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Original Article

Household Antibiotic Storage Practices and Seasonal Respiratory Infection Transmission Patterns in Crowded Urban Communities

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ABSTRACT

Background: Household retention of antibiotics may facilitate self-medication and delayed healthcare-seeking, particularly in crowded communities experiencing frequent respiratory illness. Objective: To determine the prevalence and characteristics of household antibiotic storage and examine its associations with crowding, self-medication, respiratory illness episodes, symptom duration, and healthcare consultation delay. Methods: A community-based analytical cross-sectional study included 85 households from high-density industrial and urban communities in Punjab, Pakistan, between October 2025 and January 2026. Household antibiotic inventories, respiratory illness reports, crowding indices, and healthcare-use measures were assessed. Group comparisons, correlation analysis, and multivariable regression were performed. Results: Antibiotic stockpiles were identified in 58 households (68.2%). Of 412 stored doses, 44.2% were beta-lactams and 32.8% were macrolides. Crowding correlated with stored doses ($r = 0.61$, $p < 0.001$), respiratory episodes ($r = 0.48$, $p = 0.003$), and symptom duration ($r = 0.39$, $p = 0.012$). Stockpile-positive households reported longer symptoms (8.4 ± 2.1 vs 5.9 ± 1.8 days), more self-medication incidents (2.3 ± 1.1 vs 0.4 ± 0.6), and longer consultation delays (4.8 ± 1.6 vs 2.1 ± 1.2 days; all $p < 0.001$). Stored antibiotic volume ($\beta = 0.47$, $p < 0.001$) and crowding ($\beta = 0.38$, $p = 0.002$) were independently associated with self-medication frequency. Conclusion: Household antibiotic storage was common and was associated with crowding, self-medication, prolonged reported symptoms, and delayed consultation. Prospective research is required to determine temporality. Keywords: Anti-Bacterial Agents; Crowding; Drug Storage; Healthcare-Seeking Behaviour; Respiratory Tract Infections; Self Medication.

INTRODUCTION

Antimicrobial resistance is a major global public-health concern that threatens the effectiveness of established treatments for infectious diseases. Although inappropriate prescribing within healthcare systems is an important contributor, antibiotic use outside formal clinical supervision also plays a substantial role. Household retention of leftover antibiotics creates opportunities for reuse without an updated diagnosis, use of incomplete treatment courses, sharing of medicines between family members, and consumption of expired products. These practices may expose individuals to inappropriate drug

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selection, incorrect dosing, adverse effects, treatment delay, and unnecessary antimicrobial pressure (1–3).

Household antibiotic storage and self-medication are particularly relevant in communities where access to affordable healthcare is inconsistent and antibiotics can be obtained without adequate clinical assessment. Studies conducted in low- and middle-income settings have linked non-prescription antibiotic use with financial constraints, limited health literacy, prior experience with similar symptoms, direct access to pharmacies, and retention of medicines from previous illnesses (7,11–17). Evidence from Pakistan has also demonstrated that antibiotics may be stored within households for subsequent use, highlighting the need to understand the environmental and behavioural factors associated with this practice (17). However, storage alone does not establish inappropriate use; the public-health concern arises when retained antibiotics are consumed without a current prescription, used for conditions unlikely to benefit from antimicrobial treatment, or substituted for timely professional consultation.

Seasonal respiratory illnesses may provide a common context in which stored antibiotics are used without appropriate assessment. Symptoms such as cough, fever, sore throat, nasal congestion, and general malaise are frequently interpreted by community members as indications for antibiotic treatment, despite many acute respiratory illnesses being viral or self-limiting. In densely occupied households, close interpersonal contact, shared rooms, limited ventilation, and repeated exposure to symptomatic household members may increase the occurrence of respiratory symptoms. Such circumstances may also strengthen the perceived need to keep medicines readily available, particularly where healthcare access is delayed, costly, or inconvenient (4,8).

Household crowding may therefore be associated with both a greater reported burden of respiratory illness and greater reliance on stored medicines. Nevertheless, these relationships are complex. Larger or more crowded households may experience more respiratory episodes simply because more individuals are exposed, while households with recurrent illness may accumulate antibiotics from previous prescriptions. Healthcare accessibility, income, education, chronic disease, household composition, ventilation, smoking exposure, and previous antibiotic use may also influence storage and self-medication behaviours. Consequently, associations between crowding, stored antibiotic volume, respiratory illness, and delayed consultation should be interpreted as interrelated household-level patterns rather than evidence of a direct causal pathway.

Previous research has generally examined antibiotic self-medication, medicine-storage practices, healthcare-seeking behaviour, or environmental determinants of respiratory illness separately. Less evidence is available on how these factors coexist within crowded urban households during periods of increased respiratory illness. In particular, limited local data describe whether household crowding and the quantity of retained antibiotics are associated with the frequency of non-prescription antibiotic use, reported respiratory episodes, symptom duration, and delays in seeking professional care.

Therefore, this study aimed to determine the prevalence and characteristics of household antibiotic storage and to examine its association with household crowding, self-medication frequency, retrospectively reported respiratory illness episodes, symptom duration, and healthcare consultation delay among households in crowded urban communities during the winter respiratory illness period. It was hypothesized that greater household crowding and a larger volume of stored antibiotics would be associated with more frequent self-medication and less timely professional healthcare consultation.

MATERIALS AND METHODS

A community-based analytical cross-sectional study was conducted in selected high-density industrial and urban communities in Punjab, Pakistan, between October 2025 and January 2026. This period was selected to capture household medication-use and healthcare-seeking behaviours during the winter months, when respiratory symptoms are commonly reported. The household was treated as the principal unit of analysis, and information was obtained from an adult household representative.

Households were eligible when the responding household head or nominated adult representative was aged 18 years or older and had lived in the selected community for at least one year. This residency requirement was applied to ensure that respondents had sufficient familiarity with household living conditions, medication-storage practices, and recent healthcare-use patterns. Households were excluded when the principal respondent was a licensed healthcare professional because professional knowledge and access to medicines could substantially influence storage and treatment practices. Households in which the available residential structure did not permit consistent estimation of the number of residents per usable room were also excluded.

A multistage cluster-sampling approach was used to recruit households from selected high-density residential blocks. Residential areas were first organized into geographical clusters, after which households were approached within the selected clusters. Of the 92 households approached, 85 completed the study procedures and were included in the analysis, corresponding to a response rate of 92.4%. One eligible adult representative provided information on behalf of each participating household.

Data were collected through an interviewer-administered household assessment comprising a medication-storage inventory, a respiratory illness questionnaire, and socio-demographic and environmental measures. The medication-storage component documented antibiotics retained within the household at the time of assessment. Information was recorded on the antibiotic class, available quantity, reported source, and expiration status. Antibiotics were categorized into beta-lactams, macrolides, fluoroquinolones, and other antimicrobial classes according to their active ingredients. The total volume of stored antibiotics was expressed as the number of identifiable doses recorded during the household assessment.

An active household antibiotic stockpile was defined as the presence of one or more systemic antibacterial medicines retained in the home at the time of data collection for possible future use. Stored medicines were further characterized according to whether they originated from a previous illness, had been purchased without a current prescription, or had been obtained from another person. Expiration status was determined from the date displayed on the available medicine packaging when this information was accessible.

The respiratory illness component recorded the number of acute respiratory symptom episodes reported within the household during the preceding 90 days. Information was collected on symptom duration, antibiotic use without a current medical prescription, and the interval between symptom onset and consultation with a qualified healthcare professional. A self-medication incident was defined as household use of an antibiotic for a current respiratory illness episode without a new prescription or clinical assessment for that episode. Healthcare consultation delay was measured as the reported number of days between the onset of respiratory symptoms and professional consultation.

Household crowding was quantified by dividing the total number of usual household residents by the number of rooms routinely available for living or sleeping. Rooms used exclusively as kitchens, bathrooms, corridors, storage areas, or non-residential spaces were not included in the room count. A higher crowding-index value therefore represented a greater number of residents per usable room. Additional socio-demographic information included the age and sex of the respondent and monthly household income.

Data collectors reviewed each questionnaire for completeness at the time of collection. Household-level records were checked for internally inconsistent responses, implausible values, and duplication before analysis. The analytical dataset included households that completed the medication-storage, respiratory illness, crowding, and socio-demographic assessments.

Data were analysed using IBM SPSS Statistics version 28.0. Continuous variables were summarized using means and standard deviations, while categorical variables were presented as frequencies and percentages. The distribution of continuous measures was assessed using the Shapiro–Wilk test together with inspection of their distributions. Differences in symptom duration, self-medication frequency, and healthcare consultation delay between households with and without an active antibiotic stockpile were examined using independent-samples comparisons when the assumptions of parametric analysis were satisfied. Where distributional assumptions were not satisfied, the corresponding non-parametric procedure was considered.

Associations between the household crowding index, total stored antibiotic doses, reported respiratory episodes, and symptom duration were examined using correlation analysis. Pearson correlation coefficients were used for approximately normally distributed continuous variables with linear relationships; rank-based correlation was appropriate when these assumptions were not met. All correlation estimates were interpreted as measures of association and not as evidence of temporal or causal relationships.

Multivariable analysis was used to examine whether household crowding, stored antibiotic volume, and monthly household income were independently associated with self-medication frequency. Because self-medication frequency was recorded as a count, the distribution of the outcome was assessed before model selection. A count-regression approach was considered appropriate where the outcome demonstrated a non-normal or overdispersed distribution; linear regression was retained only when its distributional and residual assumptions were adequately satisfied. Model assessment included examination of linearity where applicable, residual distribution, homoscedasticity, multicollinearity, influential observations, and overall model fit. Regression results were to be reported using effect estimates, standard errors, 95% confidence intervals, and p-values. Statistical significance was set at a two-sided p-value of less than 0.05.

RESULTS

Of the 92 households approached, 85 completed the study procedures and were included in the analysis, giving a response rate of 92.4%. The mean age of the household respondents was 41.6 ± 11.3 years. Of the respondents, 46 (54.1%) were female and 39 (45.9%) were male. Most households reported a monthly income below PKR 35,000 (61.2%), while 28.2% reported an income of PKR 35,000–70,000 and 10.6% reported an income above PKR 70,000. The mean household crowding index was 3.24 ± 0.85 residents per usable room. An active antibiotic stockpile was identified in 58 households (68.2%), whereas 27 households (31.8%) had no stored antibiotics at the time of assessment.

Table 1. Characteristics of participating households and respondents (N = 85)

Variable	Category	Value
Respondent age, years	—	41.6 ± 11.3
Respondent sex	Male	39 (45.9)
	Female	46 (54.1)
Monthly household income, PKR	<35,000	52 (61.2)
	35,000–70,000	24 (28.2)
	>70,000	9 (10.6)
Crowding index, residents per usable room	—	3.24 ± 0.85
Active household antibiotic stockpile	Present	58 (68.2)
	Absent	27 (31.8)

Values are presented as mean ± standard deviation or n (%). Percentages were calculated using 85 participating households as the denominator.

A total of 412 stored antibiotic doses were identified during the household assessments. Beta-lactams accounted for the largest proportion of stored doses, comprising 182 doses (44.2%), followed by macrolides with 135 doses (32.8%), fluoroquinolones with 65 doses (15.8%), and other antibiotics with 30 doses (7.2%). Leftovers from previous illnesses were reported as the principal source of the stored beta-lactams and fluoroquinolones, whereas over-the-counter purchase was the principal reported source of macrolides. Antibiotics categorized as "other" were principally obtained through sharing by relatives or neighbours. The highest reported proportion of expired products occurred among other antibiotics, followed by fluoroquinolones.

Table 2. Characteristics of stored antibiotics identified during household assessment

Antibiotic class	Stored doses, n (%)	Principal reported source	Reported expired proportion, %
Beta-lactams, including amoxicillin/clavulanate	182 (44.2)	Leftover from a previous illness	14
Macrolides, including azithromycin	135 (32.8)	Over-the-counter purchase	6
Fluoroquinolones, including ciprofloxacin	65 (15.8)	Leftover from a previous illness	22
Other antibiotics, including co-trimoxazole	30 (7.2)	Shared by a relative or neighbour	29
Total	412 (100.0)	—	—

Percentages in the second column were calculated using 412 identified stored doses as the denominator.

The mean number of respiratory illness episodes reported per household during the preceding 90 days was 2.8 ± 1.4. Household crowding was positively correlated with the total number of stored antibiotic doses ($r = 0.61$, $p < 0.001$), respiratory illness episodes ($r = 0.48$, $p = 0.003$), and symptom duration ($r = 0.39$, $p = 0.012$). The total number of stored antibiotic doses was also positively correlated with respiratory illness episodes ($r = 0.53$, $p < 0.001$) and symptom duration ($r = 0.44$, $p = 0.005$). Respiratory illness frequency and symptom duration were positively correlated ($r = 0.59$, $p < 0.001$).

Table 3. Correlations among household crowding, stored antibiotic doses, and respiratory illness measures (N = 85)

Variable pair	Correlation coefficient, r	95% CI	p-value
Crowding index and total stored antibiotic doses	0.61	0.46 to 0.73	<0.001
Crowding index and respiratory illness episodes	0.48	0.30 to 0.63	0.003
Crowding index and symptom duration	0.39	0.19 to 0.56	0.012
Total stored antibiotic doses and respiratory illness episodes	0.53	0.36 to 0.67	<0.001
Total stored antibiotic doses and symptom duration	0.44	0.25 to 0.60	0.005
Respiratory illness episodes and symptom duration	0.59	0.43 to 0.71	<0.001

CI: confidence interval. The 95% confidence intervals were derived from the reported Pearson correlation coefficients using Fisher's z transformation and N = 85.

Households with an active antibiotic stockpile reported a longer mean duration of respiratory symptoms than households without a stockpile, with respective means of 8.4 ± 2.1 and 5.9 ± 1.8 days. The estimated mean difference was 2.50 days (95% CI: 1.57 to 3.43), corresponding to a large standardized mean difference (Hedges' $g = 1.23$; $p < 0.001$).

The mean number of self-medication incidents was also greater among households with a stockpile than among households without a stockpile (2.3 ± 1.1 versus 0.4 ± 0.6). The estimated mean difference was 1.90 incidents (95% CI: 1.45 to 2.35), with a large standardized mean difference (Hedges' $g = 1.94$; $p < 0.001$). Similarly, the mean delay before professional healthcare consultation was 4.8 ± 1.6 days among households with a stockpile and 2.1 ± 1.2 days among those without a stockpile. This represented an estimated mean difference of 2.70 days (95% CI: 2.01 to 3.39) and a large standardized mean difference (Hedges' $g = 1.80$; $p < 0.001$).

Table 4. Respiratory illness and healthcare-seeking outcomes according to household antibiotic stockpile status

Outcome	Stockpile present (n = 58)	No stockpile (n = 27)	Mean difference (95% CI)	Hedges' g	p-value
Symptom duration, days	8.4 ± 2.1	5.9 ± 1.8	2.50 (1.57 to 3.43)	1.23	<0.001
Self-medication incidents, count	2.3 ± 1.1	0.4 ± 0.6	1.90 (1.45 to 2.35)	1.94	<0.001
Healthcare consultation delay, days	4.8 ± 1.6	2.1 ± 1.2	2.70 (2.01 to 3.39)	1.80	<0.001

The reported multivariable model included three household-level predictors and explained 54% of the variance in self-medication frequency ($R^2 = 0.54$; $F[3,81] = 31.75$; $p < 0.001$). Greater household crowding was independently associated with more frequent self-medication (standardized $\beta = 0.38$, $p = 0.002$), while a greater number of stored antibiotic doses showed the strongest reported independent association with self-medication frequency (standardized $\beta = 0.47$, $p < 0.001$). The available results identified monthly household income as the third model variable but did not provide its regression coefficient or statistical significance.

Table 5. Reported multivariable model for household self-medication frequency (N = 85)

Model component	Reported estimate	p-value
Overall model R^2	0.54	<0.001
Overall model F-statistic	F(3,81) = 31.75	<0.001
Household crowding index, standardized β	0.38	0.002
Total stored antibiotic doses, standardized β	0.47	<0.001

The reported model included three predictors: household crowding, total stored antibiotic doses, and monthly household income. A coefficient for monthly household income and unstandardized coefficients, standard errors, and confidence intervals were not available in the supplied results.

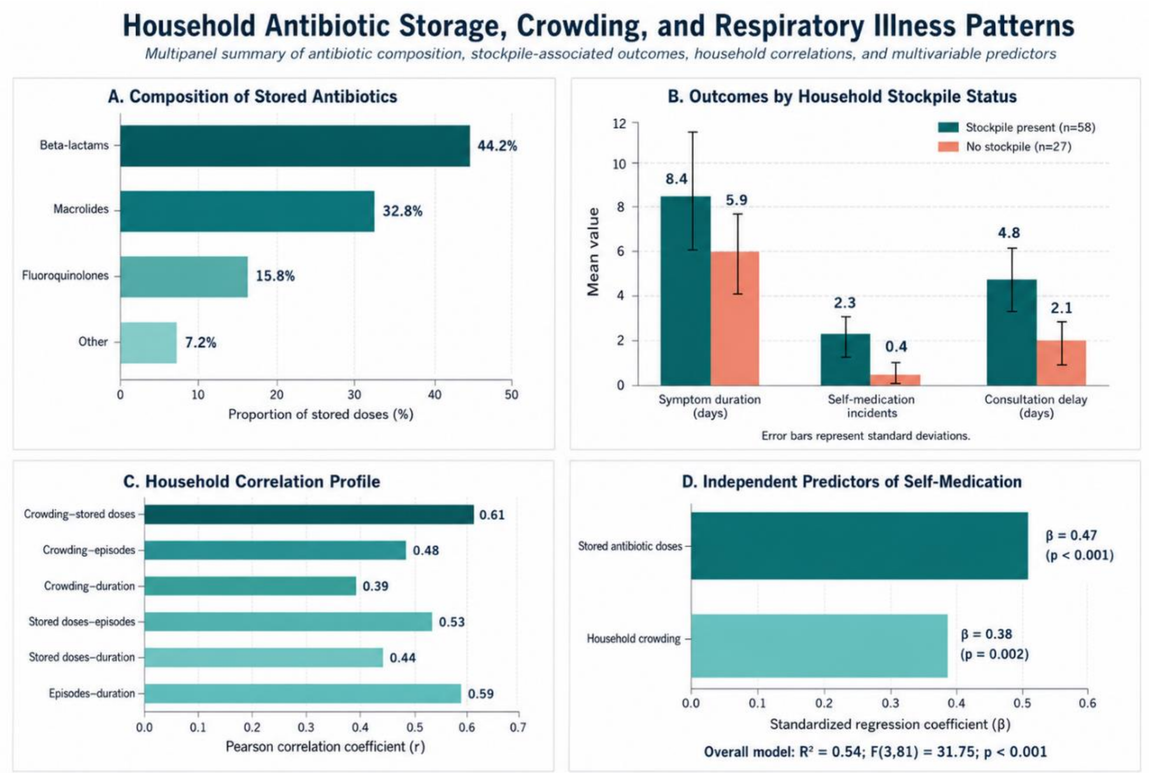

Figure 1 shows that beta-lactams were the most commonly stored antibiotics, followed by macrolides, while households with antibiotic stockpiles reported longer symptom duration, more self-medication incidents, and greater delays in seeking professional care. Crowding was positively associated with stored antibiotic volume and respiratory illness measures, and both stored antibiotic doses and household crowding independently predicted self-medication frequency.

Overall, antibiotic storage was common among the surveyed households and was associated with higher reported self-medication frequency, longer respiratory symptom duration, and greater delay before professional consultation. Household crowding and stored antibiotic volume were also positively associated with respiratory illness measures. Because these findings were obtained from cross-sectional household data, the observed relationships indicate statistical associations and do not establish whether antibiotic storage preceded or caused longer illness or delayed healthcare-seeking.

DISCUSSION

This community-based cross-sectional study identified a high prevalence of household antibiotic storage during the winter respiratory illness period, with more than two-thirds of participating households retaining at least one systemic antibiotic. Beta-lactams and macrolides constituted most of the 412 stored doses. Greater household crowding was positively associated with the volume of stored antibiotics, the reported frequency of respiratory illness episodes, and symptom duration. Households with an active antibiotic stockpile also reported more self-medication incidents, longer respiratory symptom duration, and greater delays before seeking professional healthcare than households without stored antibiotics. In the reported multivariable analysis, household crowding and the volume of stored antibiotics remained independently associated with self-medication frequency. These findings indicate interconnected patterns of household crowding, medicine retention, non-prescription antibiotic use, and delayed healthcare-seeking, although the cross-sectional design does not establish their temporal or causal sequence.

The observed prevalence of household antibiotic storage was consistent with evidence from low- and middle-income settings showing that antibiotics are frequently retained after previous illnesses or acquired for use without a current prescription. Community-based studies have attributed these practices to previous experience with similar symptoms, perceived familiarity with antibiotics, financial barriers, limited access to clinical care, and the availability of antimicrobials outside formally supervised treatment pathways (2,5–9). Evidence from Pakistan has similarly shown that households may store antibiotics for later use and that knowledge concerning appropriate indications, resistance, storage, and disposal is often incomplete (9). The present findings extend this evidence by demonstrating that stored antibiotic volume was associated not only with self-medication frequency but also with the physical density of the household environment.

Beta-lactams represented the largest proportion of stored doses, while macrolides were the second most frequently identified class. This distribution was clinically plausible because amoxicillin-containing products and azithromycin are commonly recognized and may be retained after treatment of respiratory, dental, or other presumed infectious conditions. Previous studies of household and community antibiotic use have also identified leftover prescriptions, direct pharmacy access, and medicine sharing as important sources of antibiotics used without renewed clinical assessment (5–9). The presence of expired fluoroquinolones and other antibiotics further suggested that some medicines remained in households beyond the illness for which they were originally obtained. However, the dose-based inventory did not establish whether each stored product was subsequently consumed, whether the original prescription had been clinically appropriate, or whether retained medicines were kept intentionally for future self-treatment.

The positive association between household crowding and stored antibiotic volume may reflect several overlapping mechanisms. Densely occupied households contain more individuals who may experience illness, receive prescriptions, and contribute unused medicines to a shared household supply. Recurrent exposure to symptomatic household members may also increase the perceived need to maintain readily available treatment. Crowding has broader relevance to respiratory health because close physical proximity, shared sleeping spaces, and limited ventilation may facilitate exposure to respiratory pathogens (4). Nevertheless, the present study did not identify index cases, confirm infectious aetiology, measure secondary attack rates, or trace transmission between household members. The reported association between crowding and respiratory episodes should therefore be interpreted as a household-level relationship between residential density and recalled illness frequency rather than direct evidence of infection transmission.

Households with antibiotic stockpiles reported substantially more self-medication incidents than households without stockpiles. This finding was expected because the immediate availability of retained medicines reduces practical barriers to unsupervised consumption. Similar behaviour has been described among caregivers and community members who reuse leftover antibiotics when new symptoms appear similar to a previous illness (7–9). However, the relationship may be bidirectional. Households accustomed to self-medication may intentionally accumulate antibiotics, whereas households experiencing more frequent illness may retain a larger quantity of medicines from prior prescriptions. Stored antibiotic volume and self-medication frequency may therefore represent related manifestations of the same healthcare-use pattern rather than a simple exposure–outcome pathway.

Longer symptom duration and greater consultation delay were reported among households with active stockpiles. One possible explanation is that readily available antibiotics were used as an initial substitute for professional assessment, with formal care sought only when symptoms persisted. This interpretation is supported by the greater number of self-medication incidents in stockpile-positive households and by previous evidence linking unsupervised antibiotic use with delayed or fragmented healthcare-seeking (5–9). Nevertheless, the study could not determine whether antibiotic use preceded the delay, whether prolonged symptoms encouraged self-medication, or whether underlying differences in illness severity, chronic disease, healthcare access, household composition, or socioeconomic circumstances explained both outcomes. The respiratory episodes were self-reported and were not clinically or microbiologically classified; consequently, no conclusion can be drawn regarding whether the illnesses were viral, bacterial, or non-infectious.

The positive correlations between crowding, stored doses, respiratory episodes, and symptom duration suggested that household environmental and behavioural factors did not operate independently. Greater household size or density could increase the absolute number of illnesses and prescriptions, while limited financial or geographical access to healthcare could encourage medicine retention and delayed consultation. The reported regression model explained 54% of the variance in self-medication frequency, with stored antibiotic volume demonstrating the strongest standardized association, followed by household crowding. This model indicated that both medicine availability and residential conditions were relevant to self-medication behaviour. However, the income coefficient was not reported, and the available model did not clearly account for household size, education, children in the household, smoking, chronic respiratory illness, ventilation, healthcare proximity, previous prescribing, or clustering within sampled geographical areas. Residual confounding therefore remains likely.

These findings have implications for community antimicrobial stewardship. Educational messages should distinguish between completing an appropriately prescribed course and retaining antibiotics for later unsupervised use. Community interventions may also need to address the practical conditions that make household storage appear useful, including the cost and accessibility of primary care, informal pharmacy dispensing, medicine sharing, and uncertainty about when respiratory symptoms require medical assessment. Pharmacy-based counselling, dispensing quantities that correspond to prescribed treatment duration, accessible mechanisms for returning unused or expired medicines, and community education concerning the limited role of antibiotics in many acute respiratory illnesses may be considered for future evaluation. The current study did not test these interventions, and its findings should therefore inform intervention development rather than be interpreted as evidence of their effectiveness.

The study had several strengths. It examined household antibiotic storage during a period of frequent respiratory illness, included an inventory of stored antimicrobial classes and expiration status, and analysed storage behaviour together with crowding, self-medication, symptom duration, and healthcare consultation delay. The household-level approach also captured medicine-use practices that may not be visible in prescription or facility-based records. However, several limitations require consideration. The cross-sectional design prevented determination of temporality and causality. Respiratory episodes, self-medication, symptom duration, and consultation delay were retrospectively reported over 90 days and were therefore susceptible to recall and social-desirability bias. Respiratory illnesses were not confirmed clinically or microbiologically, and antimicrobial resistance was not measured. The geographically localized sample and modest sample size limited generalizability. Cluster sampling may also have introduced within-cluster correlation that was not reflected in the reported conventional analyses.

Further limitations arose from the measurement and analytical structure. Stored antibiotics were summarized as doses, but household-level distributions by antibiotic class were unavailable. The source and expiration percentages did not include complete item-level denominators. Important confounders, including household size, age composition, education, health literacy, chronic respiratory disease, smoking exposure, ventilation, and healthcare accessibility, were not fully reported. Self-medication frequency was a count outcome, and the suitability of linear regression requires confirmation against its distribution and residual assumptions. The reported group comparisons and regression coefficients should therefore be verified using the original dataset, with cluster-adjusted and count-based analyses applied where appropriate.

Future studies should use prospective household surveillance to establish the sequence between respiratory symptom onset, medicine use, and healthcare consultation. Repeated seasonal measurements would permit genuine evaluation of seasonal variation, while clinical assessment or microbiological testing could distinguish infectious aetiologies. Larger studies should standardize respiratory episodes and antibiotic use by household size or person-time, document individual medicine packages and doses, and incorporate healthcare access, health literacy, ventilation, comorbidity, and household composition into adjusted models. Qualitative investigation may also clarify why households retain antibiotics and how decisions to self-medicate are made when respiratory symptoms arise.

CONCLUSION

Household antibiotic storage was common among the surveyed urban households and was associated with greater household crowding, more frequent self-medication, longer reported respiratory symptom duration, and delayed professional healthcare consultation. Stored antibiotic volume and household crowding were independently associated with self-medication frequency in the reported multivariable model. These cross-sectional findings identify potentially important relationships between residential conditions, medicine availability, and healthcare-seeking behaviour but do not establish that antibiotic storage caused prolonged illness or consultation delay. Community antimicrobial-stewardship strategies should account for both inappropriate access to retained antibiotics and the structural barriers that encourage households to rely on self-treatment.

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