONSENT FOR PUBLICATIONS

Informed consent was obtained from all the participants

ETHICAL APPROVAL

This research was exempted from research and ethical committee or an institutional review board (IRB) approval.

https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts-2018/index.html

ABBREVIATIONS

PHCs: Primary healthcare center; **MOH:** Ministry of Health; **KSA:** Kingdom of Saudi Arabia; **USA:** The United States of America.

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