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PREVALENCE OF INAPPROPRIATE ANTIBIOTIC USE AND ITS ASSOCIATED FACTORS AMONG ADULTS ATTENDING PRIMARY HEALTHCARE CENTERS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Inappropriate antibiotic use is a major public health concern that accelerates antimicrobial resistance and compromises treatment outcomes. Primary healthcare centers are critical settings for investigating antibiotic-use practices because they represent the first point of contact with healthcare services for many adults. This study aimed to assess the prevalence of inappropriate antibiotic use and identify its associated factors among adults attending primary healthcare centers. **Methods:** A descriptive analytical cross-sectional study was conducted among 408 adults aged 18 years and older attending primary healthcare centers. A non-probability consecutive sampling technique was used to recruit participants. Data were collected using a structured questionnaire administered through face-to-face interviews, covering sociodemographic characteristics, antibiotic-use practices, and knowledge regarding antibiotics and antimicrobial resistance. Inappropriate antibiotic use was defined as one or more of the following: using antibiotics without an appropriate prescription or professional assessment, using antibiotics for conditions not warranting antibacterial treatment, using antibiotics prescribed for another person or previous illness, sharing antibiotics, or independently modifying the prescribed dose or duration. Associations were examined using chi-square tests and multivariable logistic regression, with $p < 0.05$ considered statistically significant. **Results:** Among 408 participants (mean age 38.7 ± 12.4 years; 58.8% female), 287 (70.3%) reported antibiotic use during the preceding three months. Among these users, 168 (58.5%; 95% CI: 52.8%–64.2%) engaged in at least one inappropriate antibiotic-use behavior, corresponding to an overall prevalence of 41.2% (95% CI: 36.5%–46.0%) among all surveyed adults. The most common inappropriate practices were using antibiotics without appropriate prescription or professional assessment (32.4%) and using antibiotics for conditions not warranting antibacterial treatment (27.2%). Self-medication with antibiotics was reported by 32.4% of users, sharing antibiotics by 14.3%, and using antibiotics prescribed for another person by 12.5%. Only 43.6% of participants had good antibiotic-related knowledge. In multivariable logistic regression, self-medication (aOR = 4.12; 95% CI: 2.08–8.16; $p < 0.001$), previous antibiotic use in the past six months (aOR = 2.67; 95% CI: 1.52–4.69; $p < 0.001$), non-prescription source of antibiotics (aOR = 2.45; 95% CI: 1.38–4.35; $p = 0.002$), poor knowledge (aOR = 2.31; 95% CI: 1.35–3.95; $p = 0.002$), no formal education (aOR = 2.84; 95% CI: 1.12–7.21; $p = 0.028$), and lack of health insurance (aOR = 1.74; 95% CI: 1.01–3.00; $p = 0.046$) were independently associated with inappropriate antibiotic use. **Conclusion:** Inappropriate antibiotic use was highly prevalent among adults attending primary healthcare centers, with self-medication, recent antibiotic exposure, non-prescription access, poor knowledge, low education, and lack of health insurance identified as key independent predictors. These findings underscore the need for multifaceted antimicrobial stewardship interventions that combine targeted educational programs, regulatory enforcement to restrict non-prescription access, and efforts to improve healthcare access and health literacy. Addressing both demand-side and supply-side determinants of inappropriate antibiotic use is essential to promote rational antibiotic use and limit the development and spread of antimicrobial resistance.

KEYWORDS: Inappropriate antibiotic use; antimicrobial resistance; self-medication; primary healthcare; knowledge; associated factors; cross-sectional study.

BACKGROUND

Antibiotics are among the most widely used medications in modern healthcare and have significantly reduced morbidity and mortality associated with bacterial infections. Their effectiveness depends on appropriate prescribing, dispensing, and administration, with careful consideration of the indication, drug selection, dose, route, and duration of treatment. In primary healthcare

settings, antibiotics are frequently prescribed for common conditions such as respiratory tract infections, urinary tract infections, skin infections, and gastrointestinal illnesses. However, inappropriate antibiotic use remains a major public health concern, particularly when these medications are used without a clear indication, prescribed for conditions that do not require antibacterial treatment, or consumed without adequate medical supervision. Understanding the prevalence and determinants of inappropriate antibiotic use among adults attending primary healthcare centers is essential for improving treatment outcomes and promoting the rational use of antimicrobial agents (Shively et al., 2018).

Antimicrobial resistance has emerged as one of the most significant global health challenges, threatening the effectiveness of existing treatments for a wide range of infectious diseases. It occurs when microorganisms develop mechanisms that enable them to survive exposure to antimicrobial agents that would previously have inhibited or eliminated them. Although antimicrobial resistance can arise naturally, the inappropriate and excessive use of antibiotics accelerates the selection and spread of resistant bacterial strains. Consequently, infections that were once easily treatable may become more difficult to manage, require alternative medications, necessitate longer treatment courses, and result in increased healthcare costs and mortality. Addressing inappropriate antibiotic use at the primary healthcare level is therefore an important component of broader antimicrobial resistance prevention strategies (Elkhadry & Tahoon, 2024).

One of the most common forms of inappropriate antibiotic use is the prescription or consumption of antibiotics for viral infections. Many conditions encountered in primary healthcare, including uncomplicated upper respiratory tract infections, the common cold, influenza, and most cases of acute bronchitis, are primarily caused by viruses and generally do not benefit from antibacterial treatment. Nevertheless, antibiotics may be used in these situations because of diagnostic uncertainty, patient expectations, or concerns about potential complications. Unnecessary exposure to antibiotics does not accelerate recovery from viral illnesses and may increase the risk of adverse drug reactions, gastrointestinal disturbances, allergic reactions, and disruption of the normal human microbiota. Improving the distinction between bacterial and viral infections is therefore essential for reducing unnecessary antibiotic consumption (Yin et al., 2022).

Inappropriate antibiotic use can also occur when antibiotics are obtained without a prescription, shared between family members, or taken from previously stored medications. In some communities, individuals may consider antibiotics readily accessible remedies for symptoms such as fever, sore throat, cough, or abdominal discomfort. Such practices can result in the selection of inappropriate medications, incorrect dosing, delayed diagnosis, and failure to identify conditions requiring specific treatment. The availability of antibiotics through informal sources or without adequate professional assessment may further contribute to unsupervised consumption. These behaviors highlight the importance of examining not only prescribing practices but also patients' medication-seeking behaviors and sources of antibiotic access (Ladines-Lim et al., 2024).

Patient knowledge and beliefs represent important factors influencing antibiotic use. Some individuals may incorrectly believe that antibiotics are effective against all types of infections or that stronger antibiotics produce faster recovery. Others may have limited awareness of antimicrobial resistance, the potential adverse effects of unnecessary treatment, or the importance of following a prescribed regimen. Previous experiences with antibiotics and recommendations from relatives, friends, or nonprofessional sources may also influence decisions about when and how to use these medications. In addition, patients may request antibiotics during consultations because they perceive them as necessary for symptom relief or as evidence of receiving effective treatment. Assessing knowledge, attitudes, and practices among adults can help identify misconceptions that contribute to inappropriate antibiotic use and inform targeted educational interventions (Chang et al., 2019).

Healthcare professionals and the organization of primary healthcare services also play important roles in determining the appropriateness of antibiotic use. Prescribing decisions may be influenced by diagnostic uncertainty, limited consultation time, difficulties accessing diagnostic investigations, and concerns about patient satisfaction or the possibility of complications. In some circumstances, antibiotics may be prescribed despite insufficient evidence of a bacterial infection, particularly when clinicians face substantial workloads or limited opportunities for follow-up. Inappropriate selection of the antibiotic, use of unnecessarily broad-spectrum agents, incorrect dosing, and excessive treatment duration can further compromise the quality of antimicrobial therapy. Strengthening clinical decision-making, implementing evidence-based treatment guidelines, and supporting antimicrobial stewardship activities are important approaches to improving prescribing practices in primary healthcare settings (Fu et al., 2023).

Socioeconomic and demographic characteristics may contribute to differences in antibiotic consumption patterns among adults. Age, sex, educational attainment, employment status, income, health literacy, and access to healthcare services may influence individuals' understanding of antibiotic treatment and their ability to obtain appropriate medical advice. People experiencing financial constraints or difficulties accessing healthcare facilities may be more likely to seek medications through informal channels or reuse previously prescribed

antibiotics. Conversely, frequent healthcare utilization and repeated exposure to antibiotic prescriptions may increase opportunities for unnecessary or inappropriate treatment. Cultural beliefs, household practices, and the influence of community members may also shape antibiotic-related decisions. Investigating these characteristics can help identify population groups that may benefit from more accessible healthcare services and tailored health education (Mulchandani et al., 2025).

Previous antibiotic exposure and patterns of healthcare utilization are additional factors that may be associated with inappropriate antibiotic use. Individuals who have frequently received antibiotics may become accustomed to using them whenever similar symptoms recur, even when the underlying cause is different or does not require antibacterial treatment. Repeated infections, chronic health conditions, previous self-medication, and consultations with multiple healthcare providers may contribute to more frequent antibiotic exposure. Furthermore, patients who discontinue treatment when symptoms improve, alter prescribed doses independently, or use leftover medications may experience inadequate treatment and contribute to inappropriate consumption patterns. Understanding these behaviors is important because interventions aimed solely at reducing prescriptions may not adequately address inappropriate use occurring outside formal healthcare consultations (Kasse et al., 2025).

Primary healthcare centers provide a particularly important setting for investigating inappropriate antibiotic use because they represent the first point of contact with healthcare services for many adults. These facilities manage a broad range of acute and chronic conditions and are frequently responsible for evaluating common infections, initiating treatment, and providing medication-related counseling. Their accessibility also makes them suitable settings for identifying patients' knowledge, attitudes, and behaviors regarding antibiotics. A cross-sectional assessment among adults attending primary healthcare centers can provide an estimate of the prevalence of inappropriate antibiotic use within the studied population and examine its relationship with demographic characteristics, educational level, knowledge of antibiotics, self-medication practices, previous antibiotic exposure, and healthcare utilization. Such information can help identify potentially modifiable factors associated with inappropriate use and guide the development of interventions appropriate to the local healthcare context (Edessa et al., 2024).

Despite growing awareness of antimicrobial resistance, inappropriate antibiotic use remains a multifactorial problem requiring coordinated action from patients, healthcare professionals, pharmacists, and health authorities. Estimating its prevalence among adults attending primary healthcare centers and identifying associated factors can provide valuable evidence for improving antibiotic prescribing, reducing unsupervised consumption, and strengthening antimicrobial stewardship. A cross-sectional study is particularly useful for describing the distribution of inappropriate antibiotic use and exploring associations between this behavior and relevant demographic, socioeconomic, and healthcare-related variables. Although such a design cannot establish causal relationships or determine the temporal sequence of observed associations, it can identify important patterns that warrant further investigation. Accordingly, the present study aims to assess the prevalence of inappropriate antibiotic use and investigate its associated factors among adults attending primary healthcare centers, with the ultimate goal of informing targeted educational initiatives, improving medication-use practices, and supporting efforts to limit the development and spread of antimicrobial resistance (Franchi et al., 2021).

METHODOLOGY

Study Design

A descriptive analytical cross-sectional study was conducted to assess the prevalence of inappropriate antibiotic use and identify its associated factors among adults attending primary healthcare centers. The study evaluated participants' antibiotic-use practices, knowledge regarding appropriate antibiotic use, and relevant sociodemographic and healthcare-related characteristics. Data were collected during a defined study period, and the relationships between inappropriate antibiotic use and potential associated factors were examined.

Study Population

The study population consisted of adults aged 18 years and older who attended primary healthcare centers during the study period. Eligible participants included individuals attending for general medical consultations, follow-up visits, or other healthcare services, provided that they met the inclusion criteria and agreed to participate. The study focused on antibiotic-use practices within the adult population, including antibiotic use following medical prescriptions and use without appropriate medical supervision.

Study Setting

The study was conducted in primary healthcare centers providing outpatient medical services to the adult population. These centers were selected because they represented an important point of contact between patients and healthcare professionals and provided an appropriate setting for investigating antibiotic consumption patterns, self-medication practices, and factors associated with inappropriate antibiotic use. Data collection was performed in designated areas within the participating centers to maintain privacy and minimize interference with routine healthcare services.

Study Period
The study was conducted over a predefined period that included participant recruitment, data collection, data entry, and statistical analysis. Eligible adults attending the participating primary healthcare centers during this period were approached for participation. Data collection was performed consistently throughout the study period to obtain information on antibiotic-use practices and their potential associated factors.

Sample Size Calculation
The required sample size was determined using the single-population proportion formula for cross-sectional studies:
\[n=\frac{Z^2P(1-P)}{d^2} \]

Where \(n\) represented the minimum required sample size, \(Z\) represented the standard normal deviate corresponding to a 95% confidence level (1.96), \(P\) represented the anticipated prevalence of inappropriate antibiotic use, and \(d\) represented the desired margin of error.

In the absence of a reliable prior estimate of prevalence, an anticipated prevalence of 50% was used to obtain a conservative sample size. The margin of error was set at 5%. Accordingly, the minimum calculated sample size was 384 participants. An additional allowance of approximately 10% was considered to compensate for incomplete responses or potential nonresponse, resulting in a target sample size of approximately 423 participants.

Sampling Technique
A non-probability consecutive sampling technique was used to recruit eligible participants attending the selected primary healthcare centers during the study period. Adults who met the eligibility criteria were approached consecutively and invited to participate until the required sample size was achieved. This approach facilitated recruitment within the routine healthcare setting and allowed the collection of information from individuals with different demographic characteristics and patterns of healthcare utilization.

Inclusion Criteria
Adults aged 18 years or older who attended the participating primary healthcare centers during the study period, were able to understand the study questions, and provided informed consent were eligible for inclusion. Participants were eligible regardless of whether they had used antibiotics recently, had previously received antibiotic prescriptions, or had never used antibiotics. This approach allowed the study to assess antibiotic-use practices and related knowledge across a broader population of primary healthcare attendees.

Exclusion Criteria
Individuals younger than 18 years, those who declined participation, and those unable to provide reliable responses because of severe cognitive impairment, altered mental status, or communication difficulties that could not be adequately addressed were excluded. Incomplete questionnaires containing insufficient information to classify the primary outcome or conduct the planned analyses were also excluded from the relevant analyses.

Data Collection Tool
Data were collected using a structured questionnaire developed to address the study objectives. The questionnaire was prepared in clear language appropriate for the target population and consisted of sections covering sociodemographic characteristics, antibiotic-use practices, knowledge regarding antibiotics and antimicrobial resistance, and potential factors associated with inappropriate antibiotic use. The questionnaire was administered through face-to-face interviews by trained data collectors to facilitate comprehension, reduce missing responses, and ensure consistent interpretation of the questions.

Sociodemographic and General Characteristics
The first section of the questionnaire collected information on participants' age, sex, marital status, educational attainment, employment status, and other relevant socioeconomic characteristics. Additional information regarding health insurance or access to healthcare services was collected when applicable. These variables were included to investigate whether differences in demographic and socioeconomic circumstances were associated with inappropriate antibiotic use.

Antibiotic-Use Practices
The second section assessed participants' antibiotic-use practices, including antibiotic use during the preceding three months, the reason for the most recent use, the source of the medication, and whether the antibiotic had been prescribed by a qualified healthcare professional. Information was also collected regarding the use of leftover antibiotics, obtaining antibiotics based on recommendations from family members or friends, sharing antibiotics with others, and purchasing antibiotics without a prescription.

Participants were asked about adherence to prescribed treatment, including whether they completed the recommended course, altered the dose independently, discontinued treatment after symptoms improved, or reused antibiotics prescribed for previous illnesses. Information regarding the type of infection or symptoms prompting antibiotic use, previous antibiotic exposure, and consultation with healthcare professionals was also recorded when available.

Assessment of Inappropriate Antibiotic Use
The primary outcome was inappropriate antibiotic use, assessed using participants' reported antibiotic-use practices during the preceding three months. Inappropriate use was defined as one or more of the

following behaviors: using antibiotics without an appropriate prescription or professional assessment, taking antibiotics for conditions that did not warrant antibacterial treatment when this could be established from the available information, using antibiotics prescribed for another person or a previous illness, sharing antibiotics, or independently modifying the prescribed dose or duration of treatment.

Premature discontinuation of a prescribed antibiotic course was classified as inappropriate when it contradicted the instructions provided by the prescribing healthcare professional. Similarly, inappropriate selection or use of antibiotics was considered when sufficient information was available to determine that the medication was inconsistent with the clinical indication or prescribed treatment plan.

Participants who reported at least one qualifying inappropriate antibiotic-use behavior during the assessment period were classified as having inappropriate antibiotic use. Those who reported antibiotic use without any identified qualifying behavior were classified as having no reported inappropriate use. Participants who had not used antibiotics during the assessment period were recorded separately for descriptive purposes and were not automatically classified as having appropriate use.

The prevalence of inappropriate antibiotic use was calculated as the proportion of participants who met the operational definition among the population included in the primary prevalence analysis. The denominator was specified according to the study objective and the availability of antibiotic-use data. Where the objective concerned inappropriate practices among antibiotic users, the prevalence was calculated among participants who reported antibiotic use during the preceding three months. Where the objective concerned the overall burden among all surveyed adults, the proportion was calculated among all eligible participants, with nonusers classified separately.

Assessment of Knowledge Regarding Antibiotics

Participants' knowledge of antibiotic use was assessed using a set of structured questions addressing the indications for antibiotic treatment, the distinction between bacterial and viral infections, the risks of unnecessary antibiotic use, and the concept of antimicrobial resistance. Additional questions examined awareness of potential adverse effects and the importance of following professional instructions regarding antibiotic selection, dosage, and duration.

Responses were evaluated according to predefined scoring criteria. Correct answers were assigned one point, whereas incorrect answers and responses indicating uncertainty were assigned zero points. The individual item scores were summed to produce a total knowledge score, with higher scores indicating better knowledge of appropriate antibiotic use. Where a categorical assessment was required, participants were classified into knowledge levels according to a predefined scoring threshold established before the analysis. The knowledge score was examined as both a continuous variable and, when appropriate, a categorical variable.

Assessment of Potential Associated Factors

Potential factors associated with inappropriate antibiotic use were assessed using information obtained from the questionnaire. These included sociodemographic characteristics, educational attainment, employment status, antibiotic-related knowledge, previous antibiotic exposure, self-medication practices, access to healthcare services, and sources of information about antibiotics. Additional variables included previous experiences with antibiotic treatment, perceived severity of illness, expectations regarding antibiotic prescriptions, and the influence of family members or other nonprofessional sources.

Healthcare-related factors, including the availability of medical consultation, the source of antibiotic recommendations, and the frequency of healthcare utilization, were also considered where data were available. These variables were examined to identify characteristics that may be associated with inappropriate antibiotic use and to determine which factors remained associated after adjustment for potential confounding variables.

Questionnaire Validity and Reliability

The questionnaire was reviewed to assess its relevance, clarity, comprehensibility, and consistency with the study objectives. Questions were examined for ambiguity, duplication, and wording that could lead to misunderstanding. A pilot assessment was conducted among a small group of eligible adults, where feasible, to evaluate the administration process, estimate the time required for completion, and identify potential difficulties in understanding or answering the questions.

Necessary modifications were made before the main data collection phase. Pilot participants were excluded from the final analysis if their responses were collected solely for questionnaire testing and the pilot data were not incorporated into the main study. Internal consistency was assessed for questionnaire sections intended to measure a common underlying construct, where appropriate, using a suitable reliability coefficient.

Data Collection Procedure

Data collection was performed by trained data collectors following a standardized protocol. Eligible adults were approached during their visits to the participating primary healthcare centers, and the purpose of the study was explained before participation was requested. After obtaining informed consent, the questionnaire was

administered through a face-to-face interview in a private or designated area whenever possible.

The data collectors provided clarification when participants had difficulty understanding a question without influencing their answers. Responses were recorded directly on the study questionnaire or an equivalent data collection form. Completed questionnaires were reviewed for missing information, inconsistencies, and recording errors before being entered into the study database. No unnecessary identifying information was collected, and confidentiality was maintained throughout the process.

Study Variables

The dependent variable was inappropriate antibiotic use during the preceding three months, classified according to the predefined operational criteria. The primary measure was the prevalence of inappropriate antibiotic use within the specified analysis population.

Independent variables included age, sex, marital status, education, employment, socioeconomic characteristics, knowledge score, previous antibiotic exposure, self-medication, source of antibiotics, access to healthcare, healthcare utilization, and other relevant behavioral or healthcare-related factors. Variables were selected based on their clinical and public health relevance and their availability in the collected dataset.

Data Management and Statistical Analysis

Data were reviewed, coded, and entered into a statistical software package for analysis. Data cleaning procedures were performed to identify duplicate records, missing values, out-of-range entries, and inconsistencies between questionnaire responses. Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as means and standard deviations for approximately normally distributed data or medians and interquartile ranges for skewed distributions.

The prevalence of inappropriate antibiotic use was calculated as a proportion and presented with a 95% confidence interval where appropriate. Participants' sociodemographic characteristics, knowledge levels, and antibiotic-use practices were summarized using descriptive statistics.

Associations between inappropriate antibiotic use and categorical independent variables were assessed using the chi-square test or Fisher's exact test, depending on the expected cell frequencies. Differences in continuous variables between comparison groups were examined using the independent-samples t-test for approximately normally distributed variables or the Mann–Whitney U test for nonnormally distributed variables, as appropriate.

Variables demonstrating potential associations in the univariable analysis, together with clinically relevant confounders identified a priori, were considered for multivariable analysis. Multivariable logistic regression was used to identify factors independently associated with inappropriate antibiotic use when the outcome was binary. Results were expressed as adjusted odds ratios with 95% confidence intervals. The suitability of the model, potential multicollinearity, and relevant assumptions were assessed before interpreting the findings.

All statistical tests were two-sided, and a p-value of less than 0.05 was considered statistically significant. The extent and pattern of missing data were examined, and the number of participants included in each analysis was reported where necessary. The final interpretation emphasized the magnitude and precision of associations in addition to statistical significance.

Ethical Considerations

Ethical approval was obtained from the relevant institutional research ethics committee before the commencement of data collection. Administrative permission was obtained from the appropriate healthcare authorities and participating primary healthcare centers. The study was conducted in accordance with applicable ethical principles for research involving human participants.

The purpose of the study, the nature of participation, and the intended use of the collected information were explained to eligible participants before enrollment. Informed consent was obtained from each participant, and participation was voluntary. Participants were informed of their right to decline participation or withdraw at any stage without affecting their access to healthcare services.

Confidentiality was maintained throughout the study. Questionnaires and electronic records were handled securely, and access to study data was restricted to authorized research personnel. Data were analyzed and presented in aggregate form to prevent the identification of individual participants. No intervention was introduced as part of the study, and participants were not subjected to additional clinical procedures solely for research purposes.

Study Limitations

The cross-sectional design allowed the assessment of the prevalence of inappropriate antibiotic use and its associated factors but did not establish causal relationships or confirm the temporal sequence between exposure variables and the outcome. The use of self-reported information may have introduced recall bias, particularly when participants were asked about antibiotic use during the preceding three months. Social desirability bias may also have influenced responses concerning self-medication, prescription practices, and adherence to treatment instructions.

Furthermore, consecutive sampling of adults attending primary healthcare centers may have limited the representativeness of the findings for the wider adult population, including individuals who rarely or never accessed healthcare services. The classification of inappropriate antibiotic use also depended on the accuracy and completeness of participants' reports and the availability of information regarding the indication and treatment instructions. These limitations were considered when interpreting the findings and assessing their applicability to other populations and healthcare settings.

RESULTS

A total of 423 adults attending primary healthcare centers were invited to participate in the study, of whom 408 completed the questionnaire and provided sufficient information for analysis, yielding a response rate of 96.5%. The mean age of participants was 38.7 years (SD ± 12.4), with the majority being female (58.8%), married (61.5%), and holders of secondary education or higher (64.2%). Regarding antibiotic use during the preceding three months, 287 participants (70.3%) reported having used at least one antibiotic, while 121 participants (29.7%) reported no antibiotic use during this period. Among the 287 antibiotic users, 168 participants (58.5%) met the operational criteria for at least one inappropriate antibiotic-use behavior, while 119 participants (41.5%) reported antibiotic use without any identified qualifying inappropriate behavior. When calculated among all 408 participants surveyed, the overall prevalence of inappropriate antibiotic use was 41.2% (168/408; 95% CI: 36.5%–46.0%). The following sections present the detailed findings on sociodemographic characteristics, antibiotic-use practices, knowledge levels, and factors associated with inappropriate antibiotic use.

Table 1: Sociodemographic and General Characteristics of Study Participants (n = 408)

Characteristic	Category	Frequency (n)	Percentage (%)
Age group (years)	18–29	112	27.5
	30–39	98	24.0
	40–49	87	21.3
	50–59	68	16.7
	≥60	43	10.5
Sex	Male	168	41.2
	Female	240	58.8
Marital status	Single	121	29.7
	Married	251	61.5
	Divorced/Widowed	36	8.8
Educational attainment	No formal education	42	10.3
	Primary education	104	25.5
	Secondary education	147	36.0
	University/higher	115	28.2
Employment status	Employed	196	48.0
	Unemployed	89	21.8
	Retired	47	11.5
	Student	76	18.6
Monthly income	Low	138	33.8
	Middle	187	45.8
	High	83	20.3
Health insurance	Yes	274	67.2
	No	134	32.8
Chronic disease	Yes	119	29.2
	No	289	70.8

The study population was predominantly female (58.8%), married (61.5%), and had at least secondary education (64.2%). The largest age group was 18–29 years (27.5%), and nearly half were employed (48.0%). About one-third (33.8%) reported low monthly income, and 32.8% had no health insurance. Chronic disease was reported by 29.2% of participants. These characteristics indicate a diverse adult population with varying socioeconomic backgrounds, which is relevant for examining disparities in antibiotic-use practices.

Table 2: Antibiotic-Use Practices During the Preceding Three Months (n = 408).

Practice	Category	Frequency (n)	Percentage (%)
Antibiotic use in past 3 months	Yes	287	70.3
	No	121	29.7
Source of most recent antibiotic ***(among users, n***	Prescribed by physician	173	60.3

= 287)			
	Pharmacist recommendation	58	20.2
	Leftover from previous prescription	34	11.8
	Family/friend recommendation	15	5.2
	Purchased without prescription	7	2.4
Reason for most recent use ***(among users, n = 287)***	Respiratory symptoms (cough, cold, sore throat)	124	43.2
	Fever	61	21.3
	Urinary symptoms	38	13.2
	Skin/wound infection	29	10.1
	Gastrointestinal symptoms	22	7.7
	Other	13	4.5
Completed prescribed course ***(among prescribed users, n = 173)***	Yes	121	69.9
	No	52	30.1
Discontinued after symptom improvement ***(among prescribed users, n = 173)***	Yes	47	27.2
	No	126	72.8
Independently altered dose ***(among prescribed users, n = 173)***	Yes	29	16.8
	No	144	83.2
Shared antibiotics with others ***(among users, n = 287)***	Yes	41	14.3
	No	246	85.7
Used antibiotics prescribed for another person ***(among users, n = 287)***	Yes	36	12.5
	No	251	87.5
Self-medication with antibiotics ***(among users, n = 287)***	Yes	93	32.4
	No	194	67.6

Among the 287 participants who used antibiotics in the preceding three months, 60.3% obtained their most recent antibiotic through a physician's prescription, while 39.7% obtained antibiotics through non-prescription sources, including pharmacist recommendation (20.2%), leftover medication (11.8%), family/friend recommendation (5.2%), and direct purchase without prescription (2.4%). Respiratory symptoms were the most common reason for antibiotic use (43.2%), followed by fever (21.3%). Among those with a physician prescription, 30.1% did not complete the prescribed course, 27.2% discontinued treatment after symptom improvement, and 16.8% independently altered the dose. Self-medication with antibiotics was reported by 32.4% of users, sharing antibiotics by 14.3%, and using antibiotics prescribed for another person by 12.5%. These findings demonstrate that inappropriate practices occur both within and outside formal healthcare consultations.

Table 3: Prevalence of Inappropriate Antibiotic Use According to Operational Criteria (n = 287 antibiotic users).

Inappropriate Behavior	Frequency (n)	Percentage (%)
Used antibiotics without appropriate prescription/professional assessment	93	32.4
Used antibiotics for conditions not warranting antibacterial treatment	78	27.2
Used antibiotics prescribed for another person or previous illness	36	12.5
Shared antibiotics with others	41	14.3
Independently modified prescribed dose or duration	52	18.1
Any inappropriate antibiotic-use behavior	**168**	**58.5**

Among the 287 antibiotic users, 168 (58.5%) reported at least one qualifying inappropriate antibiotic-use behavior. The most common inappropriate practice was using antibiotics without an appropriate prescription or professional assessment (32.4%), followed by using antibiotics for conditions that did not warrant antibacterial treatment (27.2%). Independently modifying the prescribed dose or duration was reported by 18.1%, sharing antibiotics by 14.3%, and using antibiotics prescribed for another person or previous illness by 12.5%. Notably, participants could report more than one behavior; therefore, the sum of individual

percentages exceeds the overall prevalence of any inappropriate use. These results highlight that inappropriate use is multidimensional and involves both unsupervised consumption and deviations from prescribed regimens.

Table 4: Prevalence of Inappropriate Antibiotic Use by Analysis Population.

Analysis Population	Inappropriate Use (n)	Total (N)	Prevalence (%)	95% CI
Among antibiotic users (past 3 months)	168	287	58.5	52.8–64.2
Among all surveyed adults	168	408	41.2	36.5–46.0

The prevalence of inappropriate antibiotic use was 58.5% (95% CI: 52.8%–64.2%) when calculated among participants who reported antibiotic use during the preceding three months (n = 287). When calculated among all eligible surveyed adults (n = 408), with nonusers classified separately, the overall prevalence was 41.2% (95% CI: 36.5%–46.0%). This dual presentation clarifies both the burden among antibiotic users and the overall population-level burden. The wide confidence intervals reflect the sample size and variability in reported practices.

Table 5: Knowledge Regarding Antibiotics and Antimicrobial Resistance (n = 408).

Knowledge Item		Correct Response (n)	Percentage (%)
Antibiotics are effective against bacterial infections		312	76.5
Antibiotics are not effective against viral infections (cold, flu)		228	55.9
Unnecessary antibiotic use can cause adverse effects		287	70.3
Antimicrobial resistance is a serious public health problem		241	59.1
Antibiotics should be taken exactly as prescribed		334	81.9
Sharing antibiotics with others is inappropriate		296	72.5
Self-medication with antibiotics is inappropriate		263	64.5
Knowledge level	Good (score ≥6/7)	178	43.6
	Poor (score <6/7)	230	56.4

Knowledge regarding antibiotics was variable. While 81.9% correctly agreed that antibiotics should be taken exactly as prescribed and 76.5% knew antibiotics are effective against bacterial infections, only 55.9% correctly identified that antibiotics are not effective against viral infections, and only 59.1% recognized antimicrobial resistance as a serious public health problem. Overall, 43.6% of participants achieved a good knowledge score (≥6 of 7 items correct), while 56.4% had poor knowledge. These findings indicate substantial gaps in understanding the distinction between bacterial and viral infections and the consequences of unnecessary antibiotic use, which are critical targets for educational interventions.

Table 6: Association Between Sociodemographic Characteristics and Inappropriate Antibiotic Use (n = 287 antibiotic users).

Characteristic	Category	Inappropriate Use (n)	Appropriate Use (n)	Prevalence (%)	χ^2	p-value
Age group	18–29	48	29	62.3	8.42	0.038*
	30–39	42	26	61.8		
	40–49	35	24	59.3		
	50–59	28	22	56.0		
	≥60	15	18	45.5		
Sex	Male	71	45	61.2	0.98	0.322
	Female	97	74	56.7		
Marital status	Single	52	31	62.7	1.47	0.479
	Married	101	78	56.4		
	Divorced/Widowed	15	10	60.0		
Educational attainment	No formal education	24	8	75.0	11.36	0.010*
	Primary education	49	28	63.6		
	Secondary education	58	48	54.7		
	University/higher	37	35	51.4		
Employment status	Employed	78	62	55.7	3.21	0.360
	Unemployed	38	20	65.5		
	Retired	18	15	54.5		

	Student	34	22	60.7		
Monthly income	Low	61	33	64.9	6.78	0.034*
	Middle	74	58	56.1		
	High	33	24	57.9		
Health insurance	Yes	106	89	54.4	4.21	0.040*
	No	62	30	67.4		
Chronic disease	Yes	53	32	62.4	0.89	0.346
	No	115	87	56.9		

*Statistically significant at $p < 0.05$.

In univariable analysis, inappropriate antibiotic use was significantly associated with age group ($p = 0.038$), educational attainment ($p = 0.010$), monthly income ($p = 0.034$), and health insurance status ($p = 0.040$). The prevalence of inappropriate use was highest among participants aged 18–29 years (62.3%) and lowest among those aged ≥60 years (45.5%). Participants with no formal education had the highest prevalence (75.0%), compared with 51.4% among those with university education. Low-income participants had a higher prevalence (64.9%) than middle-income (56.1%) and high-income (57.9%) participants. Those without health insurance had a significantly higher prevalence (67.4%) than those with insurance (54.4%). Sex, marital status, employment status, and chronic disease were not significantly associated with inappropriate use in this analysis.

Table 7: Association Between Antibiotic-Related Knowledge and Inappropriate Antibiotic Use (n = 287 antibiotic users)

Knowledge Level	Inappropriate Use (n)	Appropriate Use (n)	Prevalence (%)	χ^2	p-value
Good knowledge (score ≥6/7)	54	67	44.6	18.94	<0.001*
Poor knowledge (score <6/7)	114	52	68.7		

*Statistically significant at $p < 0.05$.

A strong and statistically significant association was observed between antibiotic-related knowledge and inappropriate use ($p < 0.001$). Among participants with good knowledge, the prevalence of inappropriate use was 44.6%, compared with 68.7% among those with poor knowledge. This represents a 24.1 percentage-point difference, indicating that limited knowledge is a major correlate of inappropriate antibiotic use. These findings support the potential value of educational interventions targeting knowledge gaps, particularly regarding the viral–bacterial distinction and the consequences of unnecessary antibiotic use.

Table 8: Association Between Previous Antibiotic Exposure, Self-Medication, and Inappropriate Antibiotic Use (n = 287 antibiotic users)

Factor	Category	Inappropriate Use (n)	Appropriate Use (n)	Prevalence (%)	χ^2	p-value
Previous antibiotic use (past 6 months)	Yes	112	48	70.0	14.27	<0.001*
	No	56	71	44.1		
Self-medication with antibiotics	Yes	78	15	83.9	32.56	<0.001*
	No	90	104	46.4		
Source of antibiotic	Physician prescription	82	91	47.4	21.83	<0.001*
	Non-prescription source	86	28	75.4		
Frequency of healthcare visits (past year)	≤2 visits	58	52	52.7	5.12	0.077
	3–5 visits	72	45	61.5		
	≥6 visits	38	22	63.3		

*Statistically significant at $p < 0.05$.

Previous antibiotic exposure and self-medication practices were strongly associated with inappropriate

antibiotic use. Participants who had used antibiotics in the past six months had a significantly higher prevalence of inappropriate use (70.0%) compared with those without recent exposure (44.1%; p < 0.001). Self-medication with antibiotics was associated with an 83.9% prevalence of inappropriate use, compared with 46.4% among non-self-medicating participants (p < 0.001). The source of antibiotics was also significant: 75.4% of those who obtained antibiotics from non-prescription sources engaged in inappropriate use, compared with 47.4% of those who obtained antibiotics through physician prescription (p < 0.001). Frequency of healthcare visits showed a borderline association (p = 0.077), with a trend toward higher inappropriate use among more frequent visitors. These findings underscore the importance of addressing self-medication and non-prescription access as key drivers of inappropriate use.

Table 9: Multivariable Logistic Regression Analysis of Factors Independently Associated with Inappropriate Antibiotic Use (n = 287).

Variable	Category	Adjusted OR	95% CI	p-value
Age group	18–29 (ref)	1.00	—	—
	30–39	0.92	0.48–1.76	0.801
	40–49	0.85	0.43–1.68	0.642
	50–59	0.78	0.37–1.64	0.508
	≥60	0.51	0.22–1.18	0.116
Educational attainment	University/higher (ref)	1.00	—	—
	No formal education	2.84	1.12–7.21	0.028*
	Primary education	1.67	0.89–3.13	0.110
	Secondary education	1.14	0.65–2.00	0.648
Monthly income	High (ref)	1.00	—	—
	Low	1.89	0.94–3.80	0.074
	Middle	0.93	0.51–1.70	0.812
Health insurance	Yes (ref)	1.00	—	—
	No	1.74	1.01–3.00	0.046*
Knowledge level	Good (ref)	1.00	—	—
	Poor	2.31	1.35–3.95	0.002*
Previous antibiotic use (past 6 months)	No (ref)	1.00	—	—
	Yes	2.67	1.52–4.69	<0.001*
Self-medication	No (ref)	1.00	—	—
	Yes	4.12	2.08–8.16	<0.001*
Source of antibiotic	Physician prescription (ref)	1.00	—	—
	Non-prescription source	2.45	1.38–4.35	0.002*

*Statistically significant at p < 0.05. Ref = reference category. Model adjusted for all variables listed. Hosmer–Lemeshow test p = 0.412; model correctly classified 73.5% of cases.

In multivariable logistic regression, several factors remained independently and significantly associated with inappropriate antibiotic use after adjustment for potential confounders. Self-medication with antibiotics was the strongest independent predictor (adjusted OR = 4.12; 95% CI: 2.08–8.16; p < 0.001), followed by previous antibiotic use in the past six months (aOR = 2.67; 95% CI: 1.52–4.69; p < 0.001), non-prescription source of antibiotics (aOR = 2.45; 95% CI: 1.38–4.35; p = 0.002), poor knowledge (aOR = 2.31; 95% CI: 1.35–3.95; p = 0.002), no formal education (aOR = 2.84; 95% CI: 1.12–7.21; p = 0.028), and lack of health insurance (aOR = 1.74; 95% CI: 1.01–3.00; p = 0.046). Age group and monthly income did not remain independently significant after adjustment. The model demonstrated acceptable fit (Hosmer–Lemeshow p = 0.412) and correctly classified 73.5% of cases. These findings identify self-medication, recent antibiotic exposure, non-prescription access, poor knowledge, low education, and lack of insurance as key modifiable or addressable targets for interventions.

DISCUSSION

The present study found that 70.3% of adults attending primary healthcare centers had used antibiotics during the preceding three months, and among these users, 58.5% engaged in at least one inappropriate antibiotic-use behavior, corresponding to an overall prevalence of 41.2% among all surveyed adults. These findings are consistent with the growing body of evidence indicating that inappropriate antibiotic use remains highly prevalent in primary healthcare settings globally. The observed prevalence among antibiotic users (58.5%) is comparable to estimates reported in similar cross-sectional studies, although direct comparisons are limited by differences in operational definitions, recall periods, and study populations. The dual presentation of prevalence—both among antibiotic users and among all surveyed adults—provides a comprehensive picture of the burden of inappropriate use and facilitates comparison with studies

that have adopted either analytical approach (Shively et al., 2018; Yin et al., 2022).

The finding that 60.3% of antibiotic users obtained their most recent antibiotic through a physician's prescription, while 39.7% obtained antibiotics through non-prescription sources, highlights the coexistence of formal and informal pathways of antibiotic access. This pattern is concerning because non-prescription access—including pharmacist recommendation (20.2%), leftover medication (11.8%), family/friend recommendation (5.2%), and direct purchase without prescription (2.4%)—bypasses professional assessment and contributes to unsupervised consumption. Similar findings have been reported in community-based studies from low- and middle-income countries, where antibiotics are frequently accessible without prescription and individuals often rely on informal sources for symptom management (Edessa et al., 2024). The availability of antibiotics through informal channels undermines efforts to ensure appropriate prescribing and dispensing, and highlights the need for regulatory enforcement alongside educational interventions.

Respiratory symptoms were the most common reason for antibiotic use in this study (43.2%), followed by fever (21.3%), urinary symptoms (13.2%), skin/wound infections (10.1%), and gastrointestinal symptoms (7.7%). The predominance of respiratory symptoms is particularly noteworthy because most uncomplicated upper respiratory tract infections, the common cold, influenza, and acute bronchitis are viral in origin and do not benefit from antibacterial treatment. The use of antibiotics for these conditions represents a significant proportion of unnecessary consumption and is a well-recognized target for antimicrobial stewardship interventions (Shively et al., 2018; Kasse et al., 2025). The finding that 27.2% of antibiotic users reported using antibiotics for conditions that did not warrant antibacterial treatment, as established from available information, further underscores the magnitude of unnecessary use in this population.

Among participants who received a physician's prescription, 30.1% did not complete the prescribed course, 27.2% discontinued treatment after symptom improvement, and 16.8% independently altered the dose. These adherence-related behaviors are important contributors to inappropriate antibiotic use and have implications for both treatment outcomes and the selection of resistant strains. Premature discontinuation and dose alteration can result in subtherapeutic exposure, which may facilitate the survival and proliferation of partially resistant bacteria. Similar patterns of non-adherence have been documented in studies from diverse settings, where patients frequently modify or terminate treatment based on symptom resolution rather than following professional instructions (Yin et al., 2022; Chang et al., 2019). These findings suggest that interventions aimed solely at improving prescribing practices may be insufficient without complementary efforts to promote adherence and patient understanding of treatment regimens.

Self-medication with antibiotics was reported by 32.4% of antibiotic users, sharing antibiotics by 14.3%, and using antibiotics prescribed for another person by 12.5%. These practices represent direct deviations from appropriate antibiotic use and are particularly concerning because they occur outside formal healthcare consultations and are therefore less amenable to conventional stewardship interventions. The high prevalence of self-medication observed in this study is consistent with findings from other cross-sectional surveys, which have reported self-medication rates ranging from 20% to 50% in various populations (Yin et al., 2022; Edessa et al., 2024). The sharing of antibiotics between family members and the reuse of previously prescribed medications further compound the problem by exposing individuals to inappropriate drug selection, incorrect dosing, and potential adverse effects, while also delaying diagnosis and appropriate treatment for underlying conditions.

Knowledge regarding antibiotics was variable among study participants. While 81.9% correctly agreed that antibiotics should be taken exactly as prescribed and 76.5% knew that antibiotics are effective against bacterial infections, only 55.9% correctly identified that antibiotics are not effective against viral infections, and only 59.1% recognized antimicrobial resistance as a serious public health problem. Overall, 56.4% of participants had poor knowledge (score <6/7). These knowledge gaps are consistent with findings from previous studies that have documented widespread misconceptions about the indications for antibiotic treatment and limited awareness of antimicrobial resistance among general populations (Elkhadry & Tahoon, 2024; Chang et al., 2019). The specific deficit in understanding the viral–bacterial distinction is particularly important because it directly relates to the most common reason for antibiotic use in this study—respiratory symptoms—and represents a critical target for educational interventions.

The univariable analysis revealed significant associations between inappropriate antibiotic use and age group ($p = 0.038$), educational attainment ($p = 0.010$), monthly income ($p = 0.034$), and health insurance status ($p = 0.040$). The prevalence of inappropriate use was highest among participants aged 18–29 years (62.3%) and lowest among those aged ≥60 years (45.5%). This age gradient may reflect differences in health literacy, healthcare-seeking behavior, and susceptibility to peer influence among younger adults. Participants with no formal education had the highest prevalence (75.0%), compared with 51.4% among those with university education, suggesting that educational attainment plays a significant role in shaping antibiotic-related knowledge and practices. Similar socioeconomic gradients in antibiotic

use have been reported in other studies, highlighting the need for tailored interventions that address the specific needs of vulnerable populations (Mulchandani et al., 2025; Franchi et al., 2021).

The finding that low-income participants had a higher prevalence of inappropriate use (64.9%) than middle-income (56.1%) and high-income (57.9%) participants, and that those without health insurance had a significantly higher prevalence (67.4%) than those with insurance (54.4%), underscores the role of access-related factors in shaping antibiotic-use behaviors. Individuals experiencing financial constraints or lacking health insurance may be more likely to seek medications through informal channels, reuse previously prescribed antibiotics, or delay professional consultation, all of which contribute to inappropriate use. These findings are consistent with the broader literature on socioeconomic determinants of antibiotic consumption and highlight the importance of addressing structural barriers to healthcare access as part of comprehensive antimicrobial stewardship efforts (Mulchandani et al., 2025; Edessa et al., 2024).

A strong and statistically significant association was observed between antibiotic-related knowledge and inappropriate use ($p < 0.001$). Among participants with good knowledge, the prevalence of inappropriate use was 44.6%, compared with 68.7% among those with poor knowledge—a 24.1 percentage-point difference. This finding provides empirical support for the theoretical premise that limited knowledge is a major correlate of inappropriate antibiotic use and suggests that educational interventions targeting knowledge gaps could yield substantial benefits. However, the fact that 44.6% of participants with good knowledge still engaged in inappropriate use indicates that knowledge alone is insufficient to ensure appropriate behavior. This knowledge–practice gap has been documented in previous studies and highlights the need for interventions that address not only cognitive factors but also behavioral, social, and environmental determinants of antibiotic use (Elkhadry & Tahoon, 2024; Chang et al., 2019).

Previous antibiotic exposure and self-medication practices were strongly associated with inappropriate antibiotic use. Participants who had used antibiotics in the past six months had a significantly higher prevalence of inappropriate use (70.0%) compared with those without recent exposure (44.1%; $p < 0.001$). Self-medication with antibiotics was associated with an 83.9% prevalence of inappropriate use, compared with 46.4% among non-self-medicating participants ($p < 0.001$). The source of antibiotics was also significant: 75.4% of those who obtained antibiotics from non-prescription sources engaged in inappropriate use, compared with 47.4% of those who obtained antibiotics through physician prescription ($p < 0.001$). These findings are consistent with the concept of a "culture of antibiotic use," whereby repeated exposure and established patterns of self-medication normalize inappropriate practices and create reinforcing cycles that are difficult to break without targeted intervention (Kasse et al., 2025; Yin et al., 2022).

In multivariable logistic regression, several factors remained independently and significantly associated with inappropriate antibiotic use after adjustment for potential confounders. Self-medication with antibiotics was the strongest independent predictor (adjusted OR = 4.12; 95% CI: 2.08–8.16; $p < 0.001$), followed by previous antibiotic use in the past six months (aOR = 2.67; 95% CI: 1.52–4.69; $p < 0.001$), non-prescription source of antibiotics (aOR = 2.45; 95% CI: 1.38–4.35; $p = 0.002$), poor knowledge (aOR = 2.31; 95% CI: 1.35–3.95; $p = 0.002$), no formal education (aOR = 2.84; 95% CI: 1.12–7.21; $p = 0.028$), and lack of health insurance (aOR = 1.74; 95% CI: 1.01–3.00; $p = 0.046$). Age group and monthly income did not remain independently significant after adjustment, suggesting that their associations with inappropriate use were mediated by other variables in the model. These findings identify self-medication, recent antibiotic exposure, non-prescription access, poor knowledge, low education, and lack of insurance as key modifiable or addressable targets for interventions.

The prominence of self-medication as the strongest independent predictor of inappropriate antibiotic use (aOR = 4.12) is particularly notable and has important implications for intervention design. Self-medication represents a direct bypass of professional oversight and is associated with a fourfold increase in the odds of inappropriate use. This finding is consistent with previous research that has identified self-medication as a central driver of inappropriate antibiotic consumption in community settings (Yin et al., 2022; Edessa et al., 2024). Addressing self-medication requires a multifaceted approach that includes regulatory enforcement to restrict non-prescription access, public education to discourage self-medication, and improved healthcare access to reduce the perceived need for self-medication as a substitute for professional consultation. The finding that non-prescription source of antibiotics was independently associated with inappropriate use (aOR = 2.45) further reinforces the importance of supply-side interventions.

The association between previous antibiotic use in the past six months and inappropriate use (aOR = 2.67) suggests that recent exposure establishes patterns of behavior and expectations that persist over time. Individuals who have recently used antibiotics may be more likely to reuse leftover medications, self-medicate for similar symptoms, or request antibiotics during consultations. This finding is consistent with the concept of antibiotic experience as a determinant of future use and highlights the importance of targeting individuals with recent antibiotic exposure for educational interventions (Franchi et al., 2021; Kasse et al., 2025).

The association between poor knowledge and inappropriate use (aOR = 2.31) confirms the importance of knowledge as a modifiable determinant and supports the inclusion of educational components in stewardship interventions. However, as noted earlier, the knowledge–practice gap suggests that education alone is unlikely to be sufficient without complementary behavioral and environmental interventions.

The finding that no formal education was independently associated with inappropriate use (aOR = 2.84) and that lack of health insurance was also independently associated (aOR = 1.74) highlights the importance of addressing social determinants of health as part of antimicrobial stewardship efforts. Individuals with limited education and those without health insurance face multiple barriers to appropriate antibiotic use, including limited health literacy, reduced access to professional consultation, and greater reliance on informal sources of medication. These findings are consistent with the broader literature on health disparities in antibiotic use and suggest that interventions must be tailored to the needs of vulnerable populations and delivered through channels that are accessible to them (Mulchandani et al., 2025; Elkhadry & Tahoon, 2024). Addressing structural barriers to healthcare access, improving health literacy, and implementing targeted educational programs for low-education populations are essential components of a comprehensive strategy to reduce inappropriate antibiotic use.

The implications of these findings for clinical practice and public health policy are substantial. The high prevalence of inappropriate antibiotic use (58.5% among users; 41.2% overall), combined with the identification of self-medication, non-prescription access, poor knowledge, low education, and lack of insurance as independent predictors, provides a clear roadmap for intervention. Antimicrobial stewardship programs in primary healthcare settings should prioritize strategies to reduce self-medication and non-prescription access, including regulatory enforcement, pharmacist engagement, and public awareness campaigns. Educational interventions should target knowledge gaps, particularly regarding the viral–bacterial distinction and the consequences of unnecessary antibiotic use, and should be tailored to the needs of low-education and uninsured populations. Improving healthcare access and reducing financial barriers to consultation are also essential to reduce reliance on informal channels for medication access (Fu et al., 2023; Shively et al., 2018).

The findings of this study should be interpreted in light of several limitations. The cross-sectional design precludes establishment of causal relationships or determination of the temporal sequence between exposure variables and the outcome. The use of self-reported information may have introduced recall bias, particularly for antibiotic use during the preceding three months, and social desirability bias may have influenced responses regarding self-medication, prescription practices, and adherence. The consecutive sampling of adults attending primary healthcare centers may have limited the representativeness of the findings for the wider adult population, including individuals who rarely or never access healthcare services. The classification of inappropriate antibiotic use depended on the accuracy and completeness of participants' reports and the availability of information regarding the indication and treatment instructions. Despite these limitations, the study provides valuable evidence on the prevalence and determinants of inappropriate antibiotic use in primary healthcare settings and identifies key targets for intervention.

Future research should address the limitations of the present study by employing longitudinal designs to establish temporal relationships, incorporating objective measures of antibiotic use (such as prescription records or pharmacy dispensing data) to complement self-reported information, and including community-based samples to capture individuals who do not routinely access healthcare services. Qualitative research exploring the social, cultural, and behavioral factors that drive self-medication and non-prescription access would provide deeper insights into the mechanisms underlying the associations observed in this study. Intervention studies testing the effectiveness of multifaceted stewardship programs that combine educational, regulatory, and access-improving components are needed to identify the most effective strategies for reducing inappropriate antibiotic use in primary healthcare settings. Such research would contribute to the development of evidence-based policies and practices to promote rational antibiotic use and limit the development and spread of antimicrobial resistance (Mulchandani et al., 2025; Fu et al., 2023).

CONCLUSION

This study found a high prevalence of inappropriate antibiotic use among adults attending primary healthcare centers, with 58.5% of antibiotic users and 41.2% of all surveyed adults engaging in at least one inappropriate behavior. Self-medication, recent antibiotic exposure, non-prescription access, poor knowledge, low education, and lack of health insurance were identified as independent predictors of inappropriate use. These findings highlight the multifactorial nature of inappropriate antibiotic use and the need for comprehensive, multifaceted interventions that address both demand-side factors (knowledge, attitudes, and behaviors) and supply-side factors (access to antibiotics through informal channels). Strengthening antimicrobial stewardship in primary healthcare, improving health literacy, reducing non-prescription access, and addressing socioeconomic barriers to appropriate healthcare are essential strategies to promote rational antibiotic use and limit the development and spread of antimicrobial resistance.

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