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# Self-medication with antibiotics: A pervasive risk factor for antibiotic resistance and public health concerns

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## Abstract

Self-medication with antibiotics (SMA) has emerged as a significant public health concern, particularly in low- and middle-income countries (LMICs), where prevalence rates can be alarmingly high. This study systematically reviews the prevalence and factors influencing SMA, revealing a pooled prevalence of 27.7% globally, with rates ranging from 7.3% in Indonesia to 82.2% in Nigeria. Key determinants of SMA include perceived barriers to healthcare, self-medication risks, and self-efficacy, with higher perceived barriers correlating with increased SMA. The primary sources of antibiotics for self-medication include pharmacies, family and friends, and leftover prescriptions. The findings indicate that common antibiotics used for self-medication include penicillins, with respiratory infections being a frequent reason for use. Despite a significant awareness of antibiotic resistance, many individuals continue to self-medicate, often driven by factors such as dissatisfaction with healthcare services and cultural beliefs. This behavior poses serious risks to individual health and contributes to the growing challenge of antimicrobial resistance. The study underscores the urgent need for public health interventions aimed at educating communities about the dangers of self-medication and implementing stricter regulations on antibiotic dispensing to mitigate misuse and safeguard public health.

**Keywords:** Self-Medication; Antibiotics; Antimicrobial Resistance; Public Health; Education; Pharmacy; Healthcare Access; Intervention

## 1. Introduction

The World Health Organization (WHO) defines self-medication as the use of medications to treat self-diagnosed conditions without the guidance or oversight of a healthcare professional[1]. The use of antibiotics without a prescription is a widespread practice globally[1]. The practice of taking antibiotics for self-diagnosed conditions without first consulting a qualified healthcare professional is referred to as antibiotic self-medication[2]. The inappropriate drug use practices common in self-medication include short treatment duration, inadequate dosage, sharing of medicines, and discontinuation of treatment upon symptom improvement[3]. The rise of multidrug-resistant bacterial strains has heightened global concerns over antibiotic resistance, leading to longer illnesses, more frequent medical visits, extended hospitalizations, the use of costly alternative treatments, and, in some cases, fatalities[4]. Antibiotic resistance is a worldwide problem that creates a therapeutic dilemma for doctors across all fields, such as choosing the right drug and dosage for a specific illness. The lack of alternative antibiotics, ignorance and disregard of the risks of misuse, and the general public's lack of knowledge have contributed to the emergence of this global crisis[5]. Antibiotics are losing efficacy as resistant strains emerge across major Gram-positive and Gram-negative bacteria, including Staphylococcus aureus and Enterobacteriaceae. This “antibiotic resistance crisis,” worsened by slow antibiotic development, threatens essential medical practices[6]. Antibiotics, crucial for treating bacterial infections, are often

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obtained without prescriptions, accounting for 62% of purchases, particularly in developing nations[7]. It was observed that in developing countries, approximately 33.4% of individuals engaged in self-medication with antibiotics[8]. Self-medication practices, such as inadequate dosage, short treatment duration, and stopping medication upon symptom relief, contribute to antimicrobial resistance, limiting treatment options and increasing health risks in developing countries. Quantifying self-medication remains challenging due to limited monitoring. Factors include high healthcare costs and lack of strict regulations on antibiotic sales, as reported in studies with inconsistent findings[8]. The overuse and misuse of antibiotics, especially in resource-constrained areas, have contributed to the rise of antibiotic resistance and life-threatening infections. This has led to higher rates of illness and death, longer hospital stays, and increased healthcare expenses. Inappropriate antibiotic use, including self-medication, has also resulted in adverse drug reactions and altered disease manifestations, further exacerbating the issue of antimicrobial resistance in low- and middle-income countries[9]. This study aims to assess the prevalence and patterns of self-medication with antibiotics among various demographic groups, particularly focusing on factors such as parental education, age, and socioeconomic status. It will evaluate the level of knowledge and awareness regarding antibiotic resistance and the risks associated with non-prescription antibiotic use among caregivers and the general public. Additionally, the study will investigate the primary sources of antibiotics, including community pharmacies, and explore attitudes towards self-medication practices. Finally, it will analyze the effectiveness of public health campaigns and educational interventions in reducing self-medication behaviors and improving healthcare practices related to antibiotic use.

### 1.1. Global Trends and Risks of Self-Medication with Antibiotics

A review of studies (2000–2016) on self-medication with antibiotics (SMA) among adults in the Middle East found prevalence rates from 19% to 82%. Major factors included age, gender, socioeconomic status, and education. Penicillins were often obtained from stored drugs and non-prescription sources, primarily for respiratory issues, with both positive and negative health outcomes observed[10]. The study reviewed 450 papers with 21 cross-sectional studies and found that the prevalence of self-medication ranged from 12.8% to 77.1%, primarily for fever, gastrointestinal, and respiratory symptoms, involving the use of analgesics and antimicrobials often obtained from retail pharmacies or recommended by pharmacy staff and acquaintances[11]. The study by Ayalew et al. revealed that self-medication rates in Ethiopia ranged from 12.8% to 77.1%, comparable to self-medication rates in the Euro-Mediterranean region (40.9%) and developing countries (38.8%). In contrast, developed European nations reported lower rates of self-medication, ranging from 1% to 4%, likely due to stricter regulations[2]. A survey of 423 adults found that 50% reported self-medicating with antibiotics, especially those with medical knowledge. Awareness was high, with 50.4% having adequate knowledge. Community pharmacies were the main source (87.1%), driven by convenience and access, and amoxicillin/clavulanic acid was the most commonly used antibiotic[12]. This cross-sectional study found that 77.5% of 462 respondents in Arar city reported self-medication with antibiotics, primarily due to ease of use (54.6%) and cost-saving (24.8%). While 20.1% viewed self-medication as a good practice, 41.6% deemed it acceptable. Most (81.4%) understood that antibiotic resistance develops when the body becomes resistant to these medications[13]. Over the last few decades, the use of antibiotics as primary care has changed dramatically, leading to more multidrug-resistant infections due to increased antibiotic usage[14]. The scoping review found that the prevalence of nonprescription antibiotic use in the U.S. ranged from 1% to 66%. Factors contributing to this included easy access, healthcare costs, and personal networks[15]. In resource-constrained settings with limited primary healthcare access, people conveniently use retail drug outlets to promptly treat some less severe illnesses[16]. Retail drug outlets frequently sell antibiotics without prescriptions, jeopardizing public health by enabling inappropriate use and heightening the risk of antibiotic resistance. This practice, especially prevalent in treating self-limiting illnesses in children, contravenes WHO guidelines and poses substantial public health risks[17]. To address this problem, public health initiatives should concentrate on increasing awareness, enhancing access to high-quality healthcare, and implementing stricter regulations on antibiotic sales.

### 1.2. Self-Medication and Antibiotic Resistance: A Growing Concern

A study in Nepal found that over half (52.8%) of medical students self-medicated with antibiotics, primarily for common ailments, using azithromycin and amoxicillin, often relying on previous prescriptions or their knowledge, despite recognizing the risks of antibiotic resistance[18]. A study in Baghdad showed that over 45% of people self-medicated with antibiotics, often for viral infections. Despite recognizing the importance of rational use, negative attitudes persisted, leading to concerns about antibiotic resistance. Increased public health education is needed to promote responsible antibiotic use[19]. A study in Aden, Yemen, found that many people misused antibiotics, often taking them for viral infections like the common cold, despite recognizing the risk of antibiotic resistance and relying on self-medication without completing full courses of antibiotics[20]. The overuse of antibiotics in Europe is a major driver of antibiotic resistance, driven by a lack of public awareness, easy access to antibiotics, inadequate medical training, and patient-doctor interactions. Addressing these factors through improved education, stricter regulations, and better diagnostic tools can help mitigate the problem[21]. The prevalence of antibiotic resistance in common disease-causing

microorganisms is consistently observed to be greater in nations with higher rates of antibiotic consumption[21]. Antibiotic resistance is a growing problem due to bacteria's ability to evolve and become resistant to various drugs. This can occur through mutations or the acquisition of resistance genes from other bacteria. Overuse of antibiotics can accelerate this process, leading to the emergence of multidrug-resistant strains[22]. Although most parents were aware of the risks associated with inappropriate antibiotic use, a significant proportion mistakenly believed that antibiotics could treat viral infections. While interventions improved awareness and reduced children's self-medication, parental patterns of irrational antibiotic provision remained unchanged[23]. In Shastri Nagar, Patna, a study of 173 caregivers found that mothers and post-graduates had better awareness of antibiotic use, while fathers understood side effects more, though misconceptions about treating viral infections were still widespread[24]. In a study of 728 caregivers, higher parental education was associated with less antibiotic self-medication in children. Conversely, self-medication increased with frequent non-prescription antibiotic purchases, family advice, older child age, and recent antibiotic use[25]. A descriptive cross-sectional study was conducted at six different non-medical universities in Karachi. 431 students were included, 50.1% self-medicated, 47.6% used antibiotics, and 77.3% were aware of adverse effects[26]. Addressing these challenges requires stricter regulations, improved public education, and enhanced healthcare practices to curb the global threat of antibiotic resistance.

### 1.3. Global Insights on Self-Medication with Antibiotics and Antimicrobial Resistance

In a cross-sectional study of 354 parents, 61.6% displayed poor knowledge about antibiotics, and 20.6% reported non-prescription use, primarily of amoxicillin. Factors associated with self-medication were older parental age, familiarity with antibiotics, and a knowledge score greater than 2[27]. The use of self-medication in the European Union (EU) ranges from 2 to 20 per 100 respondents across different countries, with the highest rates in eastern and southern European countries, and the lowest in northern and western European countries[23]. Between 1990 and 2007, 22 national or regional campaigns in high-income countries were launched to reduce antibiotic use. Most of these campaigns targeted both the public and physicians, and they showed a reduction in antibiotic consumption, although their impact on antimicrobial resistance remains unclear[28]. A meta-ethnography of 13 studies on AMR highlighted a moral conflict between collective responsibility and personal health needs. Educating the public about AMR risks increased the willingness to prioritize societal health over personal use, though the symbolic value and perceived necessity of antibiotics remained significant influences[29]. The UK study of 15 pregnant women with UTIs revealed their awareness of antimicrobial resistance (AMR) and limited self-efficacy in managing their health. While the participants expressed concern over AMR, they felt uncertain about its societal impact and viewed antibiotics as necessary, indicating a lack of confidence in managing their condition without antibiotics[30]. Despite five years of public education campaigns in France, 54% of people remained unaware that most upper respiratory tract infections are viral and do not require antibiotics[23]. Pharmacy staff recommended antibiotics in over half of the cases, while family members did so in about a quarter of the cases. The most common reasons for self-medication were fever (38%), painful swallowing (17%), and gastrointestinal problems (12%). Caregivers cited past improvement, symptom severity, and barriers to healthcare access as their motivations[25].

A comprehensive study found that more than 80% of Chinese outpatients with upper respiratory infections were prescribed antibiotics, leading to increasing antimicrobial resistance (AMR). The detection of colistin resistance genes in community patients emphasizes the pressing need for effective AMR control measures in China[31]. Unnecessary antibiotic use among medical students is a global issue contributing to antimicrobial resistance and adverse health outcomes. In this study, 27% reported self-medication with antibiotics, which is higher than in Australia but lower than in Kosovo[32],[33]. The results indicated that students generally have a good understanding of antibiotics, with 82% rating their knowledge as good or moderate. However, 63.2% reported using antibiotics based on self-decision, primarily for sore throats (45%). Upon graduation, 56.9% of students stated they would not sell antibiotics without a prescription, and 85.4% believed that a module on the rational use of antibiotics is essential in the pharmacy curriculum[33]. In a survey of 1,188 parents in Wuhan, 14.32% reported self-medicating their children with antibiotics in the past six months. Greater perceived threats and self-efficacy were associated with reduced self-medication, whereas perceived barriers increased the likelihood of it[34]. Self-medication with antibiotics remains a widespread issue, contributing to antimicrobial resistance (AMR). Despite public health campaigns, many continue to misuse antibiotics due to convenience, lack of awareness, or misconceptions. Addressing this requires increased education, stricter regulations, and better healthcare access to reduce antibiotic overuse and combat the growing threat of AMR.

**Table 1** Prevalence and Factors of Antibiotic Self-Medication and AMR Risk

| Study/Source | Prevalence/Usage of Antibiotics | Key Factors and Insights |
|---|---|---|
| Cross-Sectional Study (354 Parents) | 20.6% reported non-prescription antibiotic use, primarily amoxicillin. | Poor knowledge in 61.6% of parents. Key factors: older parental age, familiarity with antibiotics, and higher knowledge score (>2). |
| European Union (EU) | Self-medication ranged from 2 to 20 per 100 respondents across countries. | Highest rates in eastern and southern Europe; lowest in northern and western Europe. |
| National Campaigns (1990-2007) | 22 national or regional campaigns reduced antibiotic consumption. | Most campaigns targeted both the public and physicians; impact on AMR remains unclear. |
| Meta-Ethnography (13 Studies on AMR) | Increased willingness to prioritize societal health after public education. | Moral conflict between societal health and personal need; antibiotics' symbolic value influenced usage. |
| UK Study (Pregnant Women with UTIs) | Awareness of AMR among participants, but continued reliance on antibiotics. | Lack of confidence in managing UTIs without antibiotics despite awareness of AMR risks. |
| Public Education Campaigns (France) | 54% remained unaware that most upper respiratory infections are viral. | Campaigns had limited impact on public knowledge despite five years of efforts. |
| Pharmacy and Family Recommendations | Antibiotics recommended in 50% of cases by pharmacy staff and 25% by family. | Common self-medication reasons: fever (38%), painful swallowing (17%), gastrointestinal issues (12%). |
| Chinese Outpatients Study | Over 80% of outpatients with upper respiratory infections were prescribed antibiotics. | Increased AMR and detection of colistin resistance genes in community patients. |
| Medical Students (Global Issue) | 27% reported self-medication with antibiotics. | 63.2% self-medicated for sore throats (45%). 56.9% stated they would not sell antibiotics without a prescription post-graduation. |
| Survey of Parents in Wuhan (1,188 Parents) | 14.32% reported self-medicating their children with antibiotics in the past 6 months. | Higher perceived threats and self-efficacy reduced self-medication; perceived barriers increased likelihood. |

### 1.4. Global Patterns and Drivers of Self-Medication with Antibiotics

A systematic review of 15 studies on self-medication with antibiotics (SMA) in low- and middle-income countries (LMICs) found high SMA prevalence (8.1%-93%), often influenced by education, income, and gender. Key drivers included health conditions like respiratory infections, toothaches, affordability, and healthcare access[35]. Self-medication with antibiotics (SMA) shows marked regional variation. In middle-income countries, prevalence ranges from 7.3% in Indonesia to 81.2% in Pakistan. In the Middle East, Saudi Arabia reports the highest SMA rate at 80.6%, with Jordan lowest at 40.7%. Southern Europe exhibits high SMA rates, led by Greece at 76.2%, while Portugal reports 18.9%. Eastern Europe shows a prevalence of 41.1% in Romania and Poland. Central Africa reports high SMA rates, including 82.2% in Nigeria and 79% in Guatemala[36]. A systematic review and meta-analysis of 11 studies from LMICs (2007-2017) found a pooled prevalence of self-medication with antibiotics (SMA) at 78% (95% CI: 65-89%) among 5,080 participants. SMA rates ranged from 50% to 93.8%, with antibiotics sourced mainly from pharmacies, family/friends, old prescriptions, home cabinets, and leftovers[37]. A systematic review and meta-analysis of 48 studies from 27 LMICs (2010-2020) found a pooled antibiotic prescribing rate of 52% (95% CI: 51%-53%), with a prediction interval of 44%-60%. Access-group antibiotics comprised over 60% of prescribed antibiotics in 12 countries. However, high between-study heterogeneity and methodological issues limited the interpretation, with inappropriate prescribing rates ranging from 8% to 100%[38]. A meta-analysis of 242 studies found a global self-medication with antibiotics (SMA) prevalence of 27.7% (95% CI: 24.9%-30.5%). High income, healthcare-employed family members, antibiotic stockpiling, and purchasing without prescriptions increased SMA likelihood, with contributing factors spanning individual, healthcare, pharmacy, and social influences[39]. A review of 68 studies found that factors like male sex, dissatisfaction with healthcare, and cultural beliefs influenced antibiotic self-medication. Younger age was a risk factor

in high-income countries, while greater antibiotic knowledge reduced self-medication in low- and middle-income countries[40]. This systematic review analyzed 40 studies from 19 African countries, finding a median SMA prevalence of 55.7% (IQR 41-75%). Western Africa had the highest rate (70.1%). Commonly used antibiotics included penicillins, and primary sources were pharmacies and family[41]. The Jordanian survey conducted in late 2022 involved 1,218 participants, with 56.9% reporting over-the-counter self-medication. Positive attitudes toward self-medication ranged from 13.1% to 33%. Participants aged 36–40 and 51+, married/divorced, employed, or with chronic illnesses exhibited higher self-medication rates ($p < 0.05$)[42]. In the Wuhan survey (July 2019) with 3,206 participants, 10.32% reported self-medication with antibiotics (SMA) in the last six months. Higher perceived barriers to healthcare correlated with increased SMA, while higher perceived self-medication risks and self-efficacy correlated with reduced SMA ($p < 0.05$)[43]. The studies highlight the global prevalence and factors influencing self-medication with antibiotics, revealing significant regional variations. It emphasizes the role of education, healthcare access, and socio-cultural factors in driving antibiotic misuse, with serious implications for antimicrobial resistance.

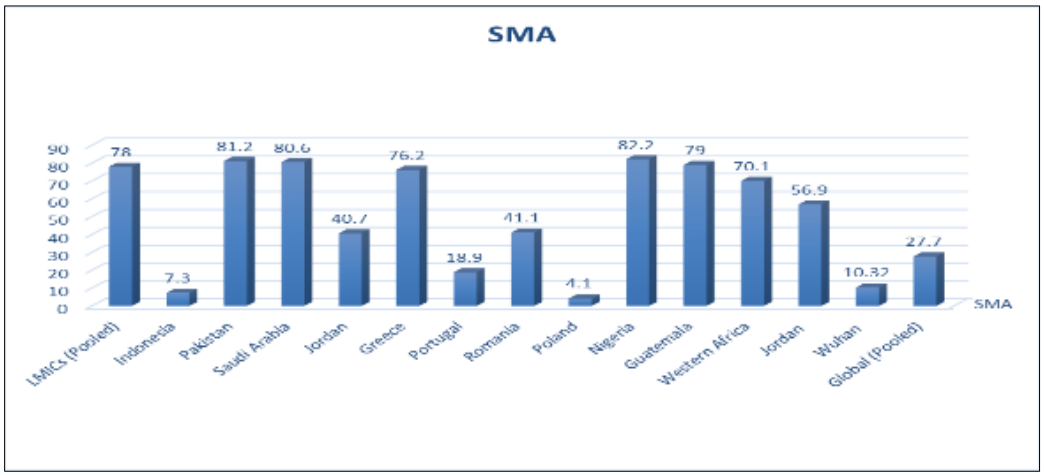


**Figure 1** Regional Variations in Self-Medication with Antibiotics

### 1.5. Factors Influencing Antibiotic Self-Medication

The study conducted in October-November 2022 found that self-medication with antibiotics was reported at 10.25% among the general public and 12.69% among health professionals. The key factors associated with this behavior were rural residency, easy access to antibiotics, and pharmacy staff recommendations for the general public, while for health professionals, it was gender, health perceptions, and antibiotic knowledge[44]. A cross-sectional study of 400 adults found 76% self-medicated with antibiotics during COVID-19. Key factors were gender, age, marital status, education, occupation, and insurance status. Main antibiotics were azithromycin (34%), amoxicillin/clavulanic acid (22%), and metronidazole (16%), commonly for respiratory and gastrointestinal symptoms[45]. A community-based study in southwestern Ethiopia found that self-medication was linked to being female (AOR 3.51), higher education (AOR 47), time wastage in public health facilities (AOR 2.71), and fear of COVID-19 (AOR 0.006). Common medications included analgesics (42.4%) and cold medicines (29.5%)[46]. In Anuradhapura, Sri Lanka, a study found that 2.6% of the population engaged in antibiotic self-medication. The primary reason was convenience, with a runny nose being the most common symptom. No significant associations were identified with demographic factors[47]. A survey of 369 community pharmacies in Sri Lanka revealed that pharmacists possessed superior antibiotic knowledge compared to their assistants. Approximately one-third of pharmacy staff dispensed antibiotics without prescriptions, and improved knowledge was associated with a reduction in illegal dispensing[48].

**Table 2** Self-Medication Trends in Medical Students

| Type of Study | Sample Size | Type of Patient | Type of Infection Treated | Type of Drugs (Antibiotics) | Region | Self-Medication Rate | References |
|---|---|---|---|---|---|---|---|
| Cross-sectional | 1,110 | Medical students | Respiratory tract infections, cough | Not explicitly mentioned. | Sudan | 60.8% | [49] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cross-sectional | 11,192 | Medical students | Self-limiting illnesses, prophylaxis | Not explicitly mentioned. | China | 54% | [50] |
| cross-sectional descriptive study | 400 | General public working in different areas | General infections | Not explicitly mentioned. | Aden-Yemen | 62.7% | [20] |
| cross-sectional survey | 531 | Medical science students | mild fever and skin infections | Primarily β-lactam antibiotics | South India | 30% | [51] |
| cross-sectional study | 332 | medical students | similar illness before, and believed to have knowledge of medications | cold medications, and dietary supplements | Turkey | 96.1% | [52] |
| cross-sectional study | 422 | Students from various faculties | Not explicitly specified | Metronidazole, Clindamycin | Northern Uganda | 74.2% with 63.7% medical Sciences | [53] |
| cross-sectional study | 558 | medical students and dental | Sore throat with runny nose | Azithromycin | Karachi, Pakistan | 51.1% | [54] |
| Cross-Sectional Survey | - | Medical and non-medical students | Tonsillitis | - | Saudi Arabia | 58.4% | [55] |
| Cross-Sectional Survey | 400 | Medicine, Dentistry, and Veterinary students | Not specified | Not specified | University of Novi Sad, Serbia | 42.8% | [56] |

Note: This table presents data on self-medication rates and practices in different medical settings. It includes information on the types of infections treated, medications used, and regions where the studies were conducted.

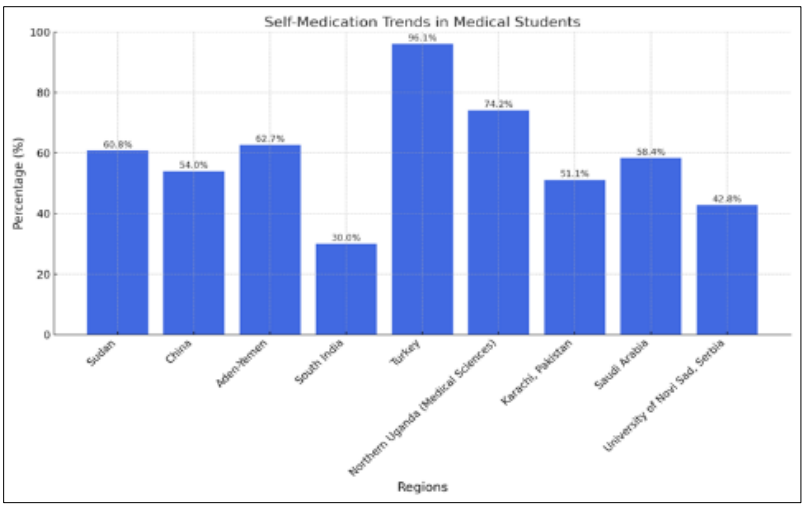


**Figure 2** Prevalence of Self-Medication Among Medical Students Across Different Regions

### 1.6. The Global Threat of Antibiotic Resistance

Antimicrobial resistance (AMR) endangers modern medicine, limiting treatment options for infections and complicating surgeries. It harms human, animal, and agricultural health, imposing economic costs globally. Key drivers include inadequate sanitation, infection control, healthcare access, awareness, and regulatory enforcement[57]. The CDC's 2019 Antibiotic Resistance Threats Report reveals that antibiotic resistance remains a significant U.S. health threat, with over 2.8 million infections and 35,000 deaths annually. Efforts in infection control, antibiotic stewardship, and vaccination are reducing death rates, especially in hospitals. However, resistance rates remain concerning, as many still face severe infections. Additionally, 223,900 cases of C. difficile led to 12,800 deaths in 2017, underscoring the need for continued vigilance and action[58]. Antibiotic self-medication accelerates resistance, endangering health, especially in low- and middle-income countries. Misuse risks adverse effects, misdiagnosis, and resistant infections due to factors like limited healthcare, unregulated access, and low awareness of antibiotic resistance's dangers[59]. Improper use of antibiotics can promote the development of antibiotic-resistant bacteria, which may spread to other microorganisms. It can also allow harmful bacteria to replace beneficial ones, heightening the risk of resistant infections[60]. A study involving 13 clinicians in Isfahan, Iran, identified concerns about antibiotic overuse and resistance. Key challenges included inactive antimicrobial stewardship committees, inefficient laboratories, poor healthcare delivery, and marketing pressures. Clinicians also noted issues in medical education and health system improvements[61]. A study using data from The Health Improvement Network (2013-2015) found that 8.8%-23.1% of systemic antibiotic prescriptions in English primary care were inappropriate. Key conditions contributing to inappropriate prescriptions included sore throat (23%), cough (22.2%), sinusitis (7.6%), and acute otitis media (5.7%). Additionally, one-third of antibiotic prescriptions lacked an informative diagnostic code. Practices had significant potential for reducing inappropriate prescribing, with reduction estimates ranging from 6.4% to 43.5%[62]. The World Health Organization considers antimicrobial resistance a threat to global security and a detriment to health initiatives[63]. The studies effectively highlight the global threat of antimicrobial resistance (AMR) driven by factors like self-medication, inadequate healthcare, and improper antibiotic use. It emphasizes the urgent need for improved stewardship, awareness, and regulations to combat this growing crisis.

### 1.7. Improving Antibiotic Stewardship and Combating Resistance

Antimicrobial resistance (AMR) poses a significant global public health threat, with projections suggesting up to 10 million deaths annually by 2050 if not effectively addressed[64]. The rising threat of AMR is closely linked to increasing antibiotic dependence, often driven by pharmaceuticalization in disease programs, with tuberculosis (TB) being a major contributor [65] [66]. Successful AMR containment requires the implementation of antimicrobial stewardship programs (ASPs), which aim to optimize antibiotic use, enhance patient outcomes, minimize adverse effects, slow the development of resistance, and preserve valuable healthcare resources [66]. A key component of effective ASPs is the active involvement of pharmacists, playing a central role in minimizing unnecessary prescriptions and improving clinical outcomes. As ASPs grow, pharmacists will continue to be vital in safeguarding antimicrobials and enhancing the quality of patient care [67]. These programs are essential in all healthcare settings, and community hospitals with limited resources may need to adopt tailored strategies for implementation, guided by the Centers for Disease Control and Prevention's Core Elements[68]. The success of ASPs depends on ongoing collaboration within healthcare, including administration, clinical services, and pharmacy, as well as external partnerships with national organizations and local ASPs. This collaborative approach fosters policy development, research, and regional expansion[69]. Evaluating the quality of antimicrobial use is a crucial responsibility of stewardship teams to establish improvement objectives. A study in Belgian hospitals developed 38 process quality indicators (QIs) to evaluate and improve antimicrobial stewardship, focusing on adherence to guidelines, documentation, resistance patterns, and antibiotic prescribing practices[70].

Education is a critical element in addressing AMR. A study in South Africa and Nigeria assessed medical student knowledge and perceptions of antibiotic use, resistance, and stewardship. While both groups recognized the issue of overuse, South African students demonstrated a better understanding of the topic. Both groups expressed a need for more education on appropriate antibiotic use. Medical and allied health students often lack adequate education on antimicrobial resistance and stewardship, highlighting the importance of improving curricula to support future healthcare professionals[71]. In low- and middle-income countries (LMICs), the implementation of clinical bacteriology faces challenges such as limited infrastructure, equipment, and trained personnel. Despite these limitations, national laboratory networks, regulatory frameworks, and workforce development are essential in improving diagnostic capabilities and combating resistance effectively. The integration of clinical bacteriology into healthcare settings can enhance patient management and support AMR containment. However, effective implementation requires adapting conventional microbiological techniques, ensuring quality assurance, and integrating diagnostics into clinical care[72] [73]. A study in Otavalo, Ecuador compared traditional microbiological methods with molecular techniques for identifying uropathogens and found a 32% misidentification rate. The study also highlighted significant antimicrobial resistance, including multidrug-resistant strains and increased resistance to nitrofurantoin and Fosfomycin [74]. These

findings underscore the need for improved diagnostic practices and the integration of molecular techniques to enhance the accuracy of pathogen identification and susceptibility testing in low-resource settings. However, the implementation of ASPs and clinical bacteriology in low-resource settings requires a multidisciplinary approach, quality management systems, and ongoing training and education to address antimicrobial resistance effectively. By fostering collaboration and adapting strategies to local contexts, healthcare systems can improve patient outcomes and contribute to global efforts in combating AMR.

### 1.8. Key summary points

- Prevalence of Self-Medication: The study highlights a high prevalence of self-medication with antibiotics, particularly in low- and middle-income countries, with rates ranging from 12.8% to 82%.
- Demographic Influences: Factors such as age, gender, socioeconomic status, and education significantly influence self-medication practices, indicating a need for targeted interventions.
- Sources of Antibiotics: Community pharmacies are the primary source for obtaining antibiotics, often without prescriptions, which raises concerns about the appropriateness of use.
- Awareness and Knowledge: While many individuals are aware of the risks associated with antibiotic misuse, a significant portion still engages in self-medication, suggesting gaps in effective education.
- Impact on Antimicrobial Resistance: The misuse of antibiotics contributes to the growing problem of antimicrobial resistance, posing a serious threat to public health globally.
- Need for Public Health Interventions: There is an urgent need for public health campaigns to educate communities about the dangers of self-medication and to promote responsible antibiotic use.

*Recommendations*

- Implement comprehensive educational programs targeting high-risk populations to raise awareness about antibiotic resistance.
- Establish stricter regulations on the sale of antibiotics in pharmacies to prevent non-prescription dispensing.
- Conduct further research to understand the underlying motivations for self-medication and develop tailored interventions.
- Enhance healthcare access and resources in underserved areas to reduce reliance on self-medication.
- Foster collaboration between healthcare providers, pharmacists, and public health officials to promote antimicrobial stewardship.
- Monitor and evaluate the effectiveness of interventions aimed at reducing self-medication and antibiotic misuse over time.

## 2. Conclusion

The study highlights the widespread practice of self-medication with antibiotics in low- and middle-income countries, driven by limited healthcare access and cultural factors. This behavior poses grave risks, including the worsening of antimicrobial resistance. To address this public health issue, targeted educational programs and stricter regulations on antibiotic sales are crucial to promote responsible use and protect communities against the growing threat of resistant infections.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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