

Determinants of Antibiotic Misuse and Barriers to Antimicrobial Stewardship Implementation in Indonesia: A Scoping Review

*Jema Kiazolu

Department of Public Health, Hasanuddin University, Makassar, Indonesia

*Corresponding Author

DOI: <https://doi.org/10.47772/IJRISS.2026.100500426>

Received: 06 May 2026; Accepted: 11 May 2026; Published: 03 June 2026

ABSTRACT

Antibiotic misuse and suboptimal implementation of Antimicrobial Stewardship Programs (ASPs) represent major drivers of antimicrobial resistance (AMR) in Indonesia. This scoping review systematically maps the determinants of antibiotic misuse and the barriers to ASP implementation across Indonesian healthcare settings. A structured literature search was conducted across PubMed, Scopus, and Google Scholar, supplemented by grey literature, covering publications from 2008 to 2024. Eligible studies addressed antibiotic prescribing, dispensing, self-medication practices, or stewardship program implementation within the Indonesian context. Evidence was synthesized thematically and organized according to a socio-ecological framework encompassing individual, prescriber, institutional, and systemic levels. Findings indicate that antibiotic misuse is driven by multifactorial determinants, including insufficient public health literacy, high rates of self-medication, unrestricted over-the-counter antibiotic availability, and prescriber-related factors such as diagnostic uncertainty and perceived patient demand. At the institutional level, key barriers to ASP implementation include inadequate microbiological infrastructure, limited interdisciplinary collaboration, a shortage of dedicated stewardship personnel, and weak enforcement of existing policies. Systemic barriers include fragmented governance structures, insufficient regulatory oversight, funding constraints, and persistent gaps between national AMR policy frameworks and local practice. Although national stewardship frameworks and regulatory instruments are in place, their operationalization remains inconsistent across hospital tiers and primary care settings. To advance ASP implementation in Indonesia, strategies must incorporate health workforce development, investment in diagnostic infrastructure, strengthened multisectoral governance, digital health integration, task-shifting models, community-based stewardship approaches, and culturally and socioeconomically appropriate community engagement. This review provides a comprehensive evidence base to support policy formulation and programmatic interventions aimed at reducing the AMR burden across Indonesia, including underserved rural and eastern regions.

Keywords: Antimicrobial Stewardship, Antibiotic Misuse, Antimicrobial Resistance, Indonesia, Scoping Review, Healthcare Policy

INTRODUCTION

Antimicrobial resistance (AMR) has become one of the most consequential public health challenges of the twenty-first century, progressively eroding the therapeutic efficacy of antibiotics that remain foundational to modern medical practice. The World Health Organization (WHO) has designated AMR as a global health priority, with projections warning that, in the absence of coordinated intervention, drug-resistant infections could contribute to up to ten million deaths annually by 2050 (WHO, 2023). Low- and middle-income countries (LMICs), and particularly those situated in South-East Asia, bear a disproportionate share of this burden. This asymmetry is attributable to a confluence of structurally weak health systems, deficient AMR surveillance capacity, and entrenched patterns of antibiotic misuse across both community and institutional settings.

Indonesia occupies a strategically critical position within the regional AMR landscape. As the world's fourth most populous nation and the largest economy in South-East Asia, the country encompasses approximately 270

million people distributed across a geographically complex archipelago of over 17,000 islands. This distribution presents formidable challenges for health system governance, supply chain integrity, and the equitable delivery of quality healthcare. Antibiotic use in Indonesia has historically been characterized by inadequate regulation, with a substantial body of evidence documenting high rates of inappropriate prescribing, widespread unrestricted over-the-counter (OTC) antibiotic availability, and culturally embedded self-medication practices (Hadi et al., 2008; Widayati et al., 2011; Siahaan et al., 2023). These dynamics are compounded by substantial variability in healthcare quality between urban and rural settings and a fragmented pharmaceutical supply chain that facilitates the unregulated distribution of antibiotics.

Antimicrobial Stewardship Programs (ASPs) constitute a cornerstone evidence-based strategy for rationalizing antibiotic use, improving patient outcomes, and retarding the emergence and dissemination of resistance. The Centers for Disease Control and Prevention (CDC) and the WHO have developed structured frameworks and core elements for ASP implementation applicable across diverse healthcare environments (CDC, 2019; WHO, 2023). Indonesia's Ministry of Health formally mandated the establishment of ASPs in accredited hospitals through national health regulations; however, implementation has remained inconsistent and substantially below the standards necessary for meaningful public health impact (Ministry of Health Republic of Indonesia, 2021; Sinto et al., 2024).

The extant literature identifies a broad and heterogeneous array of barriers impeding ASP uptake across Indonesian hospitals and primary care settings, encompassing infrastructural and human resource deficits, governance failures, and knowledge gaps among healthcare providers. Notwithstanding, a comprehensive and synthesized account of both the upstream determinants of antibiotic misuse and the multi-level barriers to stewardship implementation—spanning individual, institutional, and systemic dimensions—has yet to be assembled within a unified scoping review framework. Such a synthesis is indispensable to guide the development of contextually appropriate, evidence-informed interventions that reflect Indonesia's unique epidemiological, socioeconomic, and health system realities.

This scoping review therefore aims to systematically map the existing evidence on the determinants of antibiotic misuse and the barriers to ASP implementation across Indonesian healthcare settings. By integrating findings across the full socio-ecological spectrum of determinants, this review seeks to provide a comprehensive, policy-relevant evidence base for policymakers, healthcare administrators, clinicians, and researchers engaged in designing and scaling effective stewardship strategies commensurate with the Indonesian health system context.

Objectives

The objectives of this scoping review are to: (1) systematically identify and characterize the determinants of antibiotic misuse across community, primary care, and hospital settings in Indonesia; (2) map institutional, human resource, and systemic barriers to the implementation of Antimicrobial Stewardship Programs in Indonesian healthcare settings; and (3) synthesize the available evidence to identify critical research and practice gaps and inform actionable recommendations for strengthening ASP implementation and antibiotic governance in Indonesia.

METHODOLOGY

Study Design

This investigation employed a scoping review methodology guided by the Arksey and O'Malley (2005) framework, as subsequently refined by Levac, Colquhoun, and O'Brien (2010), and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). Scoping review methodology was selected as the most appropriate study design given the breadth and heterogeneity of the available evidence base and the overarching objective of comprehensively mapping the landscape of knowledge pertaining to antibiotic misuse and ASP barriers, rather than quantifying specific effect sizes.

Eligibility Criteria

Studies were eligible for inclusion if they: (a) examined antibiotic use practices, prescribing behaviors, dispensing patterns, or self-medication within Indonesia; (b) evaluated or reported on ASP implementation, barriers to stewardship, or healthcare provider knowledge, attitudes, or practices related to antimicrobial stewardship in Indonesia; (c) were published in English or Indonesian; and (d) were published between January 2008 and December 2024. Studies were excluded if they did not pertain to Indonesia, lacked identifiable primary data or methodological descriptions, or focused exclusively on veterinary or agricultural antibiotic use without direct human health implications.

Search Strategy

A systematic electronic search was conducted across PubMed/MEDLINE, Scopus, and Google Scholar. Supplementary sources encompassed grey literature repositories, Indonesian Ministry of Health publications, and World Health Organization regional reports. Search terms combined Medical Subject Headings (MeSH) and free-text keywords, including: 'antimicrobial stewardship', 'antibiotic stewardship', 'antibiotic resistance', 'antibiotic misuse', 'antibiotic prescribing', 'self-medication antibiotics', 'antimicrobial resistance', 'Indonesia', 'barriers', 'facilitators', and 'implementation'. Boolean operators (AND, OR) were systematically applied to optimize search sensitivity and specificity.

Study Selection

All retrieved records were imported into reference management software and de-duplicated prior to screening. Two independent reviewers screened titles and abstracts against the pre-specified eligibility criteria, followed by full-text review of potentially eligible studies. Discordant decisions were resolved through iterative discussion and consensus, with recourse to a third reviewer where resolution was not achieved bilaterally.

Table 1: PRISMA-ScR Study Selection Summary

Phase	Step	Records (n)
Identification	Records identified from databases (PubMed, Scopus, Google Scholar)	1,240
	Records from additional sources (grey literature, reference lists)	68
Screening	Duplicates removed	321
	Records screened (titles and abstracts)	987
	Records excluded (irrelevant to Indonesia or antibiotic use)	712
Eligibility	Full-text reports assessed for eligibility	275
	Full-text reports excluded (wrong setting, no primary data, not peer-reviewed)	233
Included	Studies included in final synthesis	42 (Qualitative: 14; Quantitative: 19; Mixed methods: 6; Reviews: 3)

Note: A full PRISMA-ScR flow diagram is available from the corresponding author upon request.

Data Extraction and Synthesis

Data were extracted using a standardized form capturing study design, setting, population characteristics, and key findings pertaining to antibiotic misuse determinants and barriers to ASP implementation. Extracted findings

were synthesized thematically and organized according to a socio-ecological framework distinguishing individual/patient-level, prescriber-level, dispensing/retail-level, institutional-level, and policy/systemic-level determinants and barriers.

Consistent with established scoping review methodology, formal critical appraisal of individual study quality was not performed, as the primary objective was to map the breadth and nature of available evidence rather than to evaluate methodological quality or certainty of effect. Nevertheless, in response to reviewer recommendations, a commentary on the overall confidence in the synthesized evidence, organized by study design, is provided in Table 4 of the Results section. Findings should therefore be interpreted as a synthesis of observed evidence patterns rather than a formal assessment of evidentiary strength.

RESULTS

Overview of Included Studies

A total of 42 studies satisfied the eligibility criteria and were incorporated into the final synthesis. The corpus comprised 14 qualitative studies, 19 quantitative studies (encompassing surveys, cross-sectional analyses, and point prevalence studies), six mixed-methods studies, and three systematic or scoping reviews. Studies were conducted across hospital settings ($n=26$), community and primary care settings ($n=11$), and mixed or multi-setting designs ($n=5$).

Geographically, the majority of studies were conducted in Java—particularly Jakarta, Yogyakarta, and Surabaya—reflecting the concentration of research capacity and health infrastructure in these urban centres. Studies conducted in Outer Islands, including Kalimantan, Sulawesi, and Papua, were markedly underrepresented, constituting a critical evidence gap with implications for the generalizability of findings to rural, remote, and resource-limited healthcare contexts. This geographic skew was recognized as a limitation and is discussed further in Section V.

Determinants of Antibiotic Misuse in Indonesia

The determinants of antibiotic misuse identified across the included literature operated at multiple, interconnected levels of the healthcare system and broader society.

At the individual and community level, deficient antibiotic literacy and entrenched self-medication practices were major contributors to antibiotic misuse across Indonesia. Evidence indicated that many community members held erroneous beliefs regarding antibiotic utility for viral infections, fever, and other non-bacterial conditions (Widayati et al., 2012). Self-medication was prevalent in urban and peri-urban settings, facilitated by the ready availability of antibiotics from community pharmacies, drug stores, and informal vendors without requirement for a prescription (Widayati et al., 2011; Siahaan et al., 2023).

At the prescriber level, diagnostic uncertainty under resource-limited conditions was a significant driver of empirical antibiotic overuse, particularly in settings with constrained laboratory capacity or protracted diagnostic turnaround times (Muliawan et al., 2021). Clinicians frequently initiated antibiotic therapy in response to concerns about treatment failure and patient expectations. Notably, documented recognition of AMR as an important public health issue did not consistently translate into rational prescribing behavior, indicating a substantive gap between professional knowledge and clinical practice (Setiawan et al., 2022).

At the dispensing and retail level, OTC antibiotic sales persisted as a major structural driver of misuse. Despite regulatory restrictions on antibiotic dispensing without a prescription, enforcement remained consistently weak across many regions. Antibiotics were widely accessible through community pharmacies (apotek), registered drug stores (toko obat), and informal market vendors across multiple Indonesian cities (Puspitasari et al., 2011; Widayati et al., 2011; Hadi et al., 2010). Concerns regarding subtherapeutic dosing, counterfeit pharmaceutical products, and antibiotic quality further amplified the AMR risk associated with unregulated retail distribution.

Table 2: Summary of Determinants of Antibiotic Misuse in Indonesia

Level	Key Determinants	Key Sources
Individual / Patient Level	Insufficient antibiotic health literacy; misconceptions about efficacy for viral infections; cultural norms favouring antibiotic use; pervasive self-medication behavior	Widayati et al. (2011, 2012); Siahaan et al. (2023); Ramdas et al. (2025)
Prescriber Level	Diagnostic uncertainty under resource-limited conditions; clinical risk aversion and fear of treatment failure; patient pressure for antibiotic prescriptions; inadequate stewardship training	Muliawan et al. (2021); Setiawan et al. (2022); Herawati et al. (2021)
Dispensing / Retail Level	Unrestricted over-the-counter antibiotic sales; weak regulatory enforcement at point-of-sale; pharmacist knowledge and practice gaps	Puspitasari et al. (2011); Widayati et al. (2011); Hadi et al. (2010)
Institutional Level	Inadequate microbiology laboratory capacity; absence of functional ASP teams; poor infection prevention integration; severe resource constraints	Sinto et al. (2024); Herawati et al. (2020)
Policy / Systemic Level	Regulatory gaps and enforcement deficits; fragmented health governance; limited AMR surveillance infrastructure; chronically underfunded primary care systems	Ministry of Health RI (2021); Limato et al. (2022); WHO (2023)

Barriers to Antimicrobial Stewardship Implementation

Barriers to ASP implementation were identified at institutional and systemic levels, with notable differences in the nature and severity of barriers across primary care and tertiary hospital settings.

In primary care and community health facilities (Puskesmas), stewardship challenges were predominantly associated with the near-total absence of microbiological diagnostic services, acute workforce shortages, limited pharmacist integration into prescribing oversight, and persistent OTC antibiotic dispensing practices that undermined prescribing discipline. These settings also faced particular challenges related to insufficient stewardship training and the absence of facility-level ASP infrastructure mandated under national guidelines.

In contrast, tertiary and referral hospitals more commonly encountered barriers related to interdisciplinary coordination failures, inconsistent adherence to stewardship protocols despite established ASP committees, diagnostic stewardship complexities associated with high-acuity patient populations, and the resource-intensive nature of implementing comprehensive stewardship requirements. The heterogeneity of barrier profiles across healthcare tiers underscores the necessity of tailoring stewardship implementation frameworks to the specific operational and resource contexts of different facility types.

At the institutional level, inadequate microbiology laboratory capacity was among the most consistently reported barriers. Many Indonesian hospitals—particularly at district and lower levels—lacked the functional infrastructure necessary for routine culture and antimicrobial susceptibility testing (Murni et al., 2015; Sinto et al., 2024). This diagnostic deficit compelled clinicians to rely on empirical antibiotic regimens, undermining the targeted prescribing that underpins effective stewardship (Sinto et al., 2024).

Human resource limitations constituted an equally significant institutional constraint. Widespread shortages of infectious disease specialists and clinical pharmacists with stewardship competencies impaired hospitals' capacity to establish the multidisciplinary ASP teams required under national policy (Herawati et al., 2020; Lutfiyati et al., 2022). Heterogeneity in stewardship knowledge among healthcare professionals and resistance to behavior change further complicated implementation efforts (Herawati et al., 2021; Wardhani et al., 2020).

At the systemic and policy level, fragmented governance represented a pervasive and deeply structural barrier. Although the Ministry of Health introduced formal requirements for ASP implementation in accredited hospitals,

enforcement mechanisms, dedicated financing streams, and sustained technical support remained inadequate (Ministry of Health Republic of Indonesia, 2021; Limato et al., 2022). Competing institutional priorities, fee-for-service healthcare financing incentives that may inadvertently encourage antibiotic use, and the absence of a nationally coordinated AMR surveillance system further limited the evidence base for policy refinement and programmatic monitoring.

Table 3: Barriers to Antimicrobial Stewardship Program Implementation in Indonesia

Barrier Category	Specific Barriers	Supporting Evidence
Leadership & Governance	Non-functional or absent ASP committees; insufficient hospital leadership commitment; unclear stewardship role delineation	Limato et al. (2022); Sinto et al. (2024);
Human Resources	Critical shortage of clinical pharmacists and infectious disease specialists; inadequate multidisciplinary stewardship teams	Herawati et al. (2020); Lutfiyati et al. (2022); Restika et al. (2024)
Diagnostic Capacity	Absence of functioning microbiology laboratories; prolonged culture turnaround times; limited antimicrobial susceptibility testing	Murni et al. (2015); Sinto et al. (2024); WHO (2023)
Knowledge & Attitudes	Low ASP awareness among clinicians; resistance to protocol adherence; stewardship perceived as an administrative burden	Herawati et al. (2021); Wardhani et al. (2020); Muliawan et al. (2021)
Financial Constraints	Chronically underfunded stewardship programs; high diagnostic costs; limited government budgetary allocation for AMR control	Limato et al. (2022); Kakkar et al. (2020); Ministry of Health RI (2021)
Regulatory & Policy	Inconsistent enforcement of prescription regulations; misalignment between national guidelines and local implementation; policy-to-practice translation gaps	Hadi et al. (2008); Sinto et al. (2024); Wang et al. (2025)

Commentary on Evidence Quality

Given the heterogeneous study designs included in this scoping review, a narrative assessment of evidence confidence by study type is presented below. This commentary is offered to enhance interpretive transparency while remaining methodologically consistent with the non-appraisal conventions of scoping review methodology.

Table 4: Evidence Quality Commentary by Study Design

Study Design	No. of Studies	Confidence Level*	Notes on Evidence Quality
Quantitative (surveys, cross-sectional)	19	Moderate	Findings are largely consistent across settings, though most originate from Java-based urban hospitals, limiting geographic generalizability
Qualitative	14	Moderate-High	Rich contextual detail on barriers and attitudes; risk of researcher subjectivity in thematic interpretation

Mixed Methods	6	Moderate	Provide convergent validation across qualitative and quantitative data but vary in methodological transparency
Systematic / Scoping Reviews	3	High (synthesized)	Corroborate primary study findings and strengthen overall evidence coherence

*Confidence level assessed informally based on study design hierarchy and consistency of findings across studies; formal quality appraisal was not conducted in accordance with scoping review methodology.

DISCUSSION

This scoping review demonstrates that antibiotic misuse and barriers to antimicrobial stewardship implementation in Indonesia are driven by deeply interconnected individual, institutional, and systemic factors that operate across the full socio-ecological spectrum of healthcare delivery. The findings reveal how structurally weak regulatory enforcement, pervasive self-medication, limited diagnostic capacity, and insufficient stewardship infrastructure collectively sustain inappropriate antibiotic use across Indonesian healthcare settings. These challenges are broadly consistent with AMR dynamics observed across many LMICs, where health system fragility and inadequate stewardship capacity continue to obstruct effective antibiotic governance (Harun et al., 2024; Rajendran et al., 2025).

The prevalence of self-medication and unrestricted OTC antibiotic availability in Indonesia reflects a structural failure in pharmaceutical regulation that cannot be adequately redressed through health education campaigns alone. Effective regulatory reform requires sustained political commitment, meaningful investment in pharmacy inspection and enforcement capacity, and the deliberate engagement of the pharmaceutical retail sector as a stewardship partner rather than a peripheral actor. Community-based interventions leveraging trusted community health workers (kader) and Islamic faith-based health networks—both deeply embedded in Indonesian social architecture—may offer culturally resonant and scalable channels for improving public antibiotic literacy (Ramdas et al., 2025).

At the prescriber level, the documented disconnect between AMR awareness and rational prescribing behavior underscores the inadequacy of purely informational approaches to behavior change. Effective interventions must engage the attitudinal, contextual, and systemic drivers of antibiotic overuse. Structured audit and feedback mechanisms, academic detailing, and clinical decision support tools adapted to Indonesia's digital health infrastructure represent high-potential approaches, provided they are implemented with sustained attention to workflow integration and clinician ownership (Jeffs et al., 2020; Chukwu et al., 2024).

Emerging digital health strategies offer additional and underexplored opportunities to strengthen ASP implementation in Indonesia, particularly in resource-constrained settings where specialist expertise is limited. Electronic prescribing systems with embedded stewardship alerts, mobile clinical decision-support platforms, and telemedicine-based stewardship consultation models can substantially improve prescribing oversight and guideline adherence even in facilities without on-site infectious disease specialists. Complementary task-shifting approaches—systematically delegating defined stewardship functions to pharmacists, nurses, and community health workers—may further extend ASP reach into primary care settings and support community-level engagement in responsible antibiotic use. These modalities represent particularly pertinent avenues for eastern Indonesia and rural settings where specialist human resources remain critically scarce.

The institutional barriers identified in this review—particularly the deficits in laboratory infrastructure and trained stewardship personnel—underscore the need for a more flexible and tiered national ASP implementation framework. Rather than applying uniform accreditation requirements across all facility types, stewardship standards should be explicitly calibrated according to hospital level, resource availability, and local healthcare delivery capacity. Accelerated investment in point-of-care diagnostics and rapid antimicrobial susceptibility testing technologies represents a high-impact intervention to strengthen stewardship practices in resource-limited settings (Zakhour et al., 2023; Khanal et al., 2023).

The systemic barriers documented in this review—governance fragmentation, insufficient financing, and weak regulatory enforcement—necessitate a whole-of-government and multisectoral response that positions AMR within Indonesia's national health security agenda. Specifically, stewardship financing should be strategically aligned with ongoing national health insurance (JKN) reform to ensure that financial incentives within the healthcare system support, rather than undermine, rational antibiotic prescribing. Comparative policy experiences from China's mandatory stewardship program (Wang et al., 2025) and hospital-based ASP pilots in sub-Saharan Africa (Kapatsa et al., 2025) provide instructive international lessons, though these require careful adaptation to Indonesia's federated health system architecture and socio-political context.

This review identifies important and actionable evidence gaps that should guide future research investment. The marked underrepresentation of studies from eastern Indonesia and rural primary care settings constitutes a critical limitation of the existing evidence base and risks orienting stewardship policy responses disproportionately toward urban hospital environments that may not reflect the epidemiological and operational realities facing the majority of Indonesia's population. Future empirical research should prioritize community-based, mixed-methods studies from underrepresented geographic regions—particularly Kalimantan, Sulawesi, Maluku, Papua, and Nusa Tenggara—and from lower-tier healthcare settings including Puskesmas and private clinics.

This review is subject to certain limitations. The geographic concentration of included studies in urban Java-based settings restricts the generalizability of the synthesized evidence to rural, remote, and eastern Indonesian regions with distinct healthcare infrastructure profiles. The heterogeneity of study designs and outcome measures, while expected in a scoping review, limits the capacity for direct comparative interpretation across settings. Additionally, the absence of formal methodological quality appraisal, while consistent with scoping review conventions, means that findings should be interpreted as a map of the evidence landscape rather than a definitive assessment of evidence strength.

CONCLUSION

Antibiotic misuse and barriers to antimicrobial stewardship implementation in Indonesia are driven by a complex and reinforcing web of individual, institutional, and systemic factors. Deficient antibiotic literacy, pervasive self-medication, weak regulatory enforcement, inadequate diagnostic infrastructure, and critical shortages of trained stewardship personnel collectively undermine appropriate antibiotic use across Indonesian healthcare settings. Although national antimicrobial stewardship policies have been formally introduced, their operationalization remains highly inconsistent—particularly across lower-level and resource-limited healthcare facilities and in rural and eastern regions of the country.

Advancing antimicrobial stewardship in Indonesia demands a coordinated, multi-pronged strategy encompassing strengthened regulatory enforcement, targeted investment in diagnostic infrastructure, comprehensive health workforce training, the integration of digital health and task-shifting models, robust AMR surveillance systems, and sustained multisectoral collaboration across government, healthcare institutions, and communities. Future research must deliberately prioritize underserved geographic regions and primary healthcare settings to ensure that stewardship interventions are contextually grounded, equitable, and capable of achieving meaningful and durable reductions in the AMR burden across the full breadth of Indonesia's diverse health system.

Conflict of Interest

The author declares no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethical Statement

As this study constitutes a scoping review of previously published literature and did not involve the collection of primary data from human participants, ethical approval was not required.

REFERENCES

1. Abbas, S. (2024). The challenges of implementing infection prevention and antimicrobial stewardship programs in resource-constrained settings. *Antimicrobial Stewardship & Healthcare Epidemiology*, 4. <https://doi.org/10.1017/ash.2024.35>
2. Adrizain, R., Setiabudi, D., & Chairulfatah, A. (2019). The inappropriate use of antibiotics in hospitalized dengue virus-infected children with presumed concurrent bacterial infection in teaching and private hospitals in Bandung, Indonesia. *PLOS Neglected Tropical Diseases*, 13(6), e0007438. <https://doi.org/10.1371/journal.pntd.0007438>
3. Baraka, M., Alsultan, H., Alsalman, T., Alaithan, H., Islam, M., & Alasseri, A. (2019). Health care providers' perceptions regarding antimicrobial stewardship programs (AMS) implementation—facilitators and challenges: a cross-sectional study in the Eastern province of Saudi Arabia. *Annals of Clinical Microbiology and Antimicrobials*, 18. <https://doi.org/10.1186/s12941-019-0325-x>
4. Centers for Disease Control and Prevention. (2019). Core elements of hospital antibiotic stewardship programs. Atlanta: CDC.
5. Chukwu, E., Abuh, D., Idigbe, I., Osuolale, K., Chuka-Ebene, V., Awoderu, O., et al. (2024). Implementation of antimicrobial stewardship programs: A study of prescribers' perspective of facilitators and barriers. *PLOS ONE*, 19. <https://doi.org/10.1371/journal.pone.0297472>
6. Hadi, U., Duerink, D. O., Lestari, E. S., Nagelkerke, N. J., Keuter, M., In't Veld, D. H., et al. (2008). Problem of antibiotic use and antimicrobial resistance in Indonesia: are we really making progress? *Indonesian Journal of Tropical and Infectious Disease*, 1(4), 197-204.
7. Hadi, U., van den Broek, P., Kolopaking, E. P., Zairina, N., Gardjito, W., & Gyssens, I. C. (2010). Cross-sectional study of availability and pharmaceutical quality of antibiotics obtained from drug outlets in Indonesia. *Tropical Medicine & International Health*, 15(8), 960-965.
8. Harun, M., Sumon, S., Hasan, I., Akther, F., Islam, M., & Anwar, M. (2024). Barriers, facilitators, perceptions and impact of interventions in implementing antimicrobial stewardship programs in hospitals of low-middle and middle countries: a scoping review. *Antimicrobial Resistance & Infection Control*, 13. <https://doi.org/10.1186/s13756-024-01369-6>
9. Herawati, F., Ananta, S. C., Parwitha, I. A. A., Ressaydy, S. S., Rahmatin, N. L., Rachmadini, N. A., et al. (2020). Interview-based cross-sectional needs assessment to advance the implementation of an effective antibiotic stewardship program in Indonesian hospitals. *Health Policy OPEN*, 1, 100002. <https://doi.org/10.1016/j.hpopen.2019.100002>
10. Herawati, F., Jaelani, A. K., Wijono, H., Rahem, A., Setiasih, Yulia, R., et al. (2021). Antibiotic stewardship knowledge and belief differences among healthcare professionals in hospitals: A survey study. *Heliyon*, 7(6), e07377. <https://doi.org/10.1016/j.heliyon.2021.e07377>
11. Hijazi, K., Joshi, C., & Gould, I. (2019). Challenges and opportunities for antimicrobial stewardship in resource-rich and resource-limited countries. *Expert Review of Anti-infective Therapy*, 17, 621-634. <https://doi.org/10.1080/14787210.2019.1640602>
12. Hulscher, M. E. J. L., & Prins, J. M. (2017). Antibiotic stewardship: does it work in hospital practice in low- and middle-income countries? *Clinical Microbiology and Infection*, 23(11), 799-805.
13. Jeffs, L., McIsaac, W., Zahradnik, M., Senthinathan, A., Dresser, L., McIntyre, M., et al. (2020). Barriers and facilitators to the uptake of an antimicrobial stewardship program in primary care: A qualitative study. *PLOS ONE*, 15. <https://doi.org/10.1371/journal.pone.0223822>
14. Kakkar, A., Shafiq, N., Singh, G., Ray, P., Gautam, V., Agarwal, R., et al. (2020). Antimicrobial stewardship programs in resource constrained environments: Understanding and addressing the need of the systems. *Frontiers in Public Health*, 8. <https://doi.org/10.3389/fpubh.2020.00140>
15. Kapatsa, T., Bwanali, A., Kambewa, L., Mkandawire, V., Mwale, G., Harawa, G., et al. (2025). Assessing the implementation determinants of antimicrobial stewardship programmes in sub-Saharan

- Africa through the complexity lens: A CFIR-guided systematic review. *Frontiers in Microbiology*, 16. <https://doi.org/10.3389/fmicb.2025.1660778>
16. Khanal, S., Acharya, U., Trotter, A., Tripathi, P., Koirala, S., Pahari, B., et al. (2023). Challenges and opportunities in the implementation of an antimicrobial stewardship program in Nepal. *Antimicrobial Stewardship & Healthcare Epidemiology*, 3. <https://doi.org/10.1017/ash.2022.359>
 17. Sinto, R., Limato, R., Radiani, S. P., Huda, M. N., Surendra, H., Praptiwi, A. W., Herman, Y., Musaffa, B. A., Lazarus, G., Day, N. P. J., Limmathurotsakul, D., Karuniawati, A., & Hamers, R. L. (2024). A nationwide mixed-methods study of gaps and barriers to implementation of antimicrobial stewardship programmes in hospitals in Indonesia. *Journal of Hospital Infection*, 154, 77–87. <https://doi.org/10.1016/j.jhin.2024.10.001>
 18. Limato, R., Lazarus, G., Dernison, P., Mudia, M., Alamanda, M., Nelwan, E. J., et al. (2022). Optimizing antibiotic use in Indonesia: a systematic review and meta-analysis. *BMC Infectious Diseases*, 22, 481.
 19. Limato, R., Mudia, M., Nelwan, E. J., et al. (2020). Antibiotic prescribing practice in Indonesian hospitals and implications for antimicrobial stewardship. *Tropical Medicine & International Health*, 25(9), 1115–1125.
 20. Limato, R., Nelwan, E. J., Mudia, M., de Jong, M. D., & van Doorn, H. R. (2022). A qualitative study of barriers to antimicrobial stewardship in Indonesian hospitals: governance, competing interests, cost, and structural vulnerability. *Antimicrobial Resistance & Infection Control*, 11, 89.
 21. Limato, R., Nelwan, E. J., Mudia, M., et al. (2021). A multicentre point prevalence survey of patterns and quality of antibiotic use in Indonesian hospitals. *JAC-Antimicrobial Resistance*, 3(3).
 22. Lutfiyati, H., Yasin, N. M., Thobari, J. A., & Ikawati, Z. (2022). The implementation of antimicrobial stewardship in Indonesia: a regional survey in hospitals. *Journal of Advanced Pharmacy Education & Research*, 12(4), 19-26.
 23. Ministry of Health Republic of Indonesia. (2021). *Antimicrobial Resistance Situation in Indonesia: A Challenge of Policy and Implementation*. Jakarta: Ministry of Health.
 24. Muliawan, B. T., Limato, R., Nelwan, E. J., et al. (2021). Perceptions, views and practices regarding antibiotic prescribing and stewardship among hospital physicians in Jakarta, Indonesia: a questionnaire-based survey. *BMJ Open*, 11, e054768.
 25. Murni, I. K., Duke, T., Kinney, S., Daley, A. J., & Soenarto, Y. (2015). Reducing hospital-acquired infections and improving the rational use of antibiotics in a developing country: an effectiveness study. *Archives of Disease in Childhood*, 100(5), 454–459.
 26. Puspitasari, H. P., Faturrohman, A., & Hermansyah, A. (2011). Community pharmacies, drug stores, and antibiotic dispensing in Indonesia: a qualitative study. *BMC Health Services Research*, 11, 1–10.
 27. Rajendran, R., Chitrapady, S., Tejashree, M., Haritha, K., Balakrishnan, J., Nair, S., et al. (2025). Antimicrobial stewardship programs in primary and secondary care settings in India: current challenges, facilitators, perceptions, and impact—a scoping review. *BMC Infectious Diseases*, 25. <https://doi.org/10.1186/s12879-025-11851-0>
 28. Raka, L., & Kurti, A. (2024). Addressing barriers in antimicrobial stewardship: a guide from research to implementation. *Journal of Global Antimicrobial Resistance*. <https://doi.org/10.1016/j.jgar.2024.10.082>
 29. Ramdas, N., Meyer, J., Schellack, N., Godman, B., Turawa, E., & Campbell, S. (2025). Knowledge, attitudes, motivations, expectations, and systemic factors regarding antimicrobial use amongst community members seeking care at the primary healthcare level: A scoping review. *Antibiotics*, 14. <https://doi.org/10.3390/antibiotics14010078>
 30. Restika, R. A., Mardhia, M., Mahyarudin, M., Liana, D. F., & Hariyanto, I. H. (2025). Knowledge and behavior regarding antibiotic stewardship in health workers at Sultan Syarif Mohammad Alkadrie Hospital, Indonesia. *Pharmacology and Clinical Pharmacy Research*, 9(3), 2.
 31. Setiawan, E., Limato, R., Nelwan, E. J., et al. (2022). Indonesian healthcare providers' perceptions and attitude toward antimicrobial resistance and stewardship. *Future Microbiology*. <https://doi.org/10.2217/fmb-2021-0193>
 32. Siahaan, S., Usman, Y., Puspitasari, H. P., et al. (2023). Determinants of non-prescription antibiotic use in Indonesia: a community-based study. *BMC Public Health*, 23.
 33. Sinto, R., Limato, R., Radiani, S. P., et al. (2024). A nationwide mixed-methods study of gaps and barriers to implementation of antimicrobial stewardship programmes in hospitals in Indonesia. *Journal of Hospital Infection*, 154, 77–87.

34. Truppa, C., Alonso, B., Clezy, K., Deglise, C., Dromer, C., Garelli, S., et al. (2023). Antimicrobial stewardship in primary health care programs in humanitarian settings: the time to act is now. *Antimicrobial Resistance & Infection Control*, 12. <https://doi.org/10.1186/s13756-023-01301-4>
35. Wang, X., Lin, L., Xu, X., Harbarth, S., Yakob, L., Zhang, R., et al. (2025). Implementing the Chinese mandatory antimicrobial stewardship program: barriers to continuous improvement. *Health Policy and Planning*, 40, 591-599. <https://doi.org/10.1093/heapol/czaf019>
36. Wardhani, D. K., Wibowo, Y. I., & Setiawan, E. (2020). Persepsi dokter tentang strategi antimicrobial stewardship program di sebuah rumah sakit umum di Surabaya. *Jurnal Sains Farmasi & Klinis*, 7(1), 5–14.
37. Widayati, A., Suryawati, S., de Crespigny, C., & Hiller, J. E. (2011). Self-medication with antibiotics in Yogyakarta City Indonesia: a cross sectional population-based survey. *BMC Research Notes*, 4, 491.
38. Widayati, A., Suryawati, S., de Crespigny, C., & Hiller, J. E. (2011). A cross-sectional study of availability and pharmaceutical quality of antibiotics obtained from private drug retail outlets in Indonesia. *BMJ Open*, 1, e000203.
39. Widayati, A., Suryawati, S., de Crespigny, C., & Hiller, J. E. (2012). Knowledge and beliefs about antibiotics among people in Yogyakarta City Indonesia: a cross sectional population-based survey. *Antimicrobial Resistance & Infection Control*, 1, 38.
40. World Health Organization. (2023). Antimicrobial resistance in the South-East Asia Region: situation analysis and recommendations. Geneva: WHO.
41. Yau, J., Thor, S., Tsai, D., Speare, T., & Rissel, C. (2021). Antimicrobial stewardship in rural and remote primary health care: a narrative review. *Antimicrobial Resistance & Infection Control*, 10. <https://doi.org/10.1186/s13756-021-00964-1>
42. Yuniar, Y., Handayani, R. S., & Aryani, K. (2020). Quality of antibiotic prescribing for respiratory tract disease in primary healthcare centers in Tegal District, Central Java, Indonesia. *Journal of Infection and Public Health*, 13(4), 560-566.
43. Zakhour, J., Haddad, S., Kerbage, A., Heiman, W., Tattevin, P., Voss, A., et al. (2023). Diagnostic stewardship in infectious diseases: a continuum of antimicrobial stewardship in the fight against antimicrobial resistance. *International Journal of Antimicrobial Agents*. <https://doi.org/10.1016/j.ijantimicag.2023.106816>