BMC Pediatrics

RESEARCH Open Access

Assessing pediatric antibiotic knowledge and practices among community pharmacists in Palestine: implications for antibiotic use and resistance

Banan M. Aiesh[1,2], Salsabeel Saleh[2], Nadine Matouk[2], Marah Labadi[2], Sanaa Kmail[2], Zaina Baddad[2], Amer A. Koni[2,3], Samah W. Al-Jabi[2] and Sa'ed H. Zyoud[2,4,5*]

Abstract

Background Antibiotics are widely used in the pediatric population, and their inappropriate use contributes to antibiotic resistance, which is a growing concern in developing countries. Therefore, this national cross-sectional study aimed to assess community pharmacists' knowledge, attitudes and practices regarding appropriate antibiotic use and dosing in pediatric patients and to explore the barriers to such use in Palestine.

Methods A questionnaire-based survey was conducted among community pharmacists on the West Bank, Palestine, from September 2022 to March 2023. The survey assessed the pharmacists' sociodemographic characteristics; knowledge, practices, and attitudes toward antibiotic use; and understanding of antibiotic dosing. The data were analyzed using descriptive statistics, and the factors affecting pharmacists' knowledge were evaluated.

Results The study included 301 community pharmacists, with an average age of 30.06 years, who were primarily female (75.1%). The majority of the pharmacists (80.1%) correctly believed that antibiotics are effective against bacterial infections. However, 18.3% believed that antibiotics are effective against viruses. While 61.8% knew that antibiotics kill germs, 32.0% were unaware that not all antibiotics require refrigeration. Furthermore, 67.8% were aware that antibiotics do not speed up recovery from diarrhea. Over 99% of the participants recognized that antibiotic resistance developed due to various resistant mechanisms. The majority (78.7%) believed that each infection needed a different antibiotic. Pharmacists demonstrated reasonable knowledge of antibiotic dosing in case scenarios. Knowledge was positively correlated with years of experience ($P=0.001$).

Conclusions This study revealed that community pharmacy professionals have a good understanding of antibiotic usage in pediatric patients. The findings suggest that professional expertise and quality training improve healthcare services. However, the results may not be universally applicable, as identifying knowledge gaps is necessary to help with the development of focused interventions. Therefore, ongoing educational initiatives, awareness campaigns and antibiotic stewardship programs are recommended.

*Correspondence:
Sa'ed H. Zyoud
saedzyoud@yahoo.com

Full list of author information is available at the end of the article

Keywords Community pharmacists, Knowledge, Attitude, Antibiotic resistance, Pediatrics

Background

Antibiotics are substances that specifically target bacteria, as they can inhibit growth and even kill bacteria; hence, they are intended to treat and prevent bacterial infections [1–3]. Antibiotics are among the most commonly prescribed medications, especially for childhood illnesses, as in pediatric dentistry [4, 5]. However, the major contributors to outpatient visits are acute diarrhea, acute upper or lower respiratory infection, and viral infection with fever, indicating that only a small percentage of pediatric patients (<20%) need antibiotic therapy [6]. On the other hand, the most common condition in pediatric patients who require antibiotic prescription is acute otitis media, as reported in the United States and Canada [7, 8]. While antibiotics are critical in healthcare, their usage in pediatric care, especially in developing countries, presents unique challenges. According to previous studies, antibiotics are responsible for 27% of medication-related pediatric medical errors and 19% of hazardous errors caused by systemic antibiotic use [9–11], especially those related to antibiotic dosing [5]. Antibiotic dosage is determined by taking into account a number of factors, including age, weight, and coexisting disorders [12, 13]. Furthermore, the lack of clinical trials on antibiotics for pediatric patients and the lack of new antibiotic pipelines have led to a paucity of high-level evidence [14, 15]. Antibiotic resistance has reached an alarming level worldwide, particularly in developing countries [16, 17]. The inappropriate use of antibiotics, particularly broad-spectrum antibiotics for these childhood diseases, has contributed largely to the evolution of antibiotic resistance [6], and this is the most serious problem worldwide [18]. Cultural, educational, behavioral, and socioeconomic factors are among the numerous factors that contribute to antibiotic resistance. Therefore, the exacerbation of antibiotic resistance must be clearly and deeply known by all members of the health care system, including pharmacists, and a plan must be presented for an effective strategy to improve antibiotic use and the creation of antibiotic supervision programs to prevent further spread of antibiotic resistance.

While many studies on the appropriate use and dosage of antibiotics for children have been undertaken in various regions of the world, relatively few studies have focused on Palestinian community pharmacists to assess this topic [5, 19–24]. This national study aimed to evaluate the knowledge of community pharmacists on the northern West Bank of Palestine on the appropriate use and dosing of antibiotics for pediatric patients. Overall, this study highlights the importance of increasing awareness campaigns to promote appropriate antibiotic use in pediatric patients. The results of this study may be valuable for policymakers and healthcare providers in developing local guidelines and interventions to improve appropriate antibiotic use.

Methods

Study design and setting

This was a cross-sectional questionnaire-based study that was conducted in Palestine from September 11, 2022, to March 27, 2023, targeting pharmacists working in community pharmacies. Participants were approached from 5 different cities, Nablus, Jenin, Tubas, Tulkarm, and Qalqilya, and from their respective villages and camps, which represent northern Palestine. The data were gathered through the use of a well-organized questionnaire distributed online. This online survey was administered via the SurveyMonkey platform and subsequently disseminated across various digital channels, including WhatsApp, Facebook Messenger, Facebook, and email. Due to logistical limitations, we opted for online data collection methods instead of in-person visits to specific districts. Notably, many other studies have also supported the use of a self-administered questionnaire survey method for data collection [6, 25, 26]. Approximately 10–15 min were needed to complete the questionnaire. The study protocol was approved by the *Institutional Review Board (IRB)* of An-Najah National University.

Sampling procedure

According to a previous study [27], there were 2350 pharmacists in Nablus, Jenin, Tubas, and Qalqilya. The Daniel formula was used [28]; n=Z2*P (1-P)/d2, where n=the calculated sample size for populations exceeding 10,000, z=1.96 (95% CI), d=0.05 (absolute precision as a margin of error), and P=0.5 expected prevalence or response distribution. The sample size was 385 participants. However, since our population was less than 10,000 (N=2,350), we adjusted this number using the adjusted sample equation; adjusted sample=n/(1 + (n/N)). The sample size needed was approximately 331, considering a 5% margin of error, a response of 50%, and a 95% confidence interval.

Questionnaire development

A thorough evaluation of relevant surveys was performed to identify potentially relevant questions for the questionnaire utilized in our study [5, 21, 26, 29–37]. A comprehensive review of the questionnaire was performed to validate the questions and ensure that the answers were correct. The questionnaire was subsequently sent to specialists with extensive research experience, including an infectious disease medical doctor, an infectious

disease clinical pharmacist, and an academic pharmacy researcher. These experts conducted individual reviews of the questionnaire and made comments and modifications. The initial version of the questionnaire was adjusted based on their recommendations. Minor modifications were also made in the subsequent revisions until the final version was obtained. The infectious disease specialists provided correct answers. Finally, all specialists read the final edit and approved it.

Prior to the release of the survey, a pilot study of ten questionnaires was performed to analyze and clarify the questionnaire items. The questionnaire has four major components:

- The first part contains questions regarding sociodemographic characteristics (gender, age, years of working, etc.).
- The second part included questions assessing participants' knowledge, practices, and attitudes toward antibiotic use and antimicrobial resistance.
- The third part was composed of questions regarding a case scenario for antibiotic dosing and labeling of instructions.
- The fourth part concentrates on evaluating the barriers and obstacles to the appropriate prescription and use of antibiotics, as well as the effects of sociodemographic factors on the knowledge of community pharmacists about appropriate antibiotic use in pediatrics.

Table 1 Sociodemographic characteristics of the study sample

Variable	Frequency (%) *N* = 301
Age category (years)	
< 45	270 (89.7)
≥ 45	31 (10.3)
Gender	
Male	75 (24.9)
Female	226 (75.1)
Residency	
Refugee camp	20 (6.6)
Village	131 (43.5)
City	150 (49.8)
Educational level	
Pharmacy, bachelor's degree	231(76.7)
Doctor of pharmacy	47 (15.6)
Master's degree in pharmacy	21 (7.0)
PhD in pharmacy	2 (0.7)
Graduation place	
Palestine	264(87.7)
Outside Palestine	37(12.3)
Position in the pharmacy	
Employee pharmacists	203 (67.4)
Employer pharmacists	98 (32.6)
Years of working	
< 5	183 (60.8)
≥ 5	118 (39.2)
Household income per month	
< 2000 NIS	52(17.3)
2000–4999 NIS	201(66.8)
≥ 5000 NIS	48(15.9)
Hours of work per day	
< 8 h	109(36.2)
8 h	138(45.8)
> 8 h	54 (17.9)

NIS: new Israeli shekel

Inclusion and exclusion criteria

The study included pharmacists in the northern West Bank (Jenin, Nablus, Tulkarm, Qalqilya, Tubas, and their villages and camps), provided that they were registered with Palestine Pharmacists Syndicate and working community pharmacies aged 23 years and older. The study excluded nonworking pharmacists and pharmacists working in pharmaceutical fields other than community pharmacies, such as hospital pharmacies, pharmaceutical factories, and medical representatives.

Statistical analysis

Data analysis was performed with IBM SPSS version 29. Descriptive analysis was used to summarize the data, including frequency and percentage for categorical variables and mean and median for continuous variables. The total knowledge score for antibiotics was calculated and ranged from zero to fifteen, where a score of zero indicated that all questions were answered incorrectly and a score of fifteen indicated that all questions were answered correctly. The pharmacists were then classified as knowledgeable or non-knowledgeable based on their total score. Non-knowledgeable pharmacists were those who answered fewer than eight questions correctly, while knowledgeable pharmacists were those who scored eight or more points. The Mann–Whitney test was used for binary variables, the Kruskal–Wallis test was used for variables with more than two groups to analyze the knowledge score, and a p value less than 0.05 was considered to indicate statistical significance.

Results

Sociodemographic characteristics of the study sample

Among the 301 community pharmacists who completed the questionnaire, the average age was 30.06 years, and the vast majority of the pharmacists were females (75.1%). Approximately half of them lived in the city (49.8%). In addition, 87.7% of them graduated from Palestinian universities, and more than half worked as pharmacy employees (67.4%). In addition, most of the

Table 2 Knowledge of community pharmacists in Palestine about antibiotics

Questions#	Answer	Correct answer *N* (%)	Incorrect answer *N* (%)	Don't know the answer *N* (%)
1. Antibiotics are effective against symptoms of a viral origin such as flu/common cold?	F	241(80.1)	55(18.3)	5 (1.7)
2. Antibiotics are effective for cough that lasts more than a week?	F	181 (60.1)	100 (33.2)	20 (6.6)
3. Antibiotics are safe drugs without adverse effects	F	269 (89.4)	29 (9.6)	3 (1)
4. Should all antibiotics be placed in the refrigerator after reconstitution	F	264 (87.7)	64 (32.0)	8 (2.7)
5. Is aluminum hydroxide + magnesium hydroxide an antibiotic	F	278 (92.4)	4 (1.3)	19 (6.3)
6. Are antibiotics useful for killing germs?	F	102 (33.9)	186 (61.8)	13 (4.3)
7. Does diarrhea improve faster with antibiotics	F	204 (67.8)	77 (25.6)	20 (6.6)
8. Misuse of antibiotics leads to resistance	T	298 (99)	2(0.7)	1 (0.3)
9. Resistance to antibiotics occurs when bacteria develop mechanisms that protect them from the effects of antibiotics	T	299(99.3)	2 (0.7)	0
10. If bacteria are resistant to antibiotics, it can be very difficult to treat the infections	T	276(91.7)	22 (7.3)	3 (1)
11. Each infection needs a different antibiotic	T	237 (78.7)	61 (20.3)	3 (1)
12. Is amoxicillin/clavulanate used in acute otitis media?	T	279 (92.7)	17 (5.6)	5 (1.7)
13. Is trimethoprim/sulfamethoxazole used in lower urinary tract infection	T	280 (93)	12 (4)	9 (3)
14. Is azithromycin used in acute bacterial pharyngitis?	T	280 (93)	20 (6.6)	1 (0.3)
15. Is cefdinir used in acute bacterial sinusitis?	T	244 (81.1)	29 (9.6)	28 (9.3)

#These questions were adapted from previous studies [5, 31–33, 37]

Table 3 Practices of community pharmacists in Palestine toward pediatric antibiotics

Statements #	1 (Weak)	2 (Acceptable)	3 (Good)	4 (Very good)	5 (Excellent)
1. Easily adapt a pediatric antibiotics prescription.	11 (3.7)	31 (10.3)	79 (26.2)	98 (32.6)	82 (27.2)
2. Select the most appropriate dosage form for a given pediatric prescription.	13 (4.3)	9 (3)	28 (9.3)	102 (33.9)	82 (27.2)
3. Assess the suitability of a dose for pediatric antibiotic prescription.	4 (1.3)	20 (6.6)	69 (22.9)	112 (37.2)	96 (31.9)
4. Recalculate the dose written by the physician in the child's antibiotic prescription.	13 (4.3)	29 (9.6)	87 (28.9)	78 (25.9)	92 (30.6)
5. Contact the doctor when inappropriateness in prescription is noted (dose/frequency is too high or too low).	16 (5.3)	25 (8.3)	73(24.3)	82(27.2)	105(34.9)
6. I participate in antibiotic awareness campaigns to promote the optimal use of antibiotics.	40 (13.3)	44 (14.6)	89(29.6)	41(13.5)	87(28.9)

#These statements were adapted from previous studies [35, 36]

participants had less than 5 years of experience (60.8%). All the details can be found in Table 1.

Knowledge of community pharmacists in Palestine on antibiotics

The pharmacists' knowledge about antibiotics is shown in Table 2. The results showed that 18.3% of the pharmacists still believed that antibiotics were effective against viruses. More than half of the pharmacists thought that antibiotics were effective for coughs lasting more than a week, and 61.8% answered that antibiotics were useful for killing germs. Only 67.8% knew that diarrhea did not improve faster with antibiotics.

Antibiotic resistance, according to more than 99% of the pharmacists in our study, occurs when bacteria develop various resistance mechanisms against the effects of antibiotics, and 92.1% of the pharmacists agreed that it can be very difficult to treat the infections they cause.

When azithromycin was used for acute bacterial pharyngitis, 93% of the pharmacists correctly answered that trimethoprim/sulfamethoxazole can be used for lower urinary tract infections. For the otitis and sinusitis scenarios, our findings showed that the majority of pharmacists (92.7% and 81.1%, respectively) correctly answered the use of amoxicillin/clavulanate and cefdinir as therapeutic options.

Practices of community pharmacists in Palestine toward pediatric antibiotics

A descriptive analysis of the practices of community pharmacists toward pediatric antibiotics is shown in Table 3. For example, adaptation to pediatric antibiotic prescriptions was rated as very good for 32.6% of pharmacists and weak for 3.7%. Regarding the recalculation of the dose written by the physician in the prescription of antibiotics for children, 30.6% were excellent, and 4.3% were weak. Furthermore, 34.9% of the patients were

Table 4 Prescription scenario

In this prescription scenario, respondents were shown a prescription for amoxicillin suspension 400 mg/5 mL, dose 800 mg, for a 20-kg patient.	Answer	Correct answer *N*(%)	Incorrect answer *N*(%)
1. You have the above prescription; would you fill this prescription?	No, the dose is too high, I need more information	250 (83)	51 (17)
2. How would you label this prescription?	Give 10 ml by mouth twice daily for 10 days Give 10 ml (800 mg) by mouth twice daily for 10 days	235 (78)	66 (22)

Table 5 Attitudes of pharmacists toward antibiotic use

statements #	Agree *N* (%)	Disagree *N* (%)	I don't know *N* (%)
1- Dispense antibiotics without prescription due to the demand of parents.	61 (20.3)	222 (73.8)	18(6)
2- Antibiotics are medicines of special importance.	289 (96)	7 (2.3)	5 (1.7)
3- I may be held responsible for the nonprescription dispensing of antibiotics, as this is a public health risk.	242(80.4)	46 (15.3)	13(4.3)
4- Inappropriate antibiotic therapy does not cause significant surplus health costs annually.	58(19.3)	231(76.6)	12(4)
5- Education about antibiotics and antibiotic resistance should be more prominent during university training	295(98)	4(1.3)	2(0.7)
6- I consider it important to become acquainted with the antibiotics of the current drug pool and those newly licensed on the market.	288(95.7)	5(1.7)	8(2.7)
7- For parents who request antibiotics for their children without prescription and are probably not in need of antibiotic therapy, I feel obligate to inform and educate them	288(95.7)	9(3)	4 (1.3)
8- There are several occasions when more time is needed to educate patients because doctors have not done this properly.	297(98.7)	3 (1)	1(0.3)
9- The counseling of community pharmacists is equally important as the physician's recommendations	292(97)	7(2.3)	2(0.7)
10- The personality and behavior of the patients significantly influence my dispensing practices.	207(68.8)	87(28.9)	7 (2.3)
11- In detail, the proper use of antibiotics when counseling the patient is described.	290(96.3)	7(2.3)	4(1.3)
12- Proper use of antibiotics would be greater if pharmacists had time to carry out their duties. pharmacological care duties	279(92.7)	14(4.7)	8(2.7)
13- Appropriate patient education would effectively reduce the incidence of infectious diseases	287(95.3)	11(3.7)	3(1)
14- During my work as a pharmacist, I have to make therapeutic decisions about acute infection but also have to provide lifestyle advice to the patient.	292(97)	5(1.7)	4(1.3)
15- I offer probiotics for patients purchasing a prescribed antibiotic.	143(47.5)	111(36.9)	47(15.6)

#These statements were adapted from a previous study [33]

excellent, and 5.3% of them were weak in contacting the doctor when an inappropriate regimen (antibiotic dose/frequency is too high or too low) was noted. According to the analysis of the prescription scenario, 78% of the pharmacists gave instructions correctly, and 83% refused to fill prescriptions due to the wrong dosage (Table 4).

Attitudes of pharmacists toward antibiotic use

As noted in Tables 5 and 95.7% of the pharmacists considered themselves responsible for informing and educating parents who requested antibiotics for their children without a prescription and who were probably not in need of antibiotic therapy. Furthermore, 97% of them agreed that the medicine-related counseling of community pharmacists was just as important as the recommendations of the physician. However, there is some variation, where 20.3% of pharmacists dispense antibiotics without prescriptions due to the demands of parents. Furthermore, 80.4% of the pharmacists believed that nonprescription dispensing of antibiotics was a public health risk, and 47.5% of them offered probiotics for patients purchasing prescribed antibiotics.

Barriers that prevent the appropriate prescription and use of antibiotics

According to the pharmacists, there were many barriers that could prevent appropriate antibiotic prescription and use, such as parents' behavior with respect to antibiotic use (91.7%), physician malpractice with respect to prescribing antibiotics (88.7%), and parents' pressure to prescribe antibiotics (87.3%), as illustrated in Table 6.

The effects of sociodemographic factors on the knowledge of community pharmacists about appropriate antibiotic use in pediatrics

The analysis of sociodemographic factors affecting the knowledge of community pharmacists about antibiotics showed that age, position in the pharmacy, social status, and years of work were independently associated with the knowledge of community pharmacists about

Table 6 Barriers that prevent the appropriate prescription and use of antibiotics

statements #	Yes *N* (%)	No *N* (%)
Patient pressure to prescribe antibiotic.	263 (87.3)	37 (12.3)
Parents' behavior with regard to antibiotic use.	276 (91.7)	24 (8)
Malpractice of the physician with respect to the prescribing of antibiotics.	267 (88.7)	33 (11)
Hard to clinically differentiate between viral and bacterial infections; yet, not requesting microbiological investigation	151 (50.2)	2 (0.6)
No clear understanding/follow-up of the clinical guidelines.	246 (81.7)	54 (17.9)
Limited physician-pharmacist and physician–patient communication related to antibiotic prescription and use	230 (76.4)	70 (23.3)
Antibiotic prescribing regulations.	238 (79.1)	62 (20.6)
Data on antibiotic resistance patterns and availability of narrow spectrum antibiotic.	249 (82.8)	52 (17.3)
Workload and restricted time of consultation.	227 (75.4)	73 (24.2)
Pharmacists' authority is limited	71 (23.6)	230 (76.4)

These statements were adapted from a previous study [26]

antibiotics. Age was positively associated with pharmacist knowledge, as pharmacists aged 45 years and older were more knowledgeable than those under 45 years (P value=0.013). Additionally, position in the pharmacy had a positive association with pharmacists' knowledge, and pharmacists who were employees were more knowledgeable than those who were employers (P value=0.002). Furthermore, years of work experience were positively associated with pharmacist knowledge: pharmacists with 5 years of working experience were more knowledgeable than those with less than 5 years of working experience (P value=0.001). The details are shown in Table 7.

Table 7 Knowledge of community pharmacists according to demographic characteristics

Variable	Frequency (%); *N*=301	Knowledge score; Median [Q1-Q3]	*P* value*
Age category (years)			
<45	270 (89.7)	12.5 [11–14]	**0.013**[b]
≥45	31 (10.3)	13 [12–14]	
Gender			
Male	75 (24.9)	12 [12–14]	0.689[b]
Female	226 (75.1)	13 [12–14]	
Residency			
Refugee camp	20 (6.6)	12 [11.3–13]	0.412[a]
Village	131 (43.5)	13 [11–14]	
City	150 (49.8)	13 [11–14]	
Educational level			
Pharmacist	231(76.7)	13 [11–14]	0.179[a]
Doctor of pharmacy	47 (15.6)	12 [11–14]	
Master's degree in pharmacy	21 (7.0)	12 [11–13]	
PhD in pharmacy	2 (0.7)	8.5 [6–11]	
Graduation place			
Palestine	264(87.7)	13[11–14]	0.515 [b]
Outside Palestine	37(12.3)	13 [12–14]	
Position in the pharmacy			
Employee pharmacists	203 (67.4)	12 [11–14]	**0.002**[b]
Employer pharmacists	98 (32.6)	13 [12–14]	
Years of working			
<5	183 (60.8)	12 [11–14]	**0.001**[b]
≥5	118 (39.2)	13 [12–14]	
Household income per month			
<2000 NIS	52(17.3)	12 [11-13.8]	0.127[a]
2000–4999 NIS	201(66.8)	13 [11–14]	
≥5000 NIS	48(15.9)	12 [11–14]	
Hours of work per day			
<8 h	109(36.2)	12 [11–114]	0.239 [a]
8 h	138(45.8)	13 [11–14]	
>8 h	54 (17.9)	12 [11–14]	

* Bold values denote statistical significance

a Kruskal–Wallis test

b Mann–Whitney U test

Discussion

The current study revealed that community pharmacists were highly knowledgeable about the appropriate prescription and use of antibiotics (98%). While pharmacists may not serve as prescribers in many countries, knowledge about the appropriate selection of antibiotics is crucial. They play an important role in conducting interventions or providing recommendations to clinicians regarding the appropriate choice of drugs. Several studies have evaluated pharmacists' beliefs that antibiotics are not effective at treating cold, flu, or cough. In Jordan, 56.1% of pharmacists believed that antibiotics would never treat cold, cough, or flu [38]; Zakaa El-din et al. reported that 10.4% of the respondents thought that antibiotics are helpful for sore throat and common colds [39], while in Catalonia, Spain, 34.8% of pharmacists dispensed antibiotics for sore throat complaints [40]. In our study, 80.1% of the pharmacists were against prescribing antibiotics for these indications. However, 61.8% of the pharmacists responded that antibiotics are effective at killing germs. This could be attributed to the fact that the term "germs" is generally used with antibiotics rather than specific bacteria [37]. This demonstrates the critical need for pharmacists to be more knowledgeable about antibiotic indications, and they should feel obligated to make patients aware of their misuse and the consequences of their actions.

Almost all the pharmacists (99%) in our study responded that the misuse of antibiotics led to antimicrobial resistance, whereas 79% of those in the Jordanian

study [38] and another Palestinian study (92.1%) reported antimicrobial resistance [41]. The substantial increase in knowledge could be attributed to the fact that community pharmacists are well educated and have professional skills and training that allow them to provide the best health care services [34], as well as the fact that many patients seek medical advice directly from community pharmacies because they are faster and less expensive than doctor clinic visits are and because they are considered reliable and easy to contact healthcare providers [39, 42].

The level of practice in the current study was assessed by presenting one case scenario and six questions on the practices of community pharmacists in Palestine regarding pediatric antibiotics. Approximately 61.5% of community pharmacists correctly calculated the dose of amoxicillin, compared to 54% in Chicago [25]. The variability could be attributed to differences in study objectives and study populations (age groups, sample size), in addition to the fact that more than 99.9% of community pharmacies dispense amoxicillin and cephalexin over the counter, so they are familiar with the dosing [43].

Regarding the evaluation of the practices of community pharmacists in Palestine regarding pediatric antibiotics, 86.4% would consult physicians if they were uncertain about the appropriateness of antibiotic prescription. This finding is in agreement with the results of a study in Senegal (90.2%) [44] and greater than what was reported in the Jordanian study (53.5%) [38] as well as the study by Rehman et al. in Pakistan (32%) [45]. In Palestine, as in some developing countries, patients can obtain antibiotics from pharmacies without a prescription [27, 39]. In fact, because some participants do not refer to physicians due to poor physician response, this may reflect the necessity of strengthening interprofessional relationships between healthcare teams, most likely starting with university curricula. Pharmacists and other health care practitioners should collaborate in multidisciplinary teams to minimize antimicrobial irrationality and inappropriate use and hence antimicrobial resistance. Understanding how to develop relationships with caregivers can help change their attitudes and increase the acceptability of pharmacists who interfere with children's antibiotic prescriptions. Caregivers seeking symptom relief may be more amenable to nonantibiotic options [46]. With respect to dosing considerations, 85% of the pharmacists recalculated the dose written by the physician before dispensing the antibiotic. Almost 93% of the pharmacists correctly answered the question on utilizing azithromycin for acute bacterial pharyngitis. Similarly, the use of a trimethoprim/sulfamethoxazole dosage for treating lower urinary tract infections was identified for 93% of the patients. Our knowledge rates were higher than those reported by Keewan et al. in their study in Jordan [5], where the largest number of community pharmacists (55.8%) properly answered the case of azithromycin dose in acute bacterial pharyngitis, while 15.7% of the pharmacists correctly answered the dosing of trimethoprim-sulfamethoxazole in lower urinary tract infection. To ensure the accurate dispensing of antibiotics for pediatric patients, double-checking could be implemented.

Approximately 98% of participants agreed that education about antibiotic use and antibiotic resistance should be more prominent during university education years, as concluded by studies in India [47], Trinidad and Tobago [48], and East Africa [49].

In our study, several factors exhibited statistically significant associations with pharmacist knowledge. These factors include younger age, employment status within a community pharmacy, and an accumulation of more than five years of professional experience. A study carried out in the West Bank, Palestine, demonstrated that women and those living in urban areas have higher knowledge scores [41]. On the other hand, it was discovered that pharmacist education, professional title, and years of experience had an impact on the pharmacist's understanding of antimicrobial medications [50]. These findings highlight the importance of customizing antimicrobial stewardship programs to meet pharmacist requirements, taking into account sociodemographic differences. In addition, regarding the years spent working in the pharmacy, this association could be because pharmacists spend much time in the pharmacy, which means more time communicating with patients, prescriptions, and promotional representatives who scientifically explain their medications.

Several community pharmacists have reported barriers that can contribute to inappropriate antibiotic use in pediatrics. Among them, parental behavior and pressure to prescribe antibiotics (91.7% and 87.3%, respectively) were the barriers most frequently reported. This was followed by malpractice in antibiotic prescribing (88.7%). These findings were consistent with a study conducted in Lebanon in which pharmacists first blamed parents (90.1%), second-level physicians (72.8%) and third-level physicians (59.4%) for inappropriate antibiotic use and the emergence of antimicrobial resistance [37]. Furthermore, in Qatar, patients and practitioners, mainly physicians, play a role in shaping barriers to appropriate antibiotics [26]. In contrast, unfounded assumptions about the efficacy of antibiotics by health professionals, as well as an exaggeration of parents' desire for medications, may be the key contributing cause of antibiotic overprescription for the common cold in Korea [51]. This would support the need for antibiotic stewardship programs and effective behavior change programs that are getting off to a good start to optimize antibiotic prescription.

Strengths and limitations

The strengths of this study include the high number of responses and the scenario design that community pharmacists are more likely to encounter; moreover, the study succeeded in containing clear questions about practices and attitudes toward antibiotic use. This is the first study in the West Bank, Palestine, to discuss antibiotic use and dosing among pediatric patients. However, there are a few limitations. For example, using the cross-sectional design in this study prevented us from interpreting the causality of significant associations. In addition, the current study is based on the real practice of pharmacists with respect to antibiotic use, so the pharmacist might check a reference or consult a colleague when answering the cases, which could lead to an overestimation of pharmacist knowledge. Additionally, the research in question employed an online survey featuring a convenience sample. Consequently, there is potential for bias, as the survey's reach may be confined to individuals with internet connectivity. Furthermore, the utilization of the convenience-oriented snowball sampling method raises concerns about the representativeness of this study's findings in relation to the entirety of Palestinian pharmacies. The smaller sample size and the use of online surveys may limit the generalizability of the study's findings to the entire population of pharmacists in the northern West Bank of Palestine. However, the final sample size remains statistically robust for analysis considering the population size. Further research with a larger sample size and a more representative recruitment strategy could strengthen the generalizability of the results. The final constraint pertains to the study's design, which adopts a cross-sectional analysis. This design impedes the identification of causation and limits the generalizability of the study's findings.

Conclusions

This study aimed to assess the level of knowledge possessed by community pharmacy professionals with regard to the correct use of antibiotics by pediatric patients. The investigation revealed that a significant proportion of community pharmacists demonstrated a commendable understanding of the appropriate usage of antibiotics. Furthermore, the outcomes indicated a positive correlation between pharmacists' knowledge and their years of professional experience and social status. This observation lends support to the proposition that the acquisition of professional expertise and the quality of training contribute to the provision of enhanced healthcare services. The findings derived from this investigation provide valuable insights into the proper use of antibiotics in pediatric care. Nevertheless, it is worth noting that the results of this study may not be readily generalizable to a broader population. Consequently, it is advisable to implement ongoing educational programs, including interactive workshops and lectures led by infectious disease specialists, under the coordination and support of the Palestinian Pharmacist Syndicate and awareness campaigns aimed at enhancing the prescription and utilization of antibiotics among community pharmacists. This recommendation is especially pertinent in light of the continuously evolving guidelines and evolving information within this domain.

Future perspectives

This study emphasizes the need for continuous educational and awareness efforts to improve the understanding of proper antibiotic use and prescription guidelines among children. Due to the high frequency of mistakes in pharmaceuticals, especially related to dosage, providing effective treatments for children is crucial for reducing this problem and improving patient safety standards. Future research efforts may focus on developing and implementing educational programs specifically designed to enhance the knowledge and skills of community pharmacists in this field. Moreover, there is a significant advantage in educating parents and caregivers on the prudent use of antibiotics and the possible risks associated with prescription inconsistencies. This can be achieved through the use of educational materials, such as brochures distributed in pediatric clinics. In addition, community pharmacists should take the lead in ensuring that parents understand the instructions, risks, and proper use of antibiotics. Furthermore, future research may aim to examine the impact of these treatments on the prescription practices of pharmacists, patient health outcomes, and healthcare costs. In conclusion, the results of this study have the potential to impact policy choices and inspire practical improvements in the quality of care for children while limiting the risk of prescription mistakes.

Abbreviations

IRB	Institutional Review Board
NIS	New Israeli Shekel
PhD	Doctorate of Philosophy
SPSS	Statistical Package for the Social Sciences

Acknowledgements

Many thanks to the Clinical Research Centre of An-Najah National University Hospital for constant support and wise advice.

Author contributions

SS, NM, ML, SK, and ZB performed data collection, reviewed the literature and data analysis and wrote the draft manuscript. SA and AK participated in data analysis and wrote the draft manuscript. SZ and BA conceptualized and designed the study, coordinated, supervised, and analyzed the data, critically reviewed the manuscript to improve intellectual content, and assisted in the final manuscript review. Then, all the authors reviewed and accepted the final manuscript.

Funding

None.

Data availability
The data sets supporting the results of the present research are available from the corresponding authors upon request.

Declarations

Ethics approval and consent to participate
The present study received approval from the *Institutional Review Board (IRB) of An-Najah National University* (Ref: Pharm D. Sep. 2022/34). In accordance with the principles of informed consent, the act of survey completion was construed as a manifestation of participants' consent, given that the survey was distributed via online platforms utilizing a SurveyMonkey® account. Information concerning voluntary participation and the right to withdraw from the study was provided within the invitation, prominently displayed on the cover page. The cover page additionally elucidated the study's objectives and provided guidance on how to respond to the survey questions. The data collected during the course of this study were exclusively utilized for research purposes and were diligently safeguarded to ensure anonymity and confidentiality. Participants were not provided with any form of incentive to motivate their survey participation. The IRB of An-Najah National University deemed it appropriate to waive the necessity for written informed consent, as the study was considered to pose minimal risk, and all procedures adhered rigorously to pertinent guidelines and regulations.

Consent to publish
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Infection Prevention and Control, An-Najah National University Hospital, Nablus 44839, Palestine
[2]Department of Clinical and Community Pharmacy, College of Medicine and Health Sciences, An-Najah National University, Nablus 44839, Palestine
[3]Division of Clinical Pharmacy, Department of Hematology and Oncology, An-Najah National University Hospital, Nablus 44839, Palestine
[4]Poison Control and Drug Information Center (PCDIC), College of Medicine and Health Sciences, An-Najah National University, Nablus 44839, Palestine
[5]Clinical Research Center, An-Najah National University Hospital, Nablus 44839, Palestine

Received: 21 October 2023 / Accepted: 5 September 2024
Published online: 14 September 2024

References

1. Bentley R, Bennett JW. What is an antibiotic? Revisited. Adv Appl Microbiol. 2003;52:303–31.
2. Alumran A, Hurst C, Hou X-Y. Antibiotics overuse in children with Upper Respiratory Tract Infections in Saudi Arabia: risk factors and potential interventions. Clin Med Diagn. 2012;1(1):8–16.
3. Patel P, Wermuth HR, Calhoun C, Hall GA. Antibiotics. edn. Treasure Island (FL): StatPearls Publishing Copyright © 2023. StatPearls Publishing LLC.; 2023. *StatPearls*.
4. Goel D, Goel GK, Chaudhary S, Jain D. Antibiotic prescriptions in pediatric dentistry: a review. J Family Med Prim Care. 2020;9(2):473–80.
5. Keewan N, Al-Sawalha NA, Almomani BA. The knowledge of community pharmacists about appropriate dosing of antibiotics among paediatrics: a national study from Jordan. Int J Clin Pract. 2021;75(11):e14652.
6. Bharathiraja R, Sridharan S, Chelliah LR, Suresh S, Senguttuvan M. Factors affecting antibiotic prescribing pattern in pediatric practice. Indian J Pediatr. 2005;72(10):877–9.
7. Hoberman A, Paradise JL, Rockette HE, Kearney DH, Bhatnagar S, Shope TR, Martin JM, Kurs-Lasky M, Copelli SJ, Colborn DK, et al. Shortened Antimicrobial Treatment for Acute Otitis Media in Young Children. N Engl J Med. 2016;375(25):2446–56.
8. Oyewumi M, Brandt MG, Carrillo B, Atkinson A, Iglar K, Forte V, Campisi P. Objective evaluation of Otoscopy skills among Family and Community Medicine, Pediatric, and Otolaryngology residents. J Surg Educ. 2016;73(1):129–35.
9. Iftikhar S, Sarwar MR, Saqib A, Sarfraz M, Shoaib QU. Antibiotic Prescribing practices and errors among hospitalized Pediatric patients suffering from Acute Respiratory Tract infections: a Multicenter, cross-sectional study in Pakistan. Med (Kaunas) 2019, 55(2).
10. Aldayyen AM, Alwabari MA, Alhaddad F, Alhumaid MA, Alsuwailem N, Alanzi A, Alalwan AA, Alfayez O, Alwafai S, Aldosari SA, et al. Types, trends, and patterns of the reported antimicrobial errors to the eastern region's medical centers in Saudi Arabia: a cross-sectional study. Saudi Pharm J. 2023;31(4):569–77.
11. Beatriz GC, María José O, Inés JL, Yolanda HG, Concha ÁD, Javier TS, Cecilia MF. Medication errors in children visiting pediatric emergency departments. Farm Hosp. 2023;47(4):141–7.
12. Gaeta F, Conti V, Pepe A, Vajro P, Filippelli A, Mandato C. Drug dosing in children with obesity: a narrative updated review. Ital J Pediatr. 2022;48(1):168.
13. Venekamp RP, Sanders SL, Glasziou PP, Del Mar CB, Rovers MM. Antibiotics for acute otitis media in children. Cochrane Database Syst Rev. 2015;2015(6):Cd000219.
14. Nicolini G, Sperotto F, Esposito S. Combating the rise of antibiotic resistance in children. Minerva Pediatr. 2014;66(1):31–9.
15. Moser C, Lerche CJ, Thomsen K, Hartvig T, Schierbeck J, Jensen PO, Ciofu O, Hoiby N. Antibiotic therapy as personalized medicine - general considerations and complicating factors. APMIS. 2019;127(5):361–71.
16. Sabry NA, Farid SF, Dawoud DM. Antibiotic dispensing in Egyptian community pharmacies: an observational study. Res Social Adm Pharm. 2014;10(1):168–84.
17. So AD, Gupta N, Brahmachari SK, Chopra I, Munos B, Nathan C, Outterson K, Paccaud JP, Payne DJ, Peeling RW, et al. Towards new business models for R&D for novel antibiotics. Drug Resist Updat. 2011;14(2):88–94.
18. Eisenreich W, Rudel T, Heesemann J, Goebel W. Link between antibiotic persistence and antibiotic resistance in bacterial pathogens. Front Cell Infect Microbiol. 2022;12:900848.
19. Chang J, Xu S, Zhu S, Li Z, Yu J, Zhang Y, Zu J, Fang Y, Ross-Degnan D. Assessment of non-prescription antibiotic dispensing at community pharmacies in China with simulated clients: a mixed cross-sectional and longitudinal study. Lancet Infect Dis. 2019;19(12):1345–54.
20. Chang J, Ye D, Lv B, Jiang M, Zhu S, Yan K, Tian Y, Fang Y. Sale of antibiotics without a prescription at community pharmacies in urban China: a multicentre cross-sectional survey. J Antimicrob Chemother. 2017;72(4):1235–42.
21. Hallit S, Zahreddine L, Saleh N, Shakaroun S, Lahoud N. Practice of parents and pharmacists regarding antibiotics use in pediatrics: a 2017 cross-sectional study in Lebanese community pharmacies. J Eval Clin Pract. 2020;26(1):181–9.
22. Holder K, Oprinovich S, Guthrie K. Evaluating pediatric weight-based antibiotic dosing in a community pharmacy. *J Am Pharm Assoc (2003)* 2022.
23. Shi L, Chang J, Liu X, Zhai P, Hu S, Li P, Hayat K, Kabba JA, Feng Z, Yang C et al. Dispensing antibiotics without a prescription for Acute Cough Associated with Common Cold at Community pharmacies in Shenyang, Northeastern China: a cross-sectional study. Antibiot (Basel) 2020, 9(4).
24. Acharya Y, Nepal P, Yang D, Karki K, Bajracharya D, Prentis T, Davis SL, Kaljee L. Economic and social drivers of antibiotic dispensing practices among community pharmacies in Nepal. Trop Med Int Health. 2021;26(5):557–71.
25. Brown SW, Oliveri LM, Ohler KH, Briars L. Identification of errors in Pediatric prescriptions and interventions to prevent errors: a Survey of Community pharmacists. J Pediatr Pharmacol Ther. 2019;24(4):304–11.
26. Sharaf N, Al-Jayyousi GF, Radwan E, Shams Eldin SME, Hamdani D, Al-Katheeri H, Elawad K, Habib Sair A. Barriers of appropriate antibiotic prescription at PHCC in Qatar: perspective of Physicians and pharmacists. Antibiot (Basel) 2021, 10(3).
27. Sweileh WM, Zyoud SeH, Al-Haddad MS. Chap. 13 - Pharmacy Practice in Palestine. In: *Pharmacy Practice in Developing Countries*. edn. Edited by Fathelrahman AI, Ibrahim MIM, Wertheimer AI. Boston: Academic Press; 2016: 253–266.
28. Daniel WW. Biostatistics: A Foundation for analysis in the health sciences. 7th ed. New York: Wiley; 1999.
29. Zawahir S, Lekamwasam S, Aslani P. A cross-sectional national survey of community pharmacy staff: knowledge and antibiotic provision. PLoS ONE. 2019;14(4):e0215484.
30. Gabriel S, Manumbu L, Mkusa O, Kilonzi M, Marealle AI, Mutagonda RF, Mlyuka HJ, Mikomangwa WP, Minzi O. Knowledge of use of antibiotics among consumers in Tanzania. JAC Antimicrob Resist. 2021;3(4):dlab183.

31. Jali A, Hakami A, Dahas N, Mahnashi M, Siddiq A, Alsomaili H, Alhazmi AH. Antibiotic use and resistance knowledge: awareness among the General Public in Jazan, Saudi Arabia. Cureus. 2021;13(12):e20369.
32. Kong LS, Islahudin F, Muthupalaniappen L, Chong WW. Knowledge and expectations on antibiotic Use among the General Public in Malaysia: a Nationwide Cross-sectional Survey. Patient Prefer Adherence. 2021;15:2405–16.
33. Gajdacs M, Paulik E, Szabo A. Knowledge, attitude and practice of community pharmacists regarding antibiotic Use and Infectious diseases: a cross-sectional survey in Hungary (KAPPhA-HU). Antibiot (Basel) 2020, 9(2).
34. Hamadouk RM, Mohammed FM, Albashair ED, Yousef BA. Evaluation of Community Pharmacists' Competences in Identifying and Resolve Drug-Related Problems in a Pediatric Prescription Using the Simulated Patient Method. Pharm (Basel) 2022, 11(1).
35. Tembo N, Mudenda S, Banda M, Chileshe M, Matafwali S. Knowledge, attitudes and practices on antimicrobial resistance among pharmacy personnel and nurses at a tertiary hospital in Ndola, Zambia: implications for antimicrobial stewardship programmes. JAC Antimicrob Resist. 2022;4(5):dlac107.
36. Hejaz A, Khraiwesh H, Karma A, Nassar H, Halawani I. The awareness and knowledge of pharmacists about Pediatric doses. J Med Sci. 2022;22(1):29–43.
37. Zahreddine L, Hallit S, Shakaroun S, Al-Hajje A, Awada S, Lahoud N. Knowledge of pharmacists and parents towards antibiotic use in pediatrics: a cross-sectional study in Lebanon. Pharm Pract (Granada). 2018;16(3):1194.
38. Darwish RM, Baqain GN, Aladwan H, Salamah LM, Madi R, Masri RMA. Knowledge, attitudes, and practices regarding antibiotic use and resistance among community pharmacists: a cross sectional study in Jordan. Int J Clin Pharm. 2021;43(5):1198–207.
39. Zakaa El-Din M, Samy F, Mohamed A, Hamdy F, Yasser S, Ehab M. Egyptian community pharmacists' attitudes and practices towards antibiotic dispensing and antibiotic resistance; a cross-sectional survey in Greater Cairo. Curr Med Res Opin. 2019;35(6):939–46.
40. Llor C, Cots JM. The sale of antibiotics without prescription in pharmacies in Catalonia, Spain. Clin Infect Dis. 2009;48(10):1345–9.
41. Al-Halawa DA, Seir RA, Qasrawi R. Antibiotic Resistance Knowledge, Attitudes, and Practices among Pharmacists: A Cross-Sectional Study in West Bank, Palestine. *J Environ Public Health* 2023, 2023:2294048.
42. Shawahna R, Fahed B, Qadri D, Sharawi L, Soroghli M, Dweik M. Awareness and knowledge of Autism Spectrum disorders among pharmacists: a cross-sectional study in Palestinian pharmacy practice. J Autism Dev Disord. 2017;47(6):1618–27.
43. Jaradat N, Sweileh W. A descriptive study of Community Pharmacy Practice in Palestine: analysis and future look. An-Najah Univ J Res (N Sc). 2003;17(2):191–9.
44. Bassoum O, Ba-Diallo A, Sougou NM, Lèye MMM, Diongue M, Cissé NF, Faye A, Seck I, Fall D, Tal-Dia A. Community pharmacists' knowledge, practices and perceptions on antibiotic use and resistance: a cross-sectional, self-administered Questionnaire Survey, in Guediawaye and Pikine, Senegal. Open J Epidemiol. 2019;09(04):289–308.
45. Rehman IU, Asad MM, Bukhsh A, Ali Z, Ata H, Dujaili JA, Blebil AQ, Khan TM. Knowledge and practice of pharmacists toward Antimicrobial Stewardship in Pakistan. Pharm (Basel) 2018, 6(4).
46. Toth JM, Rosenthal M, Sharma M, Barnard M. Caregivers' perspectives of pharmacist intervention in children's antibiotic prescriptions for Upper Respiratory Tract infections. J Pharm Pract. 2023;36(2):238–48.
47. Ahmad A, Khan MU, Moorthy J, Jamshed SQ, Patel I. Comparison of knowledge and attitudes about antibiotics and resistance, and antibiotics self-practicing between Bachelor of Pharmacy and Doctor of Pharmacy students in Southern India. Pharm Pract (Granada). 2015;13(1):523.
48. Ahmad A, Khan MU, Patel I, Maharaj S, Pandey S, Dhingra S. Knowledge, attitude and practice of B.Sc. Pharmacy students about antibiotics in Trinidad and Tobago. J Res Pharm Pract. 2015;4(1):37–41.
49. Lubwama M, Onyuka J, Ayazika KT, Ssetaba LJ, Siboko J, Daniel O, Mushi MF. Knowledge, attitudes, and perceptions about antibiotic use and antimicrobial resistance among final year undergraduate medical and pharmacy students at three universities in East Africa. PLoS ONE. 2021;16(5):e0251301.
50. Xue ZM, Yang G, Guo ZX, Gao ME, Qin QQ, Zhang YX, Zhao J, Kang YX, Li Y, Zhao RL. Investigation on knowledge level about rational use of antimicrobial drugs among pharmacists in medical institutions in Shanxi Province, China. Public Health. 2022;209:67–72.
51. Cho HJ, Hong SJ, Park S. Knowledge and beliefs of primary care physicians, pharmacists, and parents on antibiotic use for the pediatric common cold. Soc Sci Med. 2004;58(3):623–9.

Publisher's note