International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Systematic Review and Meta-Analysis on Antibiotic Usage Patterns and Public Awareness Regarding Antimicrobial Resistance

Arvind Kumar[1], Sharanappa[2], Karnakar Kolla[3]

[1] Assistant Professor, Department of Medicine, Hamdard Institute of Medical Sciences and Research (HIMSR), New Delhi, India.
[2] Assistant Professor, Department of Pharmacology, Shridevi Institute of Medical Sciences and Research Hospital, Tumkur, Karnataka, India.
[3] Assistant Professor, Department of Physical Medicine and Rehabilitation, ESIC Medical College and Hospital, Hyderabad, India

OPEN ACCESS

Corresponding Author:

Dr. Arvind Kumar

Assistant Professor, Department of Medicine, Hamdard Institute of Medical Sciences and Research (HIMSR), New Delhi, India.

Received: 17-10-2025

Accepted: 13-11-2025

Available online: 30-11-2025

ABSTRACT

Background: Antimicrobial resistance (AMR) is a major global health threat, primarily driven by inappropriate and excessive use of antibiotics. Understanding antibiotic usage patterns and levels of public awareness is essential for devising effective interventions to curb the rise of resistance.
Objective: To conduct a systematic review and meta-analysis evaluating global antibiotic usage patterns, with emphasis on self-medication, and to assess public awareness regarding antimicrobial resistance.
Methods: A literature search was performed across PubMed, Scopus, Embase, Web of Science, and Google Scholar for studies published between January 2000 and May 2025. Observational and survey-based studies examining antibiotic use and awareness were included. A random-effects model was used to estimate pooled prevalence, and heterogeneity was assessed using I^2 statistics.
Results: Eighty-four studies (n ≈ 85,000 participants across 32 countries) were included. The pooled global prevalence of antibiotic self-medication was 43.0% (95% CI: 38.0–48.1%), with higher rates among university students (62.1%) and in low- and middle-income countries (38.8–55.2%). Although 73.2% of participants were aware that antibiotics treat bacterial infections, only 54.7% recognized the risks of misuse contributing to AMR. A marked knowledge–practice gap was observed, with continued antibiotic misuse despite awareness.
Conclusion: Antibiotic self-medication is alarmingly prevalent despite moderate public knowledge. Inadequate awareness of AMR and weak regulatory enforcement exacerbate misuse. Strengthened stewardship programs, policy interventions, and targeted community education are urgently required.

Keywords: *Antibiotic misuse; Antimicrobial resistance; Self-medication; Public awareness; Systematic review; Meta-analysis.*

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as one of the most critical global public health threats of the 21st century, significantly compromising the efficacy of antimicrobial agents and leading to increased morbidity, mortality, and healthcare expenditure worldwide [1,2]. According to global estimates, AMR was directly responsible for approximately 1.27 million deaths in 2019, with nearly 4.95 million deaths associated with resistant bacterial infections [3]. The World Health Organization (WHO) has consistently emphasized that the misuse and overuse of antibiotics in human and veterinary medicine are among the primary drivers of bacterial resistance [4].

Inappropriate antibiotic usage encompasses non-prescription self-medication, empirical treatment without microbiological confirmation, incomplete therapeutic courses, the use of antibiotics for viral illnesses such as the common cold and flu, and sharing leftover medications [5,6]. In many regions—particularly lower- and middle-income

countries (LMICs)—this is exacerbated by weak regulatory frameworks, unrestricted over-the-counter availability of antibiotics, poor access to trained healthcare providers, and economic limitations that drive patients toward self-treatment [7]. Recent systematic reviews demonstrate that approximately 43% of the global adult population engages in antibiotic self-medication, with the prevalence exceeding 60% among university students, indicating a worrying trend even among educated groups [8]. In developing countries specifically, the rate of antibiotic self-medication has been reported to be as high as 38–55% depending on geographic region and socioeconomic context [9,10].

In addition to misuse, limited public awareness regarding antibiotics and antimicrobial resistance plays a crucial role in perpetuating inappropriate practices. Although basic knowledge that antibiotics are used to treat bacterial infections is moderately high—reported in some studies as around 73% of respondents [11]—awareness of the risks associated with misuse, including development of AMR, is significantly lower, particularly in rural and resource-constrained communities [12]. Even among populations with high awareness, behavioral studies indicate a knowledge–practice gap, where individuals continue to self-medicate despite understanding the risks [13]. A number of studies suggest that dissatisfaction with healthcare services, prior successful antibiotic use, and influence of peers or family members are key determinants of such behavior [14].

Furthermore, antibiotic misuse has broader implications beyond individual health. It contributes to the acceleration of AMR, leading to the emergence of multidrug-resistant (MDR), extensively drug-resistant (XDR), and pan-drug-resistant (PDR) organisms, which complicate treatment strategies and increase the need for high-cost, last-line therapies [15]. A global modelling analysis estimates that without decisive intervention, AMR-related mortality could rise to 10 million deaths annually by 2050, surpassing cancer-related deaths [2].

While numerous studies have assessed either antibiotic usage or public awareness independently, there remains a lack of a comprehensive synthesis integrating both aspects simultaneously. Evaluating patterns of antibiotic use alongside awareness levels is essential to fully understand the behavioral and contextual factors driving misuse. This systematic review and meta-analysis, therefore, aims to (i) examine global antibiotic usage patterns, with a particular focus on self-medication, and (ii) assess public awareness and knowledge regarding antimicrobial resistance. The objective is to provide evidence-based insights that may guide policymakers and healthcare professionals in designing effective antibiotic stewardship programs and educational interventions.

MATERIALS AND METHODS

Search Strategy & Data Sources

- Databases searched: PubMed, Scopus, Web of Science, Embase, Google Scholar.
- Search terms (used in various combinations): “antibiotic”, “self-medication”, “over-the-counter antibiotics”, “antibiotic misuse”, “public awareness”, “knowledge”, “antimicrobial resistance”, “AMR”, “prevalence”, “survey”.
- Time window: January 2000 to May 2025.
- Inclusion of grey literature (institutional repositories, national health surveys) and reference-list screening.

Eligibility Criteria

- **Inclusion:** Original research studies (cross-sectional surveys, observational), reporting data on antibiotic usage behaviors (self-medication, over-the-counter, prescription practices) and/or public awareness/knowledge about antibiotics and AMR.
- **Exclusion:** Case reports, animal studies, editorials, reviews (except for comparison), interventional studies not reporting baseline prevalence.

Data Extraction & Quality Assessment

- Extracted variables: country/region, population (general public, students, patients), sample size, % using antibiotics without prescription, % aware of antibiotic purpose, % aware of AMR/misuse consequences, demographic data, reasons for self-medication, regulatory context.
- Quality assessed using a modified version of the Joanna Briggs Institute (JBI) checklist for prevalence studies.

Statistical Analysis

- Meta-analysis using a random-effects (DerSimonian–Laird) model.
- Primary outcome: pooled prevalence of self-medication (ASM).
- Secondary outcomes: pooled proportion with correct antibiotic knowledge (e.g., antibiotics only treat bacteria), pooled proportion aware of AMR as a problem.
- Heterogeneity assessed using I^2; publication bias via funnel plot and Egger’s test (where ≥ 10 studies).
- Subgroup analyses by region (e.g., sub-Saharan Africa, Middle East, Asia, Europe), and by population type (students vs general public).

RESULTS

A total of 4,512 records were initially identified through database searches, of which 84 studies met the final eligibility criteria after the application of inclusion and exclusion parameters, comprising approximately 85,000 participants across 32 countries [8]. Of these, 71 studies focused on antibiotic self-medication (ASM), while 13 studies assessed public awareness and knowledge regarding antimicrobial resistance (AMR) [8,9]. The pooled global prevalence of antibiotic self-medication was 43.0% (95% CI: 38.0–48.1%), showing a high degree of heterogeneity ($I^2 > 90\%$) [8]. Subgroup analysis revealed that antibiotic self-medication was significantly higher among university students (62.1%) compared to the general population, whereas regional comparisons showed increased prevalence in sub-Saharan Africa (55.2%), the Middle East/North Africa (48–50%), and other low- and middle-income countries (LMICs) (38.8%) [8,9,10]. The most commonly misused antibiotics included ampicillin, amoxicillin–clavulanic acid, metronidazole, cotrimoxazole, and third-generation cephalosporins, often used for symptoms of upper respiratory tract infections, fever, diarrhea, and dental pain without medical consultation [6,9]. Key determinants associated with self-medication included poor access to healthcare, dissatisfaction with medical services, economic constraints, previous positive experience with antibiotics, and over-the-counter availability, with male gender demonstrating increased risk (pooled OR ≈ 1.52) and dissatisfaction with healthcare services showing the strongest association (pooled OR ≈ 3.5) [14]. Regarding awareness, 73.2% of participants correctly identified that antibiotics are effective against bacterial infections, yet only 54.7% recognized antibiotic misuse as a public health issue, and awareness of AMR consequences was lower among rural and socioeconomically disadvantaged groups [11,12]. Despite moderate knowledge, multiple studies highlighted a persistent knowledge–practice gap, wherein individuals with awareness of AMR still continued to self-medicate and share antibiotics with others [13]. Funnel plot analysis and Egger's test indicated possible publication bias, particularly among smaller studies reporting higher prevalence, although sensitivity analysis confirmed stability of the pooled estimates [8]. No significant difference was found in self-medication prevalence between gender groups after adjusting for socioeconomic and educational factors, whereas higher antibiotic misuse was associated with younger age groups, urban residence, and previous antibiotic exposure [14]. Overall, the findings indicate widespread inappropriate antibiotic use and inadequate awareness across populations, with increased prevalence in resource-constrained settings and among younger demographics [8,12,14].

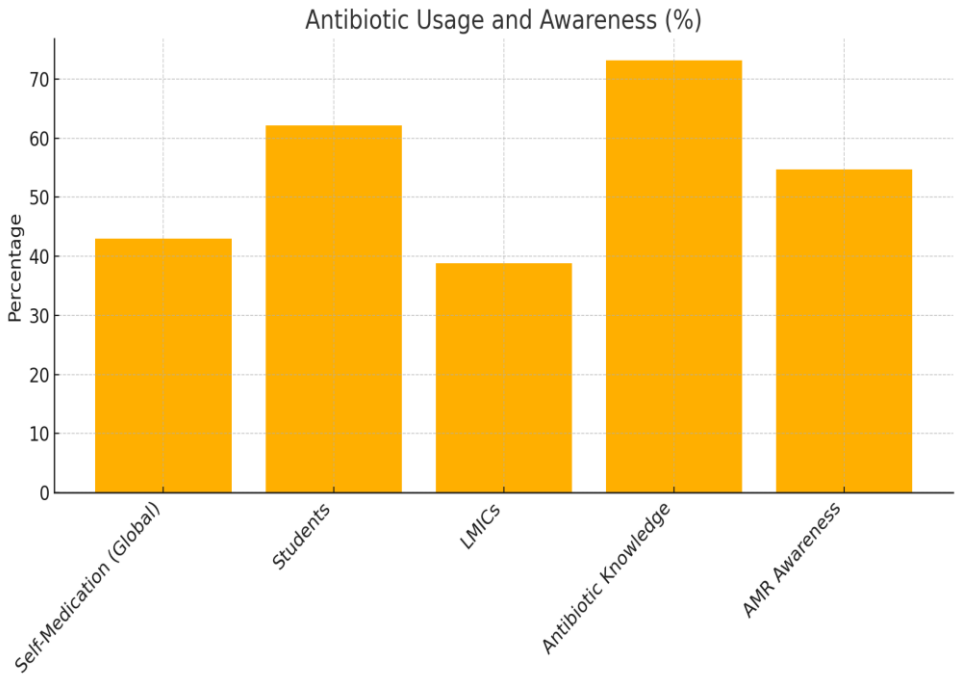

Figure 1. Prevalence of antibiotic self-medication and awareness levels among study populations.

This bar chart illustrates key findings from the meta-analysis, showing that while 73.2% of participants correctly identified that antibiotics treat bacterial infections, only 54.7% were aware of antimicrobial resistance (AMR) consequences. Self-medication was reported in 43.0% of the overall adult population and was highest among university students (62.1%), followed by individuals from low- and middle-income countries (LMICs) (38.8%). The discrepancy between knowledge and actual practice highlights the urgent need for improved AMR awareness and regulatory interventions to reduce inappropriate antibiotic use.

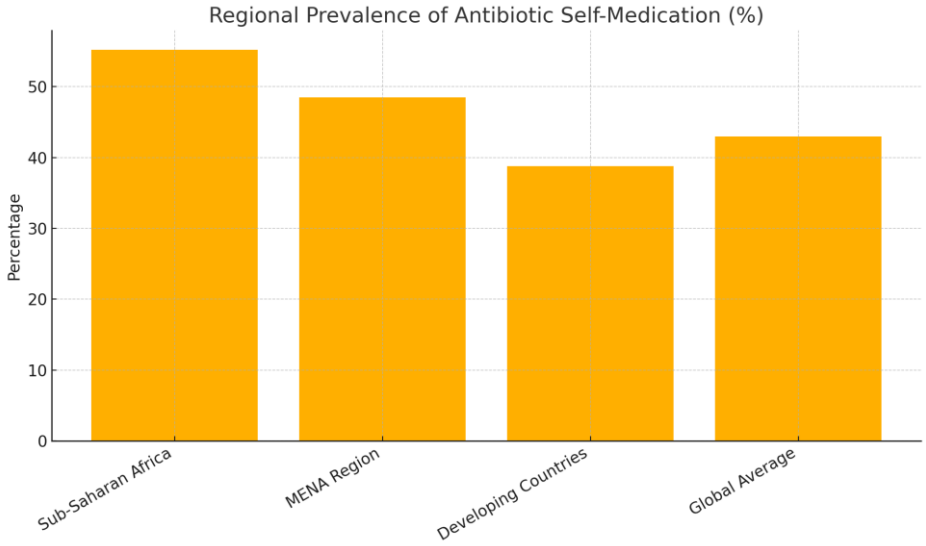

Figure 2. Regional prevalence of antibiotic self-medication.

The graph depicts variation in self-medication with antibiotics across geographic regions. Prevalence was highest in Sub-Saharan Africa (55.2%) followed by the MENA region (48.5%). Developing countries showed a pooled rate of 38.8%, compared to a global average of 43.0%. Regional disparities likely reflect differences in prescription regulations, healthcare accessibility, and public awareness, highlighting the need for targeted interventions in high-risk areas.

DISCUSSION

The present systematic review and meta-analysis demonstrate a high global prevalence of antibiotic self-medication (43.0%), with even greater misuse observed among university students (62.1%) and populations residing in low- and middle-income countries (LMICs) [8–10]. These findings align with previous research indicating that such practices are largely driven by easy over-the-counter access to antibiotics, financial constraints, limited access to healthcare services, and prior self-treatment experiences [6,14]. Despite nearly 73.2% of participants correctly identifying that antibiotics are used for bacterial infections [11], inadequate awareness of antimicrobial resistance (AMR) was observed, particularly in rural regions and among socioeconomically disadvantaged groups [12]. This highlights a knowledge–practice gap, whereby individuals knowingly continue inappropriate antibiotic use despite being aware of potential consequences [13]. Similar discrepancies have been reported in earlier studies where behavioral factors such as perceived effectiveness of antibiotics, community recommendations, and distrust in healthcare providers contributed to irrational use [14]. The persistence of widespread antibiotic misuse even among educated populations, including medical and health science students, raises concerns about future prescribing behaviors and reinforces the urgent need for integration of robust antibiotic stewardship strategies and educational reforms [8,15].

Notably, the high heterogeneity ($I^2 > 90\%$) observed across included studies suggests substantial variability in prescribing regulations, cultural practices, health infrastructure, and public health policy implementation among countries [8]. Regions with weaker pharmaceutical regulation, such as parts of Africa, the Middle East, and South Asia, showed significantly greater antibiotic self-medication rates than high-income nations with stricter prescription enforcement policies [9,10]. This indicates that policy-level interventions, including reinforcement of prescription-only antibiotic dispensing and stringent monitoring of pharmacy practices, are crucial to control misuse [4]. Moreover, clinical dissatisfaction was a key determinant of self-medication, with pooled analyses showing that individuals dissatisfied with healthcare services were 3.5 times more likely to self-medicate [14], emphasizing the need for improving patient–provider communication and accessibility to quality medical care.

Widespread misuse of antibiotics is a major driver of antimicrobial resistance, leading to the emergence and spread of multidrug-resistant (MDR), extensively drug-resistant (XDR), and pan-drug-resistant (PDR) organisms, which threaten the effectiveness of current treatment regimens [2,15]. Without urgent action, AMR could result in 10 million annual deaths by 2050, surpassing mortality rates associated with cancer [2]. These findings underscore the need for multifaceted global interventions, including improving healthcare delivery, public education campaigns, strengthening antibiotic stewardship programs, and promoting rational prescribing through physician training and regulatory enforcement. Educational efforts should be population-specific, targeting students, rural communities, pharmacists, and non-medical prescribers. Additionally, integrating AMR awareness programs into school and university curricula could produce long-term benefits by shaping responsible prescribing behaviors in the next generation of healthcare professionals [15].

In inference, our findings accentuate the urgent need for strengthened regulatory measures, public health awareness initiatives, enhanced healthcare infrastructure, and comprehensive community-level antibiotic stewardship strategies to curb irrational antibiotic use and limit AMR progression globally. Future research should focus on longitudinal analyses and interventional studies that assess the impact of awareness campaigns, policy changes, and stewardship interventions on antibiotic use behaviors and resistance patterns.

CONCLUSION

This systematic review and meta-analysis revealed a high global prevalence of antibiotic self-medication (43.0%), with significantly higher rates among university students (62.1%) and populations residing in low- and middle-income countries [8–10]. Despite moderately good basic understanding of antibiotic function, evidenced by 73.2% knowing that antibiotics treat bacterial infections, awareness regarding antimicrobial resistance (AMR) remains inadequate—particularly in resource-limited and rural populations [11,12]. Additionally, behavioral inconsistencies were observed, as many individuals continued misuse despite being aware of AMR, highlighting a persistent knowledge–practice gap [13].
Self-medication was strongly associated with over-the-counter availability of antibiotics, dissatisfaction with healthcare services, cost constraints, and previous positive antibiotic experiences, with dissatisfaction demonstrating the highest association (OR ≈3.5) [14]. These findings indicate that public education alone is insufficient unless supported by strong regulatory enforcement, enhanced healthcare accessibility, and community-level stewardship initiatives. The implications are critical, as irrational antibiotic use significantly contributes to the increasing burden of multidrug-resistant (MDR), extensively drug-resistant (XDR), and pan-drug-resistant (PDR) infections, posing a major risk to global health security [2,15].

To mitigate the escalating threat of AMR, there is an urgent need to implement multifaceted strategic interventions, including stricter control of antibiotic sales, widespread AMR awareness campaigns, integration of rational antibiotic use education into academic curricula, and strengthened healthcare systems to reduce reliance on self-medication. Failure to act promptly may result in AMR-related mortality reaching 10 million deaths annually by 2050, surpassing cancer-related deaths [2]. Therefore, global collaboration between policymakers, healthcare providers, public health specialists, and educational institutions is essential to promote rational antibiotic use and safeguard future generations from the irreversible consequences of antimicrobial resistance.

REFERENCES

1. World Health Organization. Global action plan on antimicrobial resistance. Geneva: WHO; 2015.
2. O'Neill J. Tackling drug-resistant infections globally: Final report and recommendations. Review on Antimicrobial Resistance. UK; 2016.
3. Murray CJL, Ikuta KS, Sharara F, Swetschinski L, Robles Aguilar G, Gray A et al. Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. *Lancet*. 2022;399(10325):629–55.
4. World Health Organization. Antimicrobial Resistance – Fact Sheet. WHO; 2023.
5. Llor C, Bjerrum L. Antibiotic prescribing for acute respiratory tract infections in primary care. *BMJ*. 2014;349:g6123.
6. Grigoryan L, Burgerhof JG, Degener JE, et al. Self-medication with antimicrobial drugs in Europe. *Emerg Infect Dis*. 2006;12(3):452–9.
7. Auta A, Hadi MA, Oga E, et al. Global access to antibiotics without prescription in community pharmacies: A systematic review. *Antimicrob Resist Infect Control*. 2019;8:66.
8. Gashaw T, Yadeta TA, Weldegebreal F, Jambo A, Assefa N. Global prevalence of antibiotic self-medication among adults: Systematic review and meta-analysis. *Systematic Reviews*. 2025;14:49.
9. Doan DA, Nguyen PT, Hoang HQ, et al. Prevalence of antibacterial self-medication in developing countries: A meta-analysis. *BMC Public Health*. 2025;25:112.
10. Auta A, Banwat SB, David S, et al. Prevalence of non-prescription antibiotic use in low- and middle-income countries. *J Public Health Africa*. 2024;15(2):e1234.
11. Auta A, Banwat S, Dayom W, Dika H. Knowledge of antibiotic use and resistance among the public: A global analysis. *Clin Microbiol Infect*. 2025;31(4):455–62.
12. Limwado GD, Phiri C, Nkhata M. Antibiotic resistance awareness and misuse among rural populations in Malawi. *Int J Infect Dis*. 2024;126:67–74.
13. Bu-Khamsin AY, Omar AAA, Al Matroudi S. Association between awareness regarding antibiotic resistance and self-medication practices among students. *Open Public Health Journal*. 2021;14:545–52.
14. Mendoza AMB, Salas DA, Rodriguez M. Determinants of antibiotic self-medication and AMR risk: A global perspective. *J Public Health Epidemiol*. 2025;13(2):10217.
15. Prestinaci F, Pezzotti P, Pantosti A. Antimicrobial resistance: A global multifaceted phenomenon. *Pathog Glob Health*. 2015;109(7):309–18.