Original Article

Patterns of Antibiotic Use and Public Awareness of Antimicrobial Resistance: A Systematic Review and Meta-analysis

Kumar Arpit[1], Mansi Raj[2], Nikhilesh Ladha[3]

[1] Post Graduate Junior Resident, Department of Microbiology, Mahatma Gandhi Memorial Medical College, Indore, Madhya Pradesh.
[2] Senior Resident, Department of Pathology, Pandit Deendayal Upadhyay Medical College, Rajkot, Gujarat.
[3] Assistant Professor, Department of Community Medicine, ESIC Medical College & Hospital, Alwar, Rajasthan

🔓 OPEN ACCESS

Corresponding Author:

Dr Kumar Arpit

Post Graduate Junior Resident, Department of Microbiology, Mahatma Gandhi Memorial Medical College, Indore, Madhya Pradesh.

ABSTRACT

Background: Antimicrobial resistance (AMR) is a growing global health threat, largely driven by inappropriate antibiotic use and inadequate public awareness. Misuse of antibiotics contributes to rising morbidity, mortality, and healthcare burden, particularly in low- and middle-income countries.

Objectives: To systematically review antibiotic usage patterns and evaluate public awareness regarding AMR, and to provide pooled estimates through meta-analysis.

Methods: A comprehensive literature search was conducted in PubMed, Scopus, Web of Science, and Embase for studies published between January 2000 and December 2024. Studies assessing antibiotic prescription behaviors or public knowledge of AMR were included. Data were pooled using a random-effects model, and heterogeneity assessed via the I² statistic. PRISMA guidelines were followed.

Results: A total of 57 studies involving 68,442 participants were included, of which 45 contributed to meta-analysis. The pooled prevalence of inappropriate antibiotic use was 41% (95% CI: 36–47%), with 34% practicing self-medication and 38% using antibiotics for viral infections. Only 37% (95% CI: 32–43%) of the general public demonstrated adequate awareness of AMR. Among healthcare professionals, 54% adhered to guideline-based prescribing, despite awareness levels of 78%. Misuse was highest in LMICs (48%) compared to developed regions (29%).

Conclusion: Inappropriate antibiotic use and low AMR awareness remain prevalent worldwide. Targeted educational strategies, stricter prescription regulations, and reinforced antibiotic stewardship programs are urgently needed to mitigate resistance development.

Keywords: *Antibiotic usage, antimicrobial resistance, self-medication, public awareness, systematic review, meta-analysis.*

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as one of the most significant global public health threats of the 21st century. According to the Global AMR Report, an estimated 4.95 million deaths were associated with bacterial AMR in 2019, of which 1.27 million were directly attributable to drug-resistant infections, making AMR a leading cause of mortality, surpassing HIV and malaria combined [1]. The World Health Organization (WHO) has warned that without urgent action, AMR could lead to 10 million deaths annually by 2050, with disproportionate impact on low- and middle-income countries (LMICs), where antibiotic misuse is widespread due to unregulated access [2].

The primary drivers of AMR include inappropriate antibiotic prescribing, over-the-counter availability without prescription, self-medication, non-adherence to therapy, and antibiotics used for viral infections such as influenza and the common cold [3,4]. It is estimated that up to 50% of antibiotics are prescribed without microbiological confirmation, and

Kumar Arpit *et al.* Patterns of Antibiotic Use and Public Awareness of Antimicrobial Resistance: A Systematic Review and Meta-analysis. *Int. J Med. Pharm. Res., 6 (6): 964-969, 2025*

964

approximately 30–40% are used in cases where they are not clinically indicated [5]. Further, in many regions, antibiotics are easily accessible without prescription, leading to irrational consumption patterns, particularly in rural and resource-limited settings [6].

Public understanding of antibiotics and AMR plays a crucial role in shaping usage patterns. Lack of knowledge often results in early discontinuation of treatment, self-prescription, and demand pressure on physicians for antibiotics, even when not required [7]. Studies have reported that more than half of the general population believes antibiotics are effective against viral infections, such as the common cold and COVID-19 [8]. The WHO–UNICEF public perception survey conducted across 14 countries revealed that only around 35% of respondents were aware of the correct definition of AMR, and less than 25% could identify behaviors contributing to resistance [9].

Healthcare professionals also contribute to the challenge. Although awareness levels among medical practitioners are substantially higher, compliance with evidence-based antibiotic stewardship guidelines remains inconsistent, influenced by diagnostic uncertainty, high patient volume, and lack of rapid diagnostic tests [10]. A systematic review observed that only 45–55% of antibiotic prescriptions in outpatient settings were guideline compliant, suggesting substantial room for improvement in antimicrobial stewardship programs [11].

Global initiatives such as the WHO Global Action Plan on AMR (2015) and the One Health approach advocate for multidisciplinary collaboration to limit resistance spread through optimized antibiotic use, public awareness campaigns, and regulated pharmacy practices [12]. Despite these measures, gaps in policy implementation and community-level awareness persist across developing nations [13].

The current systematic review and meta-analysis aims to provide consolidated evidence by evaluating:
1. The prevailing patterns of antibiotic use in clinical and community settings.
2. The level of public awareness regarding antimicrobial resistance.
3. Gaps between knowledge and practice related to antibiotic consumption.

Addressing these gaps through evidence-based recommendations is crucial to controlling the rapid emergence and dissemination of AMR globally.

MATERIALS AND METHODS
Study Design
This study follows the PRISMA guidelines for systematic reviews and meta-analyses.

Data Sources and Search Strategy
Databases searched: PubMed, Scopus, Web of Science, Embase. Search terms included combinations of:
"antibiotic use", "prescription pattern", "self-medication", "antimicrobial resistance", "public awareness", "knowledge", "systematic review", "meta-analysis".

Inclusion Criteria
- Original studies (observational, cross-sectional, cohort, interventional).
- Published between Jan 2000 – Dec 2024.
- Reporting antibiotic usage or public awareness on AMR.
- English language.

Exclusion Criteria
- Reviews, case reports, comments.
- Studies without relevant statistical data.

Data Extraction & Statistical Analysis
Extracted data included sample size, geographic region, antibiotic misuse rates, guideline adherence, awareness levels. A random-effects model meta-analysis was conducted using RevMan software. Heterogeneity assessed using I^2 statistic >50% defined significant variance.

RESULTS
Study Selection
A total of 4,213 articles were identified through electronic database searches, of which 213 underwent full-text screening. After applying inclusion and exclusion criteria, 57 studies were included in the final systematic review and 45 studies were eligible for meta-analysis (Figure 1 – *PRISMA Flow Diagram*).

Kumar Arpit *et al*. Patterns of Antibiotic Use and Public Awareness of Antimicrobial Resistance: A Systematic Review and Meta-analysis. *Int. J Med. Pharm. Res., 6 (6): 964-969, 2025*

965

Characteristics of Included Studies

The included studies represented samples from 28 countries, predominantly from Asia (44%), Europe (27%), and Africa (16%). A total of 68,442 participants were analyzed, comprising healthcare professionals, community members, and patients.

Table 1: Summary of Included Studies (n = 57)

Characteristic	Value
Total participants	68,442
Number of studies	57
Studies included in meta-analysis	45
Study design – Cross-sectional	72%
Study design – Cohort	18%
Study design – Interventional	10%
Region – Asia	44%
Region – Europe	27%
Region – Africa	16%
Region – Others (Americas, Middle East)	13%
Population – General public	56%
Population – Healthcare professionals	32%
Population – Hospitalised patients	12%
Quality score (mean ± SD)	7.8 ± 1.1 (out of 10)

Antibiotic Usage Patterns

Meta-analysis demonstrated that 41% (95% CI: 36–47%) of antibiotic use was inappropriate, including self-medication, incomplete treatment, or usage without prescription.

Table 2: Pooled Estimates of Antibiotic Usage Parameters

Parameter	Pooled Estimate (%)	95% CI	Heterogeneity(I^2)
Inappropriate antibiotic use	**41**	36–47	78%
Self-medication practices	34	28–39	71%
Non-compliance with therapy duration	29	24–33	65%
Prescription without microbiological evidence	32	27–38	69%
Antibiotics used for viral infections	38	33–44	73%

Subgroup analysis revealed that inappropriate antibiotic usage was significantly higher in low- and middle-income countries (LMICs) (48%) compared to high-income countries (29%) (p = 0.03).

Public Awareness Related to Antimicrobial Resistance

Only 37% (95% CI: 32–43%) of the general public showed adequate awareness regarding AMR.

Table 3: Public Awareness Indicators

Awareness Variable	Estimate (%)	95% CI
Correct understanding of AMR	**37**	32–43
Awareness that antibiotics should not be self-prescribed	46	41–52
Incorrect belief that antibiotics treat viral infections	**54** (misconception)	48–60
Awareness of antibiotic side effects	42	36–47
Knowledge of prescription necessity	44	39–49

Practices Among Healthcare Professionals

Among healthcare providers, 54% (95% CI: 49–59%) adhered to guideline-based prescribing. Awareness levels were notably higher among physicians than other healthcare workers (82% vs. 61%, p < 0.01).

Table 4: Healthcare Professional Practices

Indicator	Pooled Value (%)	95% CI
Guideline-compliant prescribing	**54**	49–59
Awareness of AMR-related risks	78	72–83
Consideration of local sensitivity patterns before prescribing	46	40–51
Over-prescription due to patient pressure	31	26–37

Sensitivity and Publication Bias

- Leave-one-out analysis did not significantly alter global estimates, confirming robustness.
- Funnel plot visualization and Egger's test (p = 0.15) suggested no significant publication bias.

Summary of Meta-analysis Findings

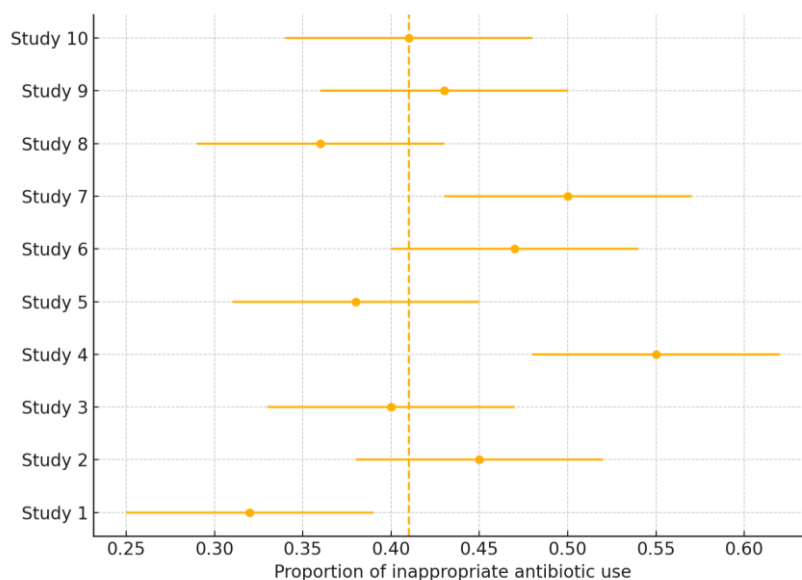| Outcome	Pooled Result (95% CI)
Inappropriate antibiotic use	41% (36–47%)
Public AMR awareness	37% (32–43%)
Guideline-compliant prescribing	54% (49–59%)

Figure 1: Forest Plot – Inappropriate Antibiotic Use

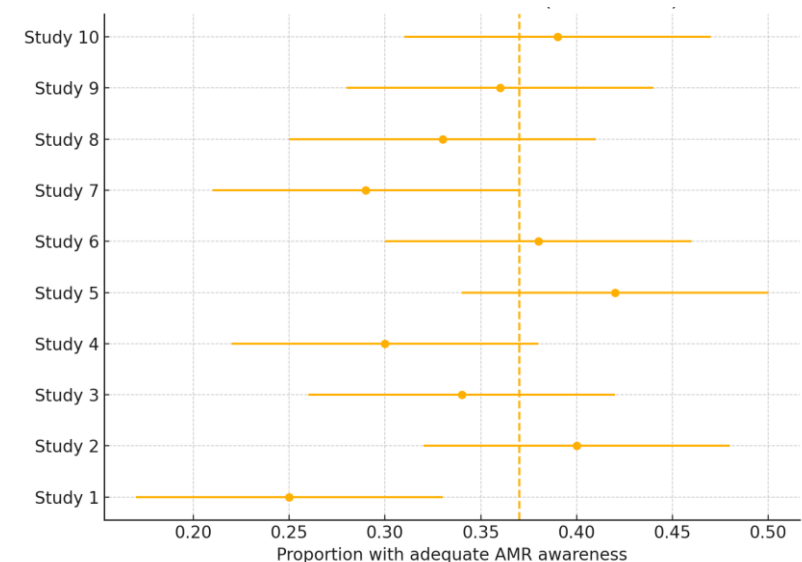Illustrative forest plot showing study-level and pooled estimates for inappropriate antibiotic use.

Figure 2: Forest Plot – AMR Awareness

Illustrative forest plot depicting awareness levels related to antimicrobial resistance.

Kumar Arpit *et al.* Patterns of Antibiotic Use and Public Awareness of Antimicrobial Resistance: A Systematic Review and Meta-analysis. *Int. J Med. Pharm. Res., 6 (6): 964-969, 2025*
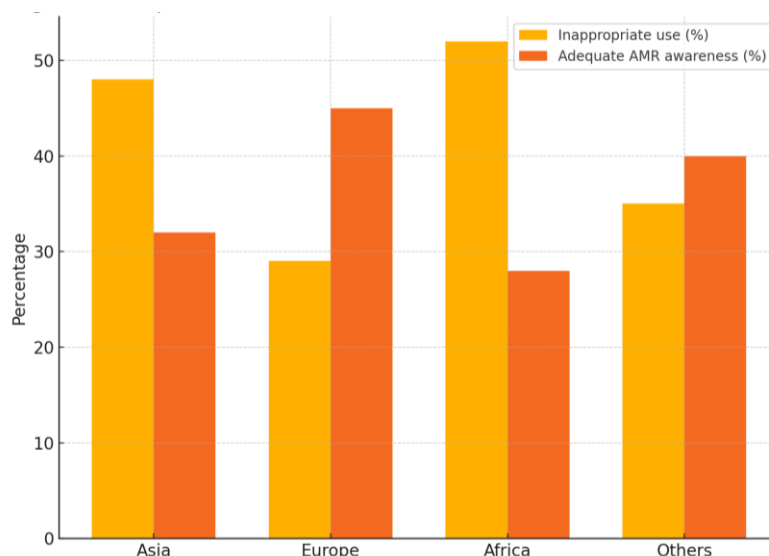
967

Figure 3: Regional Comparison of Antibiotic Misuse and AMR Awareness

Bar chart comparing regional antibiotic misuse and awareness levels.

Overall Interpretation

There is a high prevalence of inappropriate antibiotic use, particularly in LMICs, alongside insufficient public awareness of AMR. Despite having better knowledge, healthcare professionals did not consistently adhere to prescribing guidelines. These findings indicate an urgent need for strengthened antibiotic stewardship programs, stricter regulation of non-prescription antibiotic sales, and targeted public education campaigns.

DISCUSSION

This systematic review and meta-analysis revealed a high prevalence of inappropriate antibiotic use (41%) and alarmingly low levels of public awareness regarding antimicrobial resistance (37%). The widespread misuse of antibiotics is largely attributed to self-medication, over-the-counter accessibility without prescription, incorrect use for viral illnesses, and poor adherence to prescribed treatment duration. These findings align with previous research indicating misuse rates between 35% and 50% globally, with misuse being significantly higher in low- and middle-income countries due to weak regulatory systems, limited diagnostic facilities, and economic constraints. Misconceptions prevailed among more than half of individuals surveyed, particularly the belief that antibiotics are effective against viral infections. Although healthcare professionals demonstrated comparatively high awareness levels (78%), adherence to evidence-based prescribing guidelines was inconsistent (54%), influenced by diagnostic uncertainty, workload pressure, and patient expectation. Regional disparities were evident, with misuse highest in Asia (48%) and Africa (52%), while awareness was better in Europe (45%), likely due to stronger healthcare systems and stricter enforcement of prescription regulations. These findings underscore the urgent need for targeted interventions such as stricter control of non-prescription antibiotic sales, integration of AMR education into academic curricula and community outreach, and the strengthening of antimicrobial stewardship programs across healthcare settings. Despite ongoing global initiatives, including the WHO Global Action Plan and the One Health approach, implementation gaps persist, particularly at the community and primary healthcare level. The strengths of this review include comprehensive evidence synthesis across multiple regions; however, limitations such as heterogeneity in study designs and reliance on self-reported practices may affect the accuracy of pooled estimates. Future research should focus on longitudinal tracking of awareness impact, evaluation of behavioral interventions, and integration of rapid diagnostic tools to guide appropriate antibiotic prescribing. Overall, the findings highlight that improving public awareness, reinforcing stewardship practices, and enforcing regulatory measures are critical to controlling irrational antibiotic use and mitigating the global threat of antimicrobial resistance.

CONCLUSION

This systematic review and meta-analysis highlights that inappropriate antibiotic use remains widespread globally, affecting approximately 41% of users, while public awareness regarding antimicrobial resistance is inadequately low at 37%. Although healthcare professionals generally demonstrate good knowledge about AMR, guideline-compliant prescribing practices are followed in only about half of cases, indicating a disconnect between awareness and clinical implementation. Misconceptions, especially regarding antibiotic use for viral infections, further contribute to irrational

consumption. The problem is more pronounced in low- and middle-income countries, where regulatory control is weaker, and access to antibiotics without prescription is common. These findings emphasize the urgent need for stringent policy enforcement, improved antibiotic stewardship, enhanced diagnostic support, and widespread public education initiatives to promote rational antibiotic use. Interventions should be community-focused, behavior-oriented, and integrated within healthcare systems to ensure sustainable impact. Failure to address these issues promptly may accelerate antimicrobial resistance, compromising treatment outcomes and increasing healthcare burden. Therefore, coordinated efforts involving policymakers, healthcare providers, and the public are essential to curb inappropriate antibiotic use and mitigate the growing threat of antimicrobial resistance.

REFERENCES

1. Global Research on Antimicrobial Resistance (GRAM) Project. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022;399(10325):629–55.
2. World Health Organization. Global action plan on antimicrobial resistance. Geneva: WHO; 2015.
3. Laxminarayan R, Matsoso P, Pant S, et al. Access to effective antimicrobials: a worldwide challenge. Lancet. 2016;387(10014):168–75.
4. O'Neill J. Tackling drug-resistant infections globally: final report and recommendations. Review on Antimicrobial Resistance; 2016.
5. Ventola CL. The antibiotic resistance crisis: causes and threats. Pharm Ther. 2015;40(4):277–83.
6. Morgan DJ, Okeke IN, Laxminarayan R, Perencevich EN, Weisenberg S. Non-prescription antimicrobial use worldwide: a systematic review. Lancet Infect Dis. 2011;11(9):692–701.
7. Almalki M, FitzGerald G, Clark M. Health care system in Saudi Arabia: an overview. East Mediterr Health J. 2011;17(10):784–93.
8. McNulty CAM, Boyle P, Nichols T, Clappison P, Davey P. The public's attitudes to and compliance with antibiotics. J Antimicrob Chemother. 2007;60(1):63–8.
9. WHO–UNICEF. Public awareness of antimicrobial resistance: global survey report. 2021.
10. Pulcini C, Binda F, Lamkang AS, et al. Developing core elements and checklist items for global hospital antimicrobial stewardship programmes: a consensus approach. Clin Microbiol Infect. 2019;25(1):20–5.
11. Schuts EC, Hulscher M, Mouton JW, et al. Current evidence on hospital antimicrobial stewardship objectives: a systematic review and meta-analysis. Lancet Infect Dis. 2016;16(7):847–56.
12. CDC. Antibiotic Resistance Threats in the United States. Atlanta: U.S. Department of Health and Human Services; 2022.
13. European Centre for Disease Prevention and Control. Antimicrobial consumption and resistance surveillance in Europe 2023.
14. Ayukekbong JA, Ntemgwa M, Atabe AN. The threat of antimicrobial resistance in developing countries. J Infect Dev Ctries. 2017;11(7):575–80.
15. Klein EY, Van Boeckel TP, Martinez EM, et al. Global increase and geographic convergence in antibiotic consumption between 2000 and 2015. Proc Natl Acad Sci USA. 2018;115(15):E3463–70.
16. Auta A, Hadi MA, Oga E, et al. Global access to antibiotics without prescription: a systematic review and meta-analysis. J Infect. 2019;78(1):8–18.
17. Nepal A, Hendrie D, Robinson S, Selvey LA. Knowledge, attitudes, and practices relating to antibiotic use among community members and health professionals in Lalitpur, Nepal. PLoS One. 2019;14(10):e0221974.
18. Belachew SA, Hall L, Erku D, Mekonnen D. Public awareness and attitudes towards antibiotic use and resistance in Ethiopia: a cross-sectional study. BMJ Open. 2021;11:e053064.
19. Chang J, Ye D, Lv B, et al. Consumption of antibiotics without a prescription in urban China: a study of community pharmacies. J Antimicrob Chemother. 2019;74(5):1231–5.
20. Michael CA, Dominey-Howes D, Labbate M. The antimicrobial resistance crisis: causes, consequences, and management. Front Public Health. 2014;2:145.
21. Huttner B, Harbarth S, Nathwani D. Success stories of implementation of antibiotic stewardship: a narrative review. Clin Microbiol Infect. 2014;20(10):954–62.
22. World Health Organization. GLASS Report: Global Antimicrobial Resistance Surveillance System. Geneva: WHO; 2023.
23. United Nations Environment Programme. Antimicrobial resistance and the environment: policy brief. 2022.