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Understanding antibiotic purchasing practices in community pharmacies: A potential driver of emerging antimicrobial resistance

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A R T I C L E   I N F O

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A B S T R A C T

Introduction: Antimicrobial resistance (AMR), a transboundary health issue, critically impacting low- and middle-income countries (LMICs) where 80% of antibiotics are used in the community, with 20–50% being inappropriate. Southeast-Asia, including Bangladesh, faces heightened AMR risk due to suboptimal healthcare standard and unregulated antibiotic sales. This study aimed to audit antibiotic dispensing patterns from community pharmacies, identifying factors influencing purchasing behaviors.

Methods: A cross-sectional survey of 385 antibiotic customers and structured observations of 1000 pharmacy dispensing events were conducted in four urban and rural areas in Bangladesh. Descriptive analysis defined antibiotic use, while Poisson regression examined how patients' demographics and health symptoms influenced prescription behaviors.

Results: Among 1000 observed medicine dispensing events, 25.9% were antibiotics. Commonly purchased antibiotics included macrolides (22.8%), third-generation-cephalosporins (20.8%), and second-generation-cephalosporins (16.9%). Following WHO-AWaRe classifications, 73.5% of antibiotics were categorized as Watch, and 23.1% as Access. From the survey, 56.6% antibiotics were purchased without a prescription from drug-sellers and informal healthcare providers, primarily for "non-severe" health-symptoms such as upper-respiratory-tract infections (37.4%), fever (31.7%), uncomplicated skin infections (20%), gastrointestinal-infections (11.2%), and urinary-tract infections (7.9%). The likelihood of presenting a prescription while purchasing antibiotics was 27% lower for individuals aged 6–59 compared to those $\leq$5 or $\geq$ 60. Lower-respiratory-tract infections and enteric-fever had higher prescription rates, with adjusted prevalence ratios of 1.78 (95% CI: 1.04, 3.03) and 1.87 (95% CI: 1.07, 3.29), respectively. After adjusting for confounders, sex, urban-rural locations, income, education, and number of health-symptoms exhibited no significant influence on prescription likelihood.

Conclusion: This study underscores unregulated antibiotic sales without prescriptions, urging tailored interventions considering prevailing health-seeking practices in diverse healthcare settings in LMICs. Enforcing prescription-only regulations is hindered by easy access through community pharmacies and conflicts of interest. Future strategies should consider how stewardship impacts the financial interests of pharmacy personnel in settings lacking clear authority to ensure optimal compliance.

Abbreviations: AMR, Antimicrobial resistance; LMICs, Low- and middle-income countries; MBBS, Bachelor of Medicine, Bachelor of Surgery; APBS, Antibiotic purchasing behavior survey; SOs, Structured observations; HICs, High-income countries; OTC, Over-the-counter; AMS, Antimicrobial Stewardship; NAP, National Action Plan; WHO, World Health Organization; AWaRe, Access, Watch, and Reserve; PR, Prevalence ratio; CI, Confidence interval; NPA, Non-prescription antibiotic; SM, Self-medication; ASP, Antimicrobial stewardship programs..

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1. Introduction

Antimicrobial resistance (AMR) poses a substantial threat to global public health, with an estimated 1.27 million directly attributed deaths and an additional 4.95 million deaths associated in 2019.[1] Projections indicate a potential rise to 10 million yearly fatalities by 2050, particularly impacting low- and middle-income countries (LMICs) due to their heightened burden of infectious diseases.[2] A global survey across 76 countries found a 65% increase in antibiotic consumption between 2000 and 2015, driven primarily by a significant rise in LMICs,[3] nearly 80% of antibiotics are consumed in the community, of which about 20–50% are used inappropriately.[4] A systematic review of 34 studies across LMICs highlighted that 39% of respondents practiced self-medication, facilitated by easy pharmacy access and leftover drugs.[5] Over-the-counter (OTC) antibiotic availability and non-prescribed usage are prevalent, with two-thirds of antibiotics consumed without prescriptions in certain Southeast Asian countries.[6] Pharmacy drug sellers play a pivotal role in healthcare, providing advice and medications, including antibiotics, for common ailments.[7] Southeast Asia, including Bangladesh, faces elevated AMR risk[8] due to suboptimal healthcare standards and the improper use of antibiotics.[9] In Bangladesh, approximately 63% of antibiotics are prescribed by providers without any medical training at the national level, and retail pharmacies are distributing antibiotics without requiring prescriptions.[10] Aggressive marketing exposes unqualified drug sellers to overprescribing and dispensing drugs without prescriptions.[11,12] Inadequate knowledge about antibiotic use and resistance among customers and sellers, along with weak policy enforcement and limited capacity, contribute to the development of AMR.[13]

Existing studies on antibiotic use in LMICs predominantly focus on hospital settings,[8,14] often in the public sector and urban areas, relying on medical records abstraction and prescription audits. However, significant knowledge gaps persist, particularly in understanding the extent of antibiotic use at the primary care level in LMICs.[8] A recent umbrella review on antibiotic use in high-income countries (HICs) reveals factors influencing prescribing behaviors such as socio-cultural context, financial incentives, personal beliefs, patient attitudes, and AMR awareness. Similar considerations apply to LMICs, emphasizing the need for social research to understand local contexts and behavioral complexities in response to AMR.[8] However, social sciences' representation in AMR research remains inadequate, hindering behavioral interventions.[15] While hospital-based antimicrobial stewardship (AMS) interventions exhibit positive impacts on treatment durations and resistance rates, limited research targets outpatient and primary care at the community settings.[16] Insufficient understanding of socio-cultural dimensions in antibiotic prescription and use hampers the achievement of goals outlined in Bangladesh's National Action Plan (NAP) on AMR.[8,10,17] Knowledge gaps in local AMR data persist in LMICs, where AMR risks are high.[18] Conventional AMS approaches, tailored for high-income countries, might not fit the varied cultural and ecological contexts of LMICs, warranting more nuanced strategies.[19] Understanding the social determinants of health influencing antibiotic misuse and antimicrobial resistance in LMICs is a crucial research priority,[20] but it is hindered by the scarcity of large-scale comparable data, varied poverty indicators, and the neglect of intersecting deprivation domains.[21] Community-based antibiotic dispensing and consumption have received less attention compared to formal healthcare settings, and few studies delve into the socio-economic drivers of antibiotic use in unregulated markets in Bangladesh.[10,22]

This study was conducted to comprehensively examine the characteristics of antibiotics procured from community pharmacies and identify factors influencing purchasing behaviors, particularly those leading to irrational usage without consulting registered medical practitioners within the general population. This research is pivotal in formulating targeted interventions for effective prevention strategies against the irrational use of antibiotics in resource-constrained settings. In addition, the goal is to inform policymakers, stakeholders, and the scientific community about the necessity and extent of policy revisions that ensure the appropriate and responsible use of antibiotics both in the formal and community-based informal healthcare settings.

2. Methods

To accomplish the objectives of this study, a cross-sectional research design was employed in four divisions of Bangladesh from September 2022 to February 2023, encompassing two urban and two rural areas. A face-to-face Antibiotic Purchasing Behavior Survey (APBS) was conducted among customers visiting sampled community retail pharmacies to buy antibiotics. This survey was used to reveal insights into knowledge, practices, and decision-making processes of the customers related to the purchase and usage of antibiotics, along with understanding healthcare-seeking behaviors. Additionally, structured observation (SO) was utilized to assess the pattern of antibiotics in dispensed medicines and to observe purchasing and dispensing behaviors. This approach helps mitigate social desirability and recall biases, allowing for objective observation of individuals' actions rather than relying solely on self-reported accounts. Dhaka and Chittagong, the largest and second-largest metropolitan cities of Bangladesh, were purposively selected as urban sites due to their pivotal roles as the largest economic hubs. Subsequently, *Mirpur* from Dhaka and *Panchlaish* from Chittagong were randomly chosen as urban locations. Two divisions, Khulna and Rangpur, were randomly selected. From the Khulna division, Jessore district was randomly selected, followed by the random selection of *Jhikargacha* Upazila as a rural site. Similarly, in the Rangpur division, Dinajpur district was randomly selected, and subsequently, *Parbatipur* Upazila was chosen as a rural site.

The proportion of individuals purchasing antibiotics with a prescription from registered physicians was assumed to be 0.50. A 95% confidence level, corresponding to a Z-value of 1.96, was chosen, and the margin of error (E) was set to 0.05, which is a standard choice in this type of research. With those parameters, the required sample size was calculated as 385. To focus on antibiotic purchasing practices in primary care at community settings, areas within a one-kilometre radius of government or private general/tertiary/specialized hospitals were excluded to avoid potential biases arising from medication patterns influenced by nearby hospitals and their specialties. If any hospitals were included in the randomly selected areas, they were excluded, and the immediate next areas from the list were selected. Lists of pharmacies were obtained from the local pharmacy owner's association in both urban and rural selected areas. After sorting the lists based on the chosen locations, 12 pharmacies were randomly selected to conduct the survey. After completing the survey, those pharmacies were excluded from the list, and five pharmacies were randomly selected from the list in each site for structured observations. Considering resource and timeline constraints, 250 medicine dispensing events were observed in community pharmacies from each site, resulting in a total of 1,000 observations.

The study received approval from the University of New South Wales (UNSW) Human Research Ethics Committee and the Institutional Review Board (IRB) of the local implementing organization, BRAC James P. Grant School of Public Health in Bangladesh. The Antibiotic Purchasing Behavior Survey focused on individuals purchasing antibiotics for themselves, their household members or on behalf of non-household individuals from local retail pharmacies across four study sites. Prior to commencing survey, the research team informed pharmacy proprietors about stationing researchers outside the pharmacies from 5:00 pm to 10:00 pm. This timeframe was selected based on the assumption that individuals tend to purchase medicines after work while heading home, resulting in significantly higher customer traffic compared to daytime hours. Assurances were provided to the owners that the survey would have minimal impact on sales and pose no risk to the reputation or legal status of the pharmacies. Researchers stationed themselves at pharmacy exits, approached customers, explained the study's rationale, and requested them to show their purchased medicines. If purchased medicines included any antibiotics, customers were invited to partake in a 10–12-min survey. Respondents were given a written consent form in the local language. Respondents then signed the consent form before commencing the survey on the Qualtrics Survey Platform, with each participant receiving a unique non-identifiable code.

The SOs were conducted at the local retail pharmacies to document antibiotic purchasing and dispensing practices. Researchers obtained prior permission from pharmacy proprietors to be present at the dispensing area for 3–5 h, ensuring that the researcher will not use any devices for photos or voice recording and the observation would not include any identifiable information such as person, pharmacy name, or address. The researcher would not ask any questions either to salespersons or customers that may interrupt sales. After explaining the study's objective and rationale, and receiving verbal consent, researchers observed 50 individual medicine dispensing events in each pharmacy. Behaviors related to purchasing and dispensing, exhibited by both customers and sellers, were documented in the Qualtrics Survey Platform without capturing personal information.

The data were transferred to STATA-15 for both cleaning and analysis. Initial cleaning involved the use of a data editing form, provided by data collectors. During the data analysis phase, continuous variables were categorized into ordinal categories. This included the categorization of age, education, and household income. Additionally, antibiotic classes were derived from generic antibiotics. Moreover, antibiotics were categorized based on WHO-AWaRe classifications[23] — Access, Watch, and Reserve. This classification considers the varying impact of antibiotics and their classes on antimicrobial resistance, emphasizing the crucial need for their appropriate utilization. Similar reported symptoms were grouped under each symptom group, as outlined in Supplementary Table-1. Additionally, generic antibiotics were grouped under antibiotic classes, as outlined in Supplementary Table-2. Descriptive statistics were employed to summarize the data. Respondents' socio-demographic characteristics, health-seeking behaviors, and antibiotic acquisition pattern, and observed antibiotic dispensing behaviors were summarized using frequency and percentage for each category and compared between urban and rural areas using the chi-square test. Stacked bar diagrams were generated to present the percentage distribution of the reported health-symptoms for which the antibiotic was purchased and compared between urban and rural areas. Stacked bar diagrams were also generated to present the percentage distribution of antibiotic class and compared between urban and rural areas, as well as prescription and non-prescription groups. To identify the factors associated with having a prescription for purchasing antibiotics from a pharmacy, prevalence ratio (PR) was used as a measure of association because PR is a better measure than odds ratio in the case of a prevalent outcome.[24] Simple and multiple Poisson regression models were utilized to measure the unadjusted and adjusted PR and their 95% confidence interval. Statistical significance was determined at a p-value <0.05. All statistical analysis was conducted using Stata 15, and R version 4.3.2 was used to generate stacked bar diagrams.

3. Results

3.1. Characteristics of the respondents

A total of 385 individuals aged 18 years and over were enrolled, who came to the sampled pharmacy to purchase antibiotics for themselves or for someone else, with 66.2% being male and 33.8% female (Table 1). The age distribution showed the highest representation in the 21–30 age bracket, consisting of 33.5%, closely followed by the 31–40 age group, encompassing 24.9%. Rural residents are relatively older than that of urban ($p = 0.008$). Regarding education, the majority of respondents completed secondary level education (≥grade 10), comprising 33.8%, while 13.8% had no formal education. Urban respondents exhibited a

Table 1
Characteristics of individuals who purchased antibiotics for self or others.

Characteristics	Categories	Total	Urban	Rural	P-Value*
		n/385 (%)	n/192 (%)	n/193 (%)	
Sex	Male	255 (66.2)	124 (64.6)	131 (67.9)	0.495
	Female	130 (33.8)	68 (35.4)	62 (32.1)	
Age of the respondents	18–20	43 (11.2)	24 (12.5)	19 (9.8)	0.008
	21–30	129 (33.5)	72 (37.5)	57 (29.5)	
	31–40	96 (24.9)	51 (26.6)	45 (23.3)	
	41–50	68 (17.7)	32 (16.7)	36 (18.6)	
	51 and above	49 (12.7)	13 (6.8)	36 (18.6)	
Education	No formal education	53 (13.8)	18 (9.4)	35 (18.1)	<0.001
	Primary (G-5)	42 (10.9)	18 (9.4)	24 (12.4)	
	Secondary (G-10)	130 (33.8)	51 (26.6)	79 (40.9)	
	Higher Secondary (G-12)	69 (17.9)	43 (22.4)	26 (13.5)	
	Graduation and above	91 (23.6)	62 (32.3)	29 (15.0)	
Monthly household income	<91 US$	56 (14.5)	17 (8.9)	39 (20.2)	<0.001
	92 to 181 US$	135 (35.1)	49 (25.5)	86 (44.6)	
	182 to 271 US$	97 (25.2)	50 (26.0)	47 (24.4)	
	272 to 362 US$	43 (11.2)	35 (18.2)	8 (4.2)	
	363 to 453 US$	24 (6.2)	17 (8.9)	7 (3.6)	
	454 US$ and above	30 (7.8)	24 (12.5)	6 (3.1)	
Age of the patient	≤ 5 years	64 (16.6)	28 (14.6)	36 (18.7)	0.060
	6 to 10 years	24 (6.2)	13 (6.8)	11 (5.7)	
	11 to 20 years	44 (11.4)	25 (13.0)	19 (9.8)	
	21 to 40-years	152 (39.5)	87 (45.3)	65 (33.7)	
	41 to 60 years	70 (18.2)	28 (14.6)	42 (21.8)	
	≥ 60 years	31 (8.1)	11 (5.7)	20 (10.4)	
Antibiotics purchased for	Family members or others	235 (61.0)	107 (55.7)	128 (66.3)	0.030
	Respondent him/herself	150 (39.0)	85 (44.3)	65 (33.7)	
Reported symptoms presentation	Single symptom	283 (73.5)	146 (76.0)	137 (71.0)	0.261
	Multiple symptoms	102 (26.5)	46 (23.9)	56 (29.0)	
Number of purchased antibiotics	One antibiotic	356 (92.5)	179 (93.2)	177 (91.7)	0.572
	Multiple antibiotics (max. 3)	29 (7.5)	13 (6.8)	16 (8.3)	
Ability to identify antibiotics	Able to identify	249 (64.7)	137 (71.3)	112 (58.0)	0.006
	Not able to identify	136 (35.3)	55 (28.7)	81 (42.0)	

* p-values for chi-square test

statistically significant higher level of education compared to rural participants ($p < 0.001$). Most respondents reported a monthly income ranging from 92 to 181 US dollars (equivalent to BDT), totalling 35.1%, followed by an income bracket of 182 to 271 US dollars, encompassing 25.2%. There were significant differences in income levels between urban and rural areas ($p < 0.001$), with a higher proportion of rural households earning <91 US$.

Respondents purchased antibiotics for themselves, comprising 39%, or for household or non-household members, totalling 61%. Rural respondents showed a statistically significant higher tendency to purchase antibiotics for family members or others compared to urban respondents ($p = 0.030$). Most antibiotic purchases were for patients aged 21 to 40, totalling 39.5%. Notably, 16.6% were under 5 years old, and 8.1% were over 60 years old. The majority of reported symptom presentations involved a single symptom, with 73.5%. A single antibiotic was purchased by 92.5%. When asked to distinguish antibiotics among their purchased medicines, 64.7% correctly identified antibiotics. Urban respondents exhibited the significant ability to identify antibiotics in comparison to the rural respondents ($p = 0.006$).

3.2. Health-seeking behavior and antibiotic purchasing patterns

Table 2A displays whether respondents obtained prescriptions when purchasing antibiotics. Based on the presence of prescriptions during the survey, 43.4% obtained prescriptions (categorized as the prescription group) from duly registered medical practitioners who have completed their Bachelor's degrees in Medicine and Surgery (MBBS), while 56.6% belonged to the non-prescription group, lacking prescriptions when purchasing antibiotics. Among the non-prescription respondents, 58.3% bought antibiotics through self-medication—either by their own choice or by recommendation from drug sellers. Additionally, 41.7% of respondents received antibiotic suggestions from non-registered healthcare providers (non-MBBS), colloquially known as village doctors or quacks, who lack a medical degree but are recognized for their extensive experience in community pharmacy management. The majority, 88.3%, received dosage instructions for antibiotics from drug sellers.

Table 2B presents the prevalence of antibiotics among all purchases and proportion of customers observed purchasing medicines with or without prescriptions during structured observation. The analysis revealed that 25.9% of dispensed medicines were antibiotics, 71.2% were non-antibiotics, and 2.9% could not be classified as either antibiotics or non-antibiotics due to methodological constraints aimed at avoiding potential biases by refraining from questioning customers or drug sellers.

During the observations, it was observed that 37.7% of drug sellers either requested prescriptions or dispensed medicines in the presence of prescriptions, covering both antibiotics and non-antibiotics. Additionally, 20% drug sellers provided advice to customers on both dosage and duration, while 7.6% specified only the frequency, and 5.6% solely mentioned the duration.

3.3. Health-symptoms that lead to antibiotic purchases

Graph 1 presents both primary and secondary health symptoms prompting individuals to purchase antibiotics. Upper-respiratory-tract infections, comprising symptoms like cold, cough, sneezing, nasal congestion, tonsillitis, sinus infections, and ear infections, were the most common reasons, reported by 37.4% of respondents. Fever accounted for 31.7% of respondents. Uncomplicated external skin and soft tissue infections, such as wound infections, allergies, abscesses, and swelling with discharge, were reported by 20% of respondents.

Gastrointestinal infections, including diarrhea and dysentery, were reported by 11.2% of respondents, with a slightly higher percentage observed in urban areas (13.5%) compared to rural areas (8.8%). Urinary-tract infections were reported by 7.9% of respondents. Lower-respiratory-tract infections, such as bronchitis, pneumonia, and bronchiolitis, represented 4.4% of respondents, with rural areas reporting a slightly higher percentage (6.7%) compared to urban areas (2.1%). The "Others" category included various health conditions like piles, ulcers, cardiovascular infections, and pimples, accounting for 6% of respondents.

Table 2A
Characteristics of health-seeking behavior and antibiotic purchase pattern.

Characteristics	Categories	Total	Urban	Rural	P-Value
		n/385 (%)	n/192 (%)	n/193 (%)	
Dosage instructions from drug sellers	Received instruction	340 (88.3)	163 (84.9)	177 (91.7)	0.037
	Did not receive instructions	45 (11.7)	29 (15.1)	16 (8.3)	
Presence of prescription during antibiotic purchase	Had a prescription from a registered medical practitioner	167 (43.4)	84 (43.8)	83 (43.0)	0.880
	Had no prescription	218 (56.6)	108 (56.3)	110 (57.0)	
	No Prescription group	n/218 (%)	n/108 (%)	n/110 (%)	
	Self-medication*	127 (58.3)	73 (67.6)	54 (49.1)	<0.001
	Non-registered healthcare providers** (non-MBBS)	91 (41.7)	35 (32.4)	56 (50.9)	

* Self-medication encompasses both antibiotics chosen by the respondents themselves and antibiotics suggested by drug sellers.
** Non-registered healthcare providers refer quacks or village doctors who are locally known as doctors. However, they do not have any medical degrees.

Table 2B
Observed medicine dispensing and purchasing behavior (Structured Observation).

Characteristics	Categories	Total	Urban	Rural	P-Value
		n/1000 (%)	n/500 (%)	n/500 (%)	
Type of Drugs	Antibiotics	259 (25.9)	124 (24.8)	135 (27.1)	0.630
	Non-antibiotics	712 (71.2)	361 (72.1)	351 (10.3)	
	Could not determine*	29 (2.9)	16 (3.2)	13 (2.6)	
Presence of prescription	Dispensed without a prescription	623 (62.3)	328 (65.5)	295 (59.1)	0.030
	Dispensed with a prescription	377 (37.7)	173 (34.5)	204 (40.9)	
Counselling on Dosage	Frequency and duration	200 (20.0)	80 (16.0)	120 (24.1)	<0.001
	Only frequency	76 (7.6)	30 (6.0)	46 (9.2)	
	Only duration	56 (5.6)	27 (5.4)	29 (5.8)	
	No counselling	668 (66.8)	364 (72.7)	304 (61.0)	

* Dispensed medicines were indeterminate due to methodological constraints on researcher interaction with customers or dispensers to mitigate biases.

3.4. Characteristics of purchased antibiotics

Graph 2 displays the antibiotics respondents purchased. Graph A displays the antibiotic classes purchased by respondents based on their area of residence (Urban vs. Rural), and Graph B illustrates the antibiotics purchased with or without a prescription from a registered medical practitioner. Macrolides emerged as the most utilized antibiotic class, representing 22.8%. Third-generation cephalosporins were the second most frequently used class, accounting for 20.8%, followed by second-generation cephalosporins, which constituted 16.9%. Penicillins accounted for 14% of antibiotic usage and Fluoroquinolones accounted for 12.7%. The use of broad-spectrum beta-lactamase inhibitors represented 8.8%. Imidazoles constituted 5.5%, followed by first-generation cephalosporins accounted for 2.1%. Various other antibiotic classes were used in smaller percentages, including Oxazolidinones (1%), Lincosamides (1%), Nitrofuran derivatives (0.8%), Rifamycins (0.5%), Carbapenems (0.3%), and tropical antibiotics (0.3%). There were slight variations observed in antibiotic usage between urban and rural areas; however, these differences did not reach statistical significance.

Antibiotic class distribution was examined in both prescribed and non-prescribed groups to identify which antibiotics were predominantly dispensed without prescriptions (Graph- B). Macrolides (61.6%), Fluoroquinolones (71.4%), Second-generation-cephalosporins (60%), Beta-lactamase-inhibitor (55.9%), Imidazole (76.2%), and First-generation-cephalosporins (62.5%) were frequently dispensed without prescriptions. Statistical differences (0.027) were evident between prescription and non-prescription groups in different antibiotic usage.

3.5. Purchased antibiotics in WHO-AWaRe classification

The listed antibiotics were classified according to the WHO-AWaRe categories, and it was observed that the highest antibiotic purchases were in the Watch group, comprising 73.5%, followed by Access at 23.1%, and Reserve at 1.0%. However, Broad-spectrum beta-lactamase-inhibitor antibiotics like cefuroxime/clavulanic acid and amoxicillin/clavulanic acid were not categorized within the WHO AWaRe classifications. They were identified as not-recommended antibiotics,[25] and accounted for 8.8% in this survey.

3.6. Influence of demographic factors and health-symptoms in antibiotic purchasing behavior

Table 4 presents the factors associated with presenting a prescription from a registered medical practitioner (MBBS) while purchasing antibiotics. Males are more likely (Adj. PR: 1.12, 95% CI: 0.87–1.44) to present a prescription from a registered medical practitioner than females though the association was not significant. A trend towards a high likelihood of presenting a prescription among higher education groups compared to the no formal education group was found, but the associations were not statistically significant. Compared to the respondents with a monthly household income <91 US$, respondents with monthly household income between 272 and 362 US$ were more likely (Adj. PR: 1.26, 05% CI: 0.78–2.05) and respondents with monthly household income 363 to 453 US$ were less likely (Adj. PR: 0.86, 95% CI: 0.46–1.60) to present a prescription from a qualified doctor while purchasing antibiotic but the associations were not statistically significant. Compared to the respondents within the at-risk age group, respondents within the intermediate-risk group were 27% less likely to present prescriptions while purchasing antibiotics (Adj. PR: 0.73, 95% CI: 0.56–0.95) which was statistically significant. Purchasing antibiotics for patients with lower respiratory-tract infections (Adj. PR: 1.87, 95% CI: 1.07–3.29) and enteric fever (Adj. PR: 1.78, 95% CI: 1.04–3.03) were significantly associated with a higher likelihood of presenting prescriptions compared to purchasing antibiotic for fever patients.

Table 4
Factors associated with presenting a prescription from a registered medical practitioner while purchasing antibiotics.

Demographic and health symptoms	Categories	N	Had a prescription n/N (%)	Crude Prevalence Ration (95% CI)	Adj. Prevalence Ration (95% CI)
	Female	130	52 (40.0)	Reference	Reference
Sex	Male	255	115 (45.1)	1.12 (0.87, 1.44)	1.12 (0.87, 1.44)
	Urban	192	84 (43.8)	Reference	Reference
Residence location	Rural	193	83 (43.0)	0.98 (0.78, 1.23)	0.94 (0.73, 1.22)
	No formal education	53	21 (39.6)	Reference	Reference
	Primary (Gr. 5)	42	17 (40.5)	1.02 (0.62, 1.67)	0.93 (0.56, 1.52)
	Secondary (Gr. 10)	130	52 (40.0)	1.00 (0.68, 1.49)	1.07 (0.73, 1.57)
	Higher Secondary (Gr. 12)	69	35 (50.7)	1.28 (0.85, 1.92)	1.27 (0.83, 1.93)
Education	Graduation and above	91	42 (46.2)	1.16 (0.78, 1.73)	1.20 (0.77, 1.88)
	<91 US$	56	23 (41.1)	Reference	Reference
	92 to 181 US$	135	59 (43.7)	1.06 (0.73, 1.53)	1.04 (0.72, 1.51)
	182 to 271.50 US$	97	39 (40.2)	0.97 (0.65, 1.45)	0.95 (0.62, 1.46)
	272 to 362 US$	43	22 (51.2)	1.24 (0.81, 1.91)	1.26 (0.78, 2.05)
	363 to 453 US$	24	9 (37.5)	0.91 (0.49, 1.67)	0.86 (0.46, 1.60)
Monthly household income	454 US$ and above	30	15 (50.0)	1.21 (0.75, 1.96)	1.10 (0.65, 1.87)
	≤ 5 and ≥ 60 Years (at-risk)	104	57 (54.8)	Reference	Reference
Disease-susceptible age group	6 to 59 Years (Intermediate)	281	110 (39.2)	0.71 (0.56, 0.89)	0.73 (0.56, 0.95)
	Single symptom	283	121 (42.8)	Reference	Reference
Number of symptom(s)	Multiple symptoms	102	46 (45.1)	1.05 (0.81, 1.35)	1.12 (0.83, 1.51)
	Fever	29	12 (41.4)	Reference	Reference
	Upper respiratory-tract infection	138	56 (40.6)	0.98 (0.6, 1.58)	0.88 (0.51, 1.49)
	Uncomplicated external skin and soft tissue infections	73	34 (46.6)	1.12 (0.68, 1.85)	1.21 (0.71, 2.06)
	Gastrointestinal infections	40	14 (35.0)	0.84 (0.46, 1.55)	0.85 (0.45, 1.58)
	Urinary-tract infection	39	11 (28.2)	0.68 (0.35, 1.32)	0.70 (0.35, 1.38)
Primary health symptom*	Lower respiratory-tract infections	17	14 (82.4)	1.99 (1.22, 3.23)	1.78 (1.04, 3.03)
	Enteric fever	12	9 (75.0)	1.81 (1.05, 3.12)	1.87 (1.07, 3.29)
	Eye infection	10	5 (50.0)	1.20 (0.56, 2.57)	1.28 (0.60, 2.74)
	Infections in the oral cavity	10	2 (20.0)	0.48 (0.12, 1.79)	0.51 (0.14, 1.85)
	Others	17	10 (58.8)	1.42 (0.78, 2.56)	1.60 (0.86, 2.98)

* In this analysis, only the reported primary health symptoms that prompted their antibiotic purchases were considered; however, the question allowed multiple responses.

4. Discussion

This study aimed to understand antibiotic purchasing patterns in Bangladesh's community settings. Pharmacies, especially in LMICs, were key sources for over-the-counter antimicrobials, with 65.5% acquiring antibiotics from these outlets.[26] In the structured observation, it was found that 25.9% of dispensed medicines at community-based pharmacies were antibiotics, contrasting with prior studies in Bangladesh, indicating a rate of 49.4%.[27] Variance in this finding may result from excluding areas within a one-kilometre radius of hospitals to reduce biases from nearby medical specialties. In another cross-sectional study across six LMICs, including Bangladesh, varying proportions of households reported antibiotic use in the previous month: 49.4% in Bangladesh, 42.3% in Ghana, 25.2% in Mozambique, 10.2% in South Africa, 27.9% in Thailand, and 45.0% in Vietnam.[22] A recent systematic review of antibiotic prescription practices in LMICs suggested that the actual rate may remain closer to 50%, surpassing the WHO's outpatient antibiotic threshold of 30%.[8]

With this survey, 56.6% of participants purchased antibiotics without a formal prescription from a registered medical practitioner, slightly higher at 62.3% in the structured observation. Another recent study in Bangladesh revealed a non-prescription antibiotic dispensing rate of 50.9% at pharmacies.[27] Across LMICs, rates of non-prescription antibiotics varied: 36.1% in Ghana, 45.7% in Bangladesh, 55.2% in Vietnam[22] and 66.5% in Nepal.[28] A meta-analysis showed LMICs' non-prescription antibiotic use ranged from 50% to 93.8%, with a pooled prevalence of 78%.[29] Another systematic review of 162 studies from 52 countries found that the overall prevalence of non-prescription antibiotic dispensing in community pharmacies was 63.4%.[30] No significant urban-rural differences were found in this study, echoing findings from Ghana.[31] These findings suggest that non-prescription antibiotic users often rely on advice from community pharmacy drug sellers or non-registered healthcare providers, often referred to as village doctors or quacks, known for their expertise in pharmacy management. This trend aligns with previous studies in Bangladesh[32] and other LMICs.[33,34] Informal healthcare providers play a significant role in developing nations' healthcare systems[35] and contribute to irrational antibiotic use.[32]

In this study, it was found that antibiotic purchases were mainly for "non-severe" health symptoms.[36] Common reasons included upper respiratory-tract infections, fever, uncomplicated skin infections, gastrointestinal infections, and urinary-tract infections, consistent with trends in other LMICs.[37–45] A wide use of broad-spectrum antibiotics including macrolides, third-generation cephalosporins, fluoroquinolones, second-generation cephalosporins, penicillins, and Beta-lactamase-inhibitors dispensed without a prescription was found, reflecting patterns in many LMICs.[8,46] This widespread use of broad-spectrum antibiotics, even when narrow-spectrum options could suffice, heightens the risk of antibiotic-resistant infections.[29] This unrestricted use increases the risk of antibiotic-resistant infections.[47] In 2017, WHO introduced the AWaRe classification, emphasizing narrow-spectrum drugs in the Access group to combat resistance, with a recommended minimum of 60% Access-group antibiotics.[48] This study found that 73.5% of dispensed antibiotics were in the Watch group, with only 23.1% in the Access group. Nearly half were obtained without prescriptions, consistent with research in Bangladesh and other LMICs.[27,49] In LMICs across Asia and Africa, Watch-group antibiotics prevailed more in Asian sites, echoing the findings of this study.[22] Self-treatment with antibiotics from drug stores is common due to factors like convenience and cost-effectiveness, despite regulations against over-the-counter sales being inadequately enforced in many LMICs.[22] Despite the current prohibition in the National Drug Policy in Bangladesh against selling antibiotics without a prescription from a registered physician, poor compliance persists, with unregistered practitioners often prescribing antibiotics and OTC dispensing being widespread.[50] Discussions about strengthening regulations to address this issue have emerged, with a proposed draft law suggesting a financial penalty for selling antibiotic drugs without a prescription and maximum life imprisonment for illegally stocking medicines or producing adulterated medicines.[51] Imposing prescription-only rules faces challenges due to easy access through community pharmacies, prevailing health-seeking behaviors, and potential conflicts of interest from suppliers.[31,33,52] A systematic review assessed law enforcement impact on reducing OTC antibiotic sales in LMICs, finding prescription-only regulations effective but lacking guidance. However, multifaceted interventions targeting stakeholders with policy evaluation using robust study designs are crucial.[53]

Studies in similar contexts consistently highlight insufficient antibiotic knowledge among individuals, with a significant portion unable to discern antibiotics from other medications. This study found that 35.3% couldn't differentiate antibiotics from their other medications, aligning with research in Africa and other Asian countries.[22,54] Prioritizing people's ability to distinguish antibiotics from common medicines is crucial. Complicating this is pharmacy retailers' inadequate antibiotic knowledge, leading to prescription-less dispensing, emphasizing the need for improved antimicrobial product labelling patterns.[55] Initiatives like India's Red Line campaign, focusing on clear antibiotic labelling, have proven effective, aligning with global strategies for community resilience.[22]

Poisson regression was used to analyze the influence of demographics and health conditions on antibiotic purchasing behavior. Patients aged 6 to 59 had a 27% lower likelihood of antibiotic prescription compared to the at-risk group (under 5 or over 60), aligning with findings from LMIC studies.[29] Certain health conditions like lower respiratory tract infections and enteric fever correlated with higher prescription rates. Factors such as sex, location, education, income, and multiple symptoms showed no significant associations. While some findings align with other LMIC studies, not all are matched.[44,45,56]

An umbrella review outlined key factors influencing antibiotic prescriptions in LMICs. These factors included socio-cultural context, financial incentives, personal beliefs, patients' attitudes, and AMR awareness.[57,58] Challenges persist due to poor clinical documentation and limited diagnostic tools in resource-constrained areas, making misuse assessment complex.[59] Future studies need comprehensive methodologies bridging formal and informal healthcare settings to enhance data quality.[3,60,61] Future research should identify barriers and facilitators to antimicrobial stewardship programs (ASPs) implementation, assess the impact of ASP interventions in LMICs,[62] enhance surveillance of antimicrobial use and resistance, and analyze antimicrobial usage trends in LMIC settings.[63] ASPs have succeeded in promoting appropriate antimicrobial use in LMICs through evidence-based interventions,[64] necessitating universal implementation adaptable to local contexts and cultures.[65] Tailored approaches and targeted communication strategies are vital for user-centric outcomes in health promotion, especially in diverse socioeconomic classes.[29] Effective interventions require understanding motivations behind antibiotic self-medication and implementing context-specific interventions targeting at-risk groups, with healthcare policies focusing on identified health system factors to curb inappropriate antibiotic use.[66,67]

5. Limitations

Despite careful efforts to minimize gaps, this study had certain limitations. The survey's representativeness relied on population diversity and geographic distribution. However, the findings may lack representativeness due to the sample size. Estimating proportions or means without prior similar research in Bangladesh posed a challenge. A 50% prevalence was assumed, guiding the sample size of 385 individuals for precision. Data collection was conducted from 5 PM to 10 PM to get the high volume of medicine sells. This, however, coincided with MBBS physicians' after-duty practices in the community pharmacies, potentially affecting prescription numbers. While many studies found associations between socio-economic factors like sex, age, education, and income with prescription likelihood, no such associations were observed in this study. This discrepancy may be due to the focus on antibiotic purchasing behavior, surveying only customers who visited a community pharmacy to buy antibiotics, which might not capture the true associations present in the larger population. Many participants could not differentiate between registered medical practitioners (MBBS) and non-certified healthcare providers, affecting clarity of registered medical practitioners and non-registered healthcare providers. In this study, the proportion of antibiotics sold was lower than in previous studies in Bangladesh. This may be due to the exclusion of pharmacies within one kilometre of hospitals. Hospital-adjacent pharmacies typically have higher antibiotic sales due to the severity of patients' conditions and surgeries. The focus of the current study was specifically on antibiotics purchased by the general population in community settings. External factors influencing antibiotic acquisition were not accounted for this analysis. Limitations underscore cautious interpretation, highlighting the need for nuanced research in similar settings. Poisson regression was used by adjusting other confounders, but not all factors may have been accounted for, impacting analysis comprehensiveness.

6. Conclusions

Antibiotics are widely accessible in community pharmacies and informal healthcare settings, often without prescriptions. Targeted interventions across both formal and informal healthcare settings are crucial, considering diverse health system contexts across LMICs, with particular emphasis on informal settings where irrational antibiotic practices are prevalent. Understanding social determinants of health is key to designing effective interventions. Developing user-centric approaches, informed by co-designed research with stakeholders from the supply and demand sides, and prioritizing education and monitoring of over-the-counter sales are imperative. Informal healthcare providers, including those posing as doctors, should be actively engaged in intervention efforts. Community-based initiatives are essential for raising public awareness about preserving antibiotics. Ensuring better quality data through rigorous studies with comprehensive methodologies and robust documentation via antimicrobial resistance surveillance is crucial. In conclusion, there is an urgent need for multifaceted approaches to tackle antibiotic misuse in LMICs.

Ethics approval

The study was undertaken following approval from the University of New South Wales (UNSW) Human Research Ethics Committee (HC220360) and the Institutional Review Board (IRB) of the local implementing organization, BRAC James P. Grant School of Public Health, Bangladesh (IRB-22 September'22–037).

All participants involved in the study provided informed consent to participate, understanding the nature of the research, their rights, and the potential risks involved. Additionally, any identifiable information related to participants has been handled with utmost confidentiality and in accordance with ethical guidelines.

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Declaration on the use of AI assisted tools

During the preparation of this manuscript, AI-assisted tools were used limitedly for language editing and fixing grammatical errors.

CRediT authorship contribution statement

Abdullah Al Masud: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ramesh Lahiru Walpola:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Malabika Sarker:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Alamgir Kabir:** Writing – review & editing, Visualization, Validation, Supervision, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Muhammad Asaduzzaman:** Writing – review & editing, Visualization, Validation, Methodology, Funding acquisition, Conceptualization. **Md Saiful Islam:** Writing – review & editing, Visualization, Validation, Methodology, Funding acquisition. **Ayesha Tasnim Mostafa:** Writing – review & editing, Validation, Resources, Project administration, Methodology, Investigation, Data curation. **Zubair Akhtar:** Writing – review & editing, Visualization, Validation, Software, Methodology, Formal analysis. **Mrittika Barua:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Holly Seale:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare no conflicts of interest regarding the presented research. Any potential competing interests have been acknowledged and managed to maintain the study's integrity and impartiality.

Data availability

The datasets utilized in this study are accessible from the corresponding author upon reasonable request, in accordance with the data sharing policies of the University of New South Wales (UNSW) and BRAC James P. Grant School of Public Health. Supplementary files, including supporting data and summaries, are available.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rcsop.2024.100485.

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