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Global variation in antibiotic prescribing guidelines and the implications for decreasing AMR in the future

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Introduction: Antimicrobial resistance (AMR) has become a global burden, with inappropriate antibiotic prescribing being an important contributing factor. Antibiotic prescribing guidelines play an important role in improving the quality of antibiotic use, provided they are evidence-based and regularly updated. As a result, they help reduce AMR, which is a critical challenge in low- and middle-income countries (LMICs). Consequently, the objective of this study was to evaluate local, national, and international antibiotic prescribing guidelines currently available—especially among LMICs—and previous challenges, in light of the recent publication of the WHO AWaRe book, which provides future direction.

Methodology: Google Scholar and PubMed searches were complemented by searching official country websites to identify antibiotic prescribing guidelines, especially those concerning empiric treatment of bacterial infections, for this narrative review. Data were collected on the country of origin, income level, guideline title, year of publication, development methodology, issuing organization, target population, scope, and coverage. In addition, documentation on implementation strategies, compliance, monitoring of outcome measures, and any associated patient education or counseling efforts were reviewed to assess guideline utilization.

Results/findings: A total of 181 guidelines were included, with the majority originating from high-income countries (109, 60.2%), followed by lower-middle-income (40, 22.1%), low-income (18, 9.9%), and upper-middle-income (14, 7.7%) countries. The GRADE methodology was used in only 20.4% of the sourced guidelines, predominantly in high-income countries. Patient education was often underemphasized, particularly in LMICs. The findings highlighted

significant disparities in the development, adaptation, and implementation of guidelines across different WHO regions, confirming the previously noted lack of standardization and comprehensiveness in LMICs.

Conclusion: Significant disparities exist in the availability, structure, and methodological rigor of antibiotic prescribing guidelines across countries with different income levels. Advancing the development and implementation of standardized, context-specific guidelines aligned with the WHO AWaRe framework—and supported by equity-focused reforms—can significantly strengthen antimicrobial stewardship and help address the public health challenge of AMR.

KEYWORDS

antibiotic prescribing guidelines, antimicrobial resistance, AWaRe classification, GRADE methodology, low- and middle-income countries, patient counselling, World Health Organization regions

1 Introduction

Inappropriate antibiotic usage is now a critical global health issue as it is a leading cause of antimicrobial resistance (AMR), which results in the reduced effectiveness of antimicrobials (Godman et al., 2021; Aldarhami, 2023; Baran et al., 2023; Ho et al., 2024). According to current estimates, AMR causes nearly 1.17 million deaths annually, with the number of deaths likely to more than double by 2050 if key issues and challenges are not addressed (Murray et al., 2022; Do et al., 2023). Infections caused by resistant bacteria increase morbidity and treatment costs, along with higher mortality and the risk of such infections spreading (Dadgostar, 2019; Wagenlehner and Dittmar, 2022; Spellberg et al., 2025; Wan et al., 2025). The impact of AMR is likely to be greater in low- and middle-income countries (LMICs), where the infection burden is higher and antimicrobial choices and usage are impacted by high levels of patient co-payments (Godman et al., 2021; Sulis et al., 2022; Khan et al., 2024; Lewnard et al., 2024; Sartorius et al., 2024; Saleem et al., 2025a).

In response to this critical public health issue, the World Health Organization (WHO, 2015) developed the Global Action Plan (GAP) on AMR, which led to the creation of National Action Plans (NAPs) aimed at encouraging countries to address the emerging public health threat of AMR (WHO, 2016). The purpose of the NAPs is to facilitate effective policy and stewardship measures to reduce the prevalence of AMR within each country (Godman et al., 2022; Willemsen et al., 2022; Charani et al., 2023). However, there have been concerns regarding the implementation of NAPs, especially in LMICs, due to resource constraints and shortage of trained personnel (Chua et al., 2021; Godman et al., 2022; Ohemu, 2022; Saleem et al., 2022). Notably, the fourth objective of NAPs emphasizes the development and implementation of clinical practice guidelines to promote the appropriate use of antimicrobials. These serve as tools for promoting rational prescribing practices and reducing the inappropriate use of antibiotics within countries. Clinical guidelines can be defined as documents that provide recommendations for clinical practice, aiming to minimize variability in care, particularly when scientific evidence is limited or when multiple therapeutic options are available (Steinberg et al., 2011; Johnson et al., 2021). The development and implementation of evidence-based guidelines support clinical decision-making by enhancing the quality of care, improving patient outcomes, and promoting the efficient use of resources (Sackett et al., 1996). The publication and implementation of antibiotic guidelines are regarded as important educational measures, especially for physicians in LMICs. This is because robust clinical guidelines are believed to significantly improve the quality of antibiotic prescribing across all sectors of care (Cooper et al., 2020; D'Arcy et al., 2021; Foxlee et al., 2021; Akhloufi et al., 2022; Boltena et al., 2023). As a result, adherence to published guidelines is increasingly incorporated into antimicrobial stewardship programs (ASPs) both in hospitals and primary care settings, often as part of agreed quality indicator targets (Versporten et al., 2018; Foxlee et al., 2021; Chigome et al., 2023; Funiciello et al., 2024; Lubanga et al., 2024). ASPs increasingly play a pivotal role in monitoring the implementation of national or regional guidelines to improve clinical outcomes across all sectors while minimizing the consequences of inappropriate antibiotic use (Nathwani et al., 2019; Brinkmann and Kibuule, 2020; Akhloufi et al., 2022; Siachalinga et al., 2022; Haseeb et al., 2023). ASPs in high-income countries (HICs) are often supported by electronic health records (EHRs)—digital systems that store patient medical information and can be integrated with clinical decision support tools. As a result, EHRs facilitate the monitoring of prescribing practices, facilitate audits, and help ensure adherence to national or institutional guidelines as part of ASPs. However, there have been concerns about implementing ASPs in LMICs due to resource limitations and personnel issues shortages; encouragingly, this is now beginning to change despite previous challenges (Cox et al., 2017; Brinkmann and Kibuule, 2020; Godman et al., 2021; Borde et al., 2022; Siachalinga et al., 2022).

Meanwhile, there is often a lack of national AMR surveillance, especially within LMICs, which limits the development of national evidence-based guidelines and the subsequent implementation of targeted policies to improve future antibiotic use (Woolf et al., 1999; Ohemu, 2022; Do et al., 2023; Okolie et al., 2023; Kiggundu et al., 2023; Mustafa et al., 2024). HICs often have access to resources for comprehensive guideline development, including local antimicrobial resistance data, systematic reviews, and advanced methodologies, including GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) (Barker et al., 2021). Conversely, LMICs frequently rely on expert opinions and internationally derived guidelines to help improve

antibiotic prescribing, which may not be well-adapted to local AMR patterns and healthcare contexts. Moreover, due to resource constraints, implementing such guidelines or establishing such programs is more challenging in LMICs. In addition to this, adherence to national or international guidelines remains highly variable, especially across LMICs, leading to inappropriate and excessive use of antibiotics, which may be a reflection of concerns about the local relevance of adapted guidelines (Sulis et al., 2020; Thi et al., 2024; Wang et al., 2022; Mahmudul Islam et al., 2024).

Consequently, there is a need to evaluate the availability and scope of current national and international antibiotic guidelines. It is important to identify disparities in their development, adaptation, and implementation. These insights can inform strategies to improve guideline adherence, particularly by assessing the extent to which local AMR patterns are incorporated into guideline updates. We acknowledge that the WHO AWaRe book has recently been published, covering 35 common infections across healthcare sectors; this builds on the WHO AWaRe classification, which is part of the Essential Medicines List (Moja et al., 2024; WHO, 2022; Sharland et al., 2019). However, this guidance may require local adaption based on local resistance patterns. In addition, many existing local or national guidance may be outdated, highlighting the urgent need for updates—especially in light of the recent United Nations General Assembly (UN-GA) target, which calls for 70% of antibiotics used across sectors to come from the Access group (United Nations, 2024). We are also aware that the WHO AWaRe classification system is increasingly being used across studies, including those conducted in LMICs, to assess current antibiotic use patterns and set targets for ASPs—a trend that is expected to continue (Saleem et al., 2025a; Saleem et al., 2025b).

In view of the rising global threat of AMR, coupled with the variability in national and local antibiotic prescribing practices, the first objective of this review was to assess the availability, scope, and quality of current antibiotic prescribing guidelines across countries of varying income levels, specifically to identify gaps in guideline development and adaptation. This review also aimed to evaluate the degree to which current guidelines incorporate the WHO AWaRe book recommendations and address key components such as patient education, AMR surveillance, and stewardship strategies (Funiciello et al., 2024; Moja et al., 2024). By identifying these gaps and emphasizing the importance of locally adapted, evidence-based guidelines, this review seeks to contribute to ongoing global efforts to optimize antibiotic use, reduce the reliance on broad-spectrum antibiotics, and assist in achieving the NAP goals, especially in LMICs. This is viewed as essential for meeting the UN-GA target of reducing AMR and increasing the use of Access antibiotics (United Nations, 2024).

2 Materials and methods

2.1 Study design

This study was conducted as a narrative review to comprehensively analyze antibiotic prescribing guidelines from diverse regions and income-level countries. The main objective was to identify disparities in guideline development, adaptation, and implementation, providing a robust understanding of current practices in antibiotic prescribing at local, national, and international levels. We have used this approach in multiple previous publications (Godman et al., 2021; Godman et al., 2022; Chigome et al., 2023; Haseeb et al., 2023) and believed this design is better suited to the heterogeneity of the included studies and the descriptive goals of the review, especially given the wide variation in regions and income levels included.

2.2 Search strategy

A comprehensive search was conducted between June and September 2024 to identify eligible antibiotic prescribing guidelines. The primary sources for data collection and extraction were Google Scholar and PubMed, alongside other search engines, with most of the data obtained directly from Google and official country websites. We first conducted a PubMed search using MeSH terms and Boolean operators, including "antibiotic prescribing guideline*," "clinical practice guideline*," or "antibiotic guideline*" in the title. Subsequently, we used Google as a search engine to locate guidelines not included in the medical literature but available online. This approach was conducted based on the assumption that a significant number of guidelines might be published by scientific societies or governmental agencies and made available on the internet without being captured by formal literature repositories.

We subsequently accessed possible antibiotic prescribing guidelines by analyzing official country websites. The search for guidelines on official country websites was conducted manually using a structured and systematic approach. For every country, the official website of the Ministry of Health, or equivalent national health authority, was identified via a Google search. Furthermore, country-specific AMR National Action Plan pages were examined as they often linked to or referenced available antibiotic prescribing guidelines. This method ensured that both recent and archived guidelines could be identified, even in countries with limited digital infrastructure or non-indexed resources.

2.2.1 Eligibility criteria

A country was included if it had at least one publicly accessible antibiotic prescribing guideline available in English that met the review's inclusion criteria. Countries were not excluded based on income level or geographic region.

2.2.2 Guideline inclusion criteria

This review focused on bacterial infections and clinical syndromes that are commonly managed with antibiotic therapy. Inclusion criteria encompassed any English-language antibiotic prescribing guidelines from across all income countries that provided specific treatment recommendations, including antibiotic names, dosages, and durations. To ensure a comprehensive overview, local, national, and international guidelines were considered.

2.2.3 Exclusion criteria

Guidelines were excluded if they focused solely on infection prevention or non-antibiotic therapies. Additionally, guidelines that lacked detailed prescribing information, such as those offering only general guidance without specifying antibiotic names, dosages, or durations, were excluded. Finally, documents not published in

English were excluded due to translation constraints. In addition, English is recognized as the international scientific language.

2.3 Information sought for each guideline

For each guideline included, we collected general information on the country of origin and its geographic location according to WHO regions and its income classification—i.e., low-income, lower-middle, upper-middle, and high-income—based on the World Bank classification (World Bank, 2025), consistent with our previous reviews (Saleem et al., 2025a; Saleem et al., 2025c). Additional data were extracted on the guideline title, year of publication, development methodology, issuing organization, target population, scope, and extent of local adaptation. We also noted whether the guidelines addressed current AMR patterns and included implementation strategies, compliance and monitoring, outcome measures, and patient education or counseling components. These key variables and their distribution across guidelines are visually summarized in Figure 1. Patient-related data were collected due to their recognized role in influencing antibiotic prescribing and dispensing, especially in LMICs (Nair et al., 2019; Antwi et al., 2020; Khan et al., 2020; Ramdas et al., 2025). Effective patient counseling is increasingly regarded as essential to enhance adherence to prescribed antibiotics, educate patients on the importance of completing treatment courses, and raise awareness of the risks associated with misuse (Saleem et al., 2025a; Saleem et al., 2025c; Balea et al., 2025; Sakeena et al., 2018; Hunter and Owen, 2024).

As part of our data extraction process, we also assessed whether each guideline utilized a structured evidence-based grading methodology, specifically the GRADE framework. For each guideline, we recorded whether GRADE was explicitly mentioned as part of the guideline development methodology. This included checking the methodology sections of the guidelines for references to GRADE terminology, use of evidence quality ratings (e.g., "low," "moderate," and "high" certainty), and the presence of structured recommendation grading. This enabled us to evaluate the extent to which evidence-based approaches were incorporated into the development of antibiotic prescribing guidelines by various country income groups. Each guideline was thoroughly reviewed to determine whether it included information on AMR patterns and patient counseling. As a result, we aimed to provide a thorough evaluation of current antibiotic guidelines and their applicability across various healthcare settings.

For the purpose of this review, a guideline was considered "outdated" if it was published more than 10 years before the date of data collection, i.e., prior to 2014, and showed no evidence of revision, update, or endorsement in more recent policy documents or on websites. This cutoff was chosen based on international best practices, which recommend regular updates to clinical guidelines every 3–5 years to ensure alignment with evolving evidence, AMR trends, and AMS practices.

2.4 Ethical considerations

Ethical approval was not needed for this study as we included only readily available published material and no patients were involved in the study.

3 Results

We retrieved 335 antibiotic prescribing guidelines, with the majority of data obtained directly from Google and official country websites. Of these, 181 guidelines met our inclusion criteria, provided sufficient information for our review, and were subsequently described in detail. Figure 2 illustrates the guideline selection process.

The general characteristics of the included antibiotic prescribing guidelines are summarized in Table 1 and Supplementary Table S1.

3.1 Distribution by income group and WHO region

Most guidelines (n = 109; 60.2%) originated from HICs, followed by lower-middle-income countries with 40 guidelines (22.1%), low-income countries (LICs) with 18 guidelines (9.9%), and upper-middle-income countries with 14 guidelines (7.7%). The geographical distribution also varied significantly, with the European Region and the Region of the Americas contributing the majority of guidelines, while the African and Southeast Asian regions were underrepresented. Figure 3 illustrates the geographical distribution of antibiotic prescribing guidelines among the countries worldwide.

3.2 Methodological approaches and use of GRADE

Out of the 181 guidelines, only 37 (20.4%) explicitly referenced the use of the GRADE framework. The majority of these were from HICs, reflecting higher methodological standards and resources for evidence synthesis (Jackson et al., 2020; NICE CAP Guideline, 2019a; Autore et al., 2023; Sanford Guideline, 2024). For example, the UK's NICE and the USA's IDSA guidelines extensively apply the GRADE methodology to support transparency and methodological rigor (NICE Guidelines, 2023; Tamma et al., 2024).

In contrast, most guidelines from LMICs relied on expert consensus or non-transparent development processes, often lacking structured grading of recommendations (Bartlett et al., 1998; BSMMU Guideline Bangladesh, 2023; Antibiotic Guidelines Myanmar, 2019). For example, guidelines from Pakistan and Bhutan primarily relied on literature reviews without systematic evidence-based grading, resulting in broad recommendations (MMIDSP Guideline, 2022; Ministry of Health Bhutan, 2018). Details are mentioned in Table 2 and Supplementary Table S2.

3.3 Scope and coverage of guidelines

Antibiotic prescribing guidelines differed substantially in scope, focus, and strategy as a result of variations in epidemiology, cultural context, and healthcare infrastructure within the regions. Guidelines from HICs were generally more

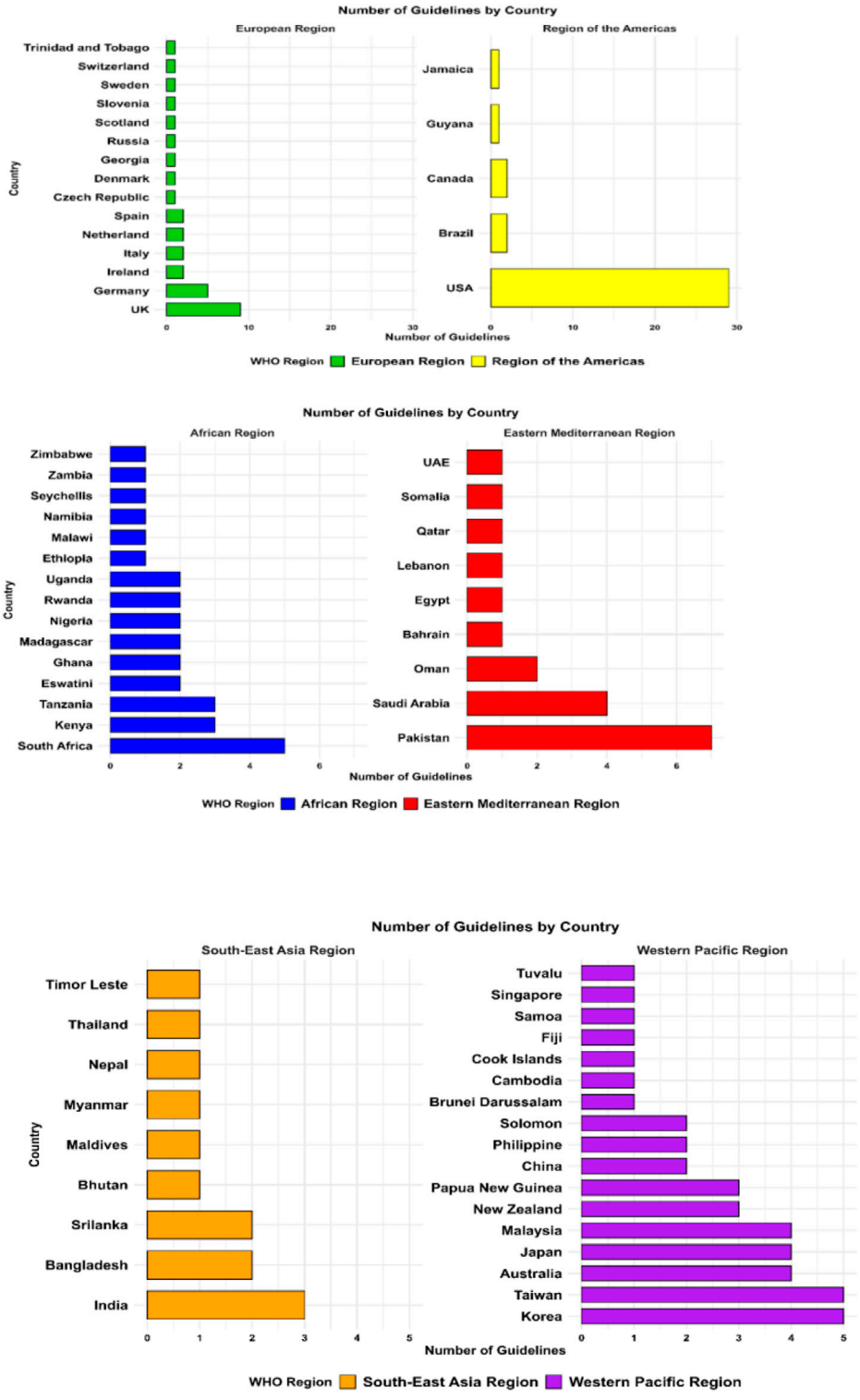

FIGURE 1
Geographical distribution of included antibiotic prescribing guidelines by WHO regions.

detailed, including diagnostic criteria, age-specific dosing, and alternative regimens. For example, USA IWGDF/IDSA guidelines for diabetic foot infection incorporate pathogen-specific approaches (Senneville et al., 2024), while guidelines from LMICs, such as those from Ethiopia and Malawi, typically use syndromic management protocols without referencing pathogen-specific resistance data (Ministry of Health Ethiopia, 2014; Ministry of Health Malawi, 2015) (Supplementary Table S2).

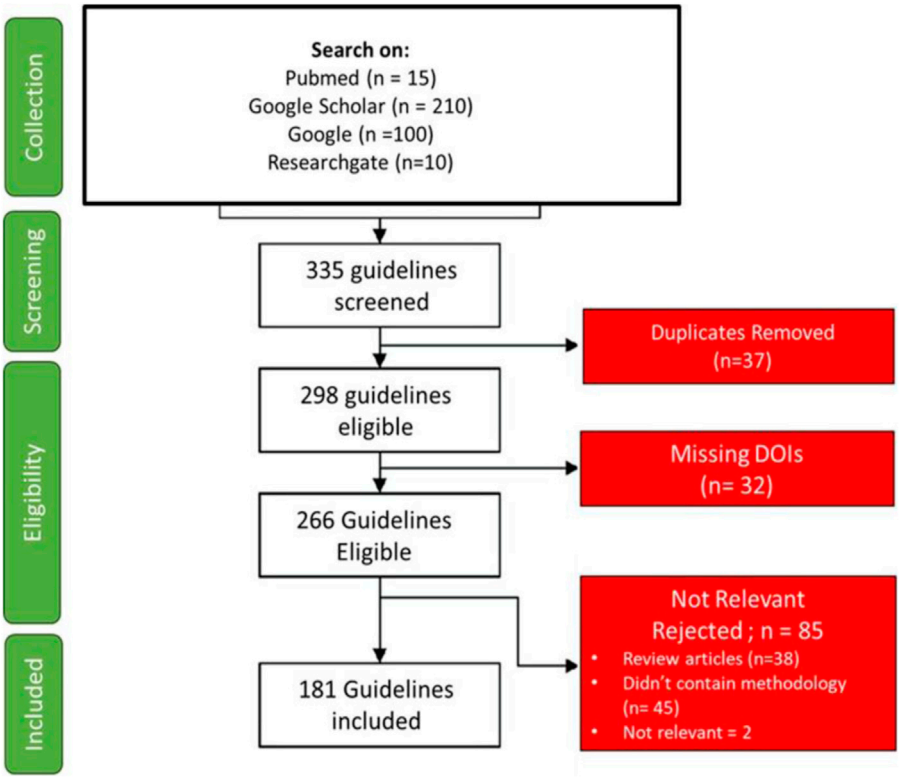

FIGURE 2
Flow diagram illustrating the process of identification, screening, eligibility assessment, and inclusion of antibiotic prescribing guidelines reviewed in this study.

3.4 Implementation and monitoring strategies

Only a limited number of guidelines, primarily from HICs, included implementation strategies such as audit and feedback mechanisms, performance indicators, or integration with EHR systems (Jackson et al., 2020; NICE CAP Guideline, 2019; Bisno et al., 2002; NICE HAP Guideline, 2019). For instance, the Netherlands and Sweden have institutionalized prescribing audits within their national EHR infrastructure to support stewardship programs (Akhloufi et al., 2022; Spindler et al., 2012). In contrast, guidelines from many LMICs, such as Nigeria and Bangladesh, lacked such structured implementation frameworks, largely due to limited digital health infrastructure and financial constraints (Ministry of Health Nigeria, 2016; Ministry of Health Bangladesh, 2021a).

3.5 Patient education and communication features

The majority of guidelines emphasized the importance of patient counseling. However, those from LMICs often lacked modern communication strategies to support effective implementation. Patient education was notably underrepresented, particularly in LMIC guidelines. HIC guidelines, such as those from the UK and Canada, commonly include patient-facing leaflets, risk communication tools, and checklists to facilitate counseling (Greater Manchester, 2024; Desrosiers et al., 2011). In contrast, guidelines from LICs such as Malawi and Ethiopia rarely provide structured education materials, contributing to gaps in patient engagement and adherence (Ministry of Health Ethiopia, 2014; Ministry of Health Malawi, 2015). Moreover, modern communication tools such as mobile applications, SMS-based adherence reminders, and visual aids, including infographics, were rarely utilized, limiting the potential for patient engagement and behavior change in these settings (see Supplementary Table S2).

3.6 AMR surveillance and local adaptation

Guidelines from HICs typically incorporated recent AMR data into their recommendations. For example, national guidelines from Australia and the Netherlands rely on routine national antibiograms (Guideline Netherlands, 2024; Therapeutic Guidelines Australia, 2024). Conversely, many LMIC guidelines, such as those from Eswatini and Ethiopia, are considered outdated as they were published over 10 years ago and made no reference to local surveillance data or antibiograms (Ministry of Health Ethiopia, 2014; Ministry of Health Eswatini, 2012). This lack of local data hampers effective empiric prescribing and contributes to the overuse of broad-spectrum antibiotics in these countries. Supplementary Table S2 provides examples of guideline recency and AMR data inclusion by income group.

TABLE 1 Characteristics of included guidelines in the review.

Characteristic	Number of guidelines (% total)
Income group	
HICs	109 (60.22)
UMICs	14 (7.73)
LMICs	40 (22.10)
LICs	18 (9.94)
Global	
European guidelines	13 (7.18)
WHO regions	
African Region	29 (16)
Eastern Mediterranean Region	19 (10.5)
European Region	31 (17.13)
Region of the Americas	35 (19.3)
Southeast Asia Region	13 (7)
Western Pacific Region	41 (23)
Scope	
International	45 (24.86)
National	116 (64.09)
Local	20 (11.05)
Grade methodology used	
Yes	37 (20.44)
No	144 (79.56)

NB: HIC, high-income country; UMIC, upper-middle income country; LMIC, lower-middle income country; and LIC, low-income country.

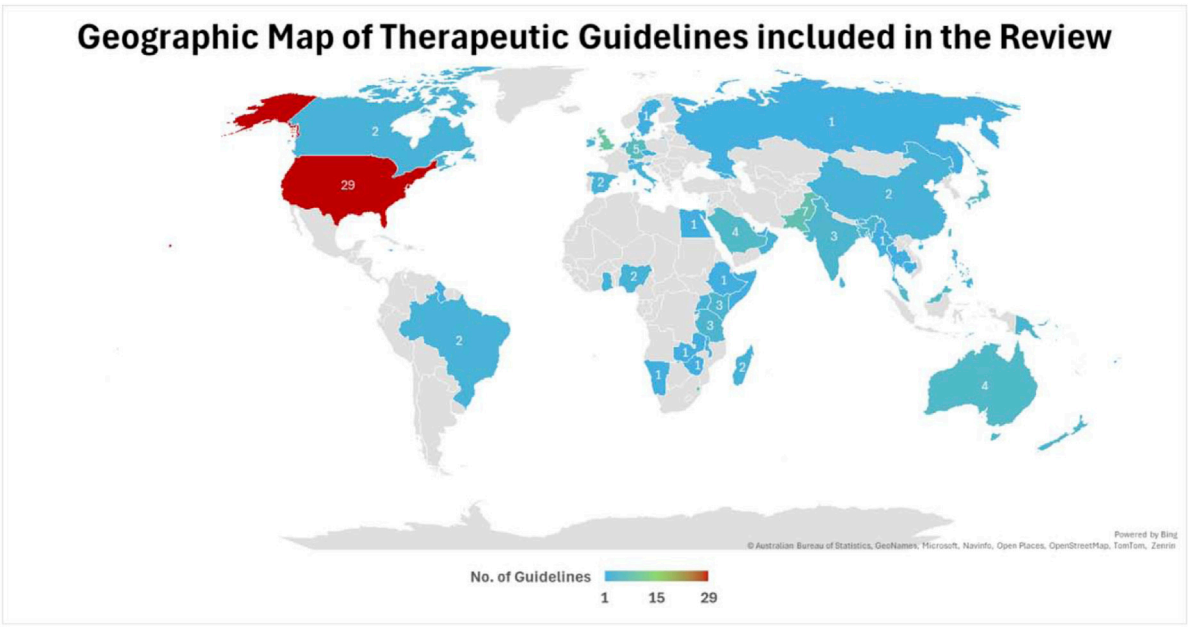

FIGURE 3
Geographical distribution of included antibiotic prescribing guidelines among the countries.

TABLE 2 Global variation in antibiotic prescribing guidelines.

Global guidelines	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
Europe	EAU GUIDELINES UI	2024	Evidence-based review and expert consensus	EAU	International	Bonkat et al. (2017)
	ESCMID ED ST Guidelines	2024	Evidence-based review and expert consensus	ESCMID and EAHP	International	Schoffelen et al. (2024)
	ERS/ESICM/ESCMID/ALAT CAP-Guidelines	2023	GRADE	ERS/ESICM/ ESCMID/ALAT	National	Martin-Loeches et al. (2023)
	ESCMID–EUCIC Guidelines	2019	Evidence-based review and expert consensus	ESCMID and EUCIC	International	Tacconelli et al. (2019)
	ERS guidelines for AB	2017	GRADE	ERS	International	Polverino et al. (2017)
	ERS-HAP/VAP Guidelines	2017	GRADE	ERS/ESICM/ ESCMID/ALAT	International	Torres et al. (2017)
	ESCMID Meng. Guidelines	2016	GRADE	Microbiology ESCMID	International	Van de Beek et al. (2016)
	ESMO-febrile neutropenia	2016	GRADE	ESMO	International	Klastersky et al. (2016)
	Blue Book	2016	Evidence-based review and expert consensus	OUP and ESPID	International	Butler (2016)
	ESC-Endocarditis-G	2015	Evidence-based expert consensus	ESC-EACTS and EANM	International	Habib et al. (2016)
	EAU/ESPU-UTI	2015	Literature review (evidence-based)	EAU/ESPU	International	Stein et al. (2015)
	EAU UTI Guidelines	2014	GRADE	EAU	International	Debast et al. (2014)
	ESCMID-ST Guidelines	2012	GRADE	ESCMID/ ESCMID STG	International	Pelucchi et al. (2012)
Income level	**Country**	**Guideline abbreviation**	**Publication date**	**Methodology**	**Prepared by**	**Scope**	**Reference**
African Region							
HIC	Seychelles	Seychelles STGs	2003	Combined local medical practice experience with relevant international standards	MOH	National	Ministry of Health Seychelles (2003)
UMIC	Namibia	Namibia STG	2011	Evidence based guidelines	MOH and SC	National	Ministry of Health Namibia (2011)
LMIC	Eswatini	Eswatini STG-EML 2020	2020	Evidence-based recommendations aligned with WHO EML	MOH	National	Ministry of Health Eswatini (2020)
		Eswatini STG-EML 2012	2012	Evidence-based guidelines	MOH	National	Ministry of Health Eswatini (2012)
	Ghana	Ghana COVID-19 STG	2020	Evidence-based review, expert consensus, and local AMR	MOH	National	Ministry of Health Ghana (2020)
		GNDP STG	2017	Based on evidence quality RCTs, clinical studies, and expert opinions	MOH	National	Ministry of Health Ghana (2017a)
	Kenya	Kenya AMS Guidelines	2020	Based on AMS spectrum, development, and implementation of systems and interventions	MOH	National	Ministry of Health Kenya (2020)

(Continued on following page)

TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
		Kenya AMS Protocol	2020	Multiregional stepwise stewardship intervention: 18-month ASP adaptation	KNRF	Local	Gitaka et al. (2020)
		Kenya AMS Guidelines	2012	GRADE	MMS	National	Agweyu et al. (2012)
	Nigeria	Nigeria ICU Guidelines	2023	Based on evidence-based published data and local prospective antibiograms	Expert Committee	National	Oladele et al. (2023)
		Nigeria STG	2016	Evidence-based guidelines	MOH	National	Ministry of Health Nigeria (2016)
	Tanzania	STG/NEMLIT	2021	NEMLIT new edition aligns with WHO recommendations	MOH/CD	National	Ministry of Health Tanzania (2021)
		AMS Policy Guidelines	2020	Evidence-based recommendations aligned with WHO AMR Action Plan and local data	MOH	National	Ministry of Health Tanzania (2020)
		STG-NEMLIT	2017	Evidence-based recommendations, expert consensus, and local AMR data	MOH	National	Ministry of Health Tanzania (2017)
	Zambia	ENC Guidelines	2014	Evidence-based guidelines	MCD/MCH	National	Ministry of Health Zambia (2014)
LIC	Ethiopia	Ethiopia PH STGs	2014	Evidence-based recommendations aligned with WHO EML and local disease burden	MOH	National	Ministry of Health Ethiopia (2014)
	Malawi	MSTG 5th Edition	2015	Evidence-based guidelines	MOH	National	Ministry of Health Malawi (2015)
	Madagascar	(Madagascar IG) Guide	2020	Evidence-based, expert consensus, and local disease burden	Ministry of Public Health	National	Ministry of Health Madagascar (2020)
		Antibiotika Tsara	2018	Digital tool combining local AMR data and stewardship algorithms	SPIM	Local	SPIM. Antibiotika Tsara (2018)
	Rwanda	Rwanda Guidelines	2022	Based on available evidence and literature review	MOH	National	Ministry of Health Rwanda (2022)
		Rwanda COVID-19 Guidelines	2020	Evidence-based expert consensus in alignment with WHO recommendations	RBC	National	Ministry of Health Rwanda (2020)
	South Africa	SA Hospital AMR Guidelines	2023	Policy framework aligned with WHO and national AMR action plans	NDH	National	Department of Health South Africa (2023)
		Africa CDC Guidelines	2021	Evidence-based expert consensus in alignment with local AMR data	Africa CDC and OHT	International	African Union (2021)
		AMPATH Guidelines	2017	Laboratory-driven, local antibiograms and diagnostic protocols	AMPATH	National	AMPATH Antibiotic Guide (2017)
		SA CAP Guidelines	2017	Evidence-based expert consensus	SATC	National	Boyles et al. (2017)

(Continued on following page)

TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
		SAASP Pocket Guide	2014	Evidence-based expert consensus and local resistance data	SAASP	National	SAASP (2014)
	Uganda	Uganda Clinical Guidelines	2023	Evidence-based expert consensus	MOH	National	Ministry of Health Uganda (2023)
		Uganda Guidelines	2020	Ugandan approach combines WHO guidance, national policies, and local innovation	MOH	National	Ministry of Health Uganda (2020)
	Zimbabwe	EDLIZ Guidelines	2015	Evidence-based guidelines	NMTPAC/ MOH	National	Ministry of Health Zimbabwe (2015)
Eastern Mediterranean Region							
HIC	Bahrain	TG and pathways	2022	Evidence-based guidelines	NHRA	National	NHRA Bahrain (2022)
	Oman	Oman AMS Guidelines	2016	Evidence-based recommendations and expert consensus aligned with international standards	MOH	National	Ministry of Health Oman (2016)
		Oman SAP Guidelines	2015	National Antimicrobial Subcommittee (surgical team practice-based)	MOH	National	Ministry of Health Oman (2015)
	Qatar	Qatar CAP Guidelines	2016	Evidence-based recommendations aligned with WHO standards	MOH	National	Ibrahim (2016)
	Saudi Arabia	UTI infection protocol	2023	Evidence-based recommendations aligned with IDSA, WHO, and local AMR	MOH	National	Ministry of Health Saudi Arabia (2023)
		Lower RTI protocol	2020	Evidence-based expert consensus	MOH	National	Ministry of Health Saudi Arabia (2020)
		NAT-G for CAP–HAP Adults	2018	Evidence-based selection and local epidemiology of antimicrobial resistance	MOH	National	Ministry of Health Saudi Arabia (2018)
		Saudi CAP In adults	2017	Evidence-based recommendations, expert consensus, and literature review	SPIDS	National	Alzomor et al. (2017)
	UAE	UAE IAI Guidelines	2022	Evidence-based recommendations aligned with local AMR data	N-ASC	National	Ministry of Health UAE (2022)
LMIC	Egypt	Egypt Preauthorization Guidelines	2022	Based on Egyptian Hospital Antimicrobial Data	EDA/NARC	National	Egypt Drug Authority Guideline (2022)
	Lebanon	LSIDCM CAP Guidelines	2014	Evidence-based recommendations adapted to Lebanese local AMR	LSIDCM	National	Moghnieh et al. (2014)
	Pakistan	Bahria Hospital Guidelines	2023	Hospital formulary and stewardship-driven recommendations	BIH	Local	Bahria International Hospital Guideline (2023)
		Typhoid Management Guidelines	2022	Evidence-based local resistance surveillance and expert consensus	MMIDSP	National	MMIDSP Guideline (2022)

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TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
		DRAP Guidelines	2022	Regulatory framework aligned with WHO Global Action Plan on AMR	DRAP	National	DRAP Guidelines (2022)
		PCS COPD Guideline	2020	Evidence-based	PCS	Local	Pakistan Chest Society Guideline (2020)
		MMIDSP IDSP and PARN Guidelines	2019	Evidence-based recommendations and expert consensus	MMIDSP IDSP/PARN	Local	IDSP and PARN Guidelines (2019)
		PCS Guidelines for CAP in adults	2017	Evidence-based expert consensus and local resistance data	PCS	National	Bokhari et al. (2017)
		SGP Pakistan	2015	Evidence-based locally adapted sepsis management	AKU	Local	Hashmi et al. (2015)
LIC	Somalia	Somali STGs	2015	Evidence-based data aligned with WHO EML	MOH	National	Ministry of Health Somalia (2015)
European Region							
HIC	Czech Republic	Czech CDI Guidelines	2022	Evidence-based guideline updated version	DID	Local	Beneš et al. (2022)
	Denmark	Danish Antibiotic Guidelines	2013	Evidence-based practices, laboratory testing, and rational use of antibiotics	DHMA	National	Danish Health and Medicine Authority Guidelines (2013)
	Germany	German LRTI Guidelines	2024	Clinical experts collaborated on recommendations	GSPID/AWMF	National	Mauritz et al. (2024)
		Pediatric CAP Guidelines	2020	Evidence-based review and expert consensus	PCAP-DGPI/GPP	National	Rose et al. (2020)
		German ABS Guidelines	2016	Evidence-based grading according to the AWMF Guidance Manual	GSID	International	De With et al. (2016)
		GT Guidelines	2015	Evidence-based review, expert consensus	GSO and HNS	National	Windfuhr et al. (2016)
		German CAPNETZ Guidelines	2009	Key points based on the Oxford Center for evidence-based structures	Paul-Ehrlich-SC, GRS, GSI, and CAPNETZ	National	Höffken et al. (2009)
	Ireland	CHI-Antimicrobial Guidelines	2020	Evidence-based recommendations, local resistance data, and expert consensus	CHI	National	CHI Guideline Ireland (2020)
		PiPc children Guidelines	2016	Two-round modified Delphi consensus method	DGP RCS/ CPRG	Local	Barry et al. (2016)
	Italy	UTI-Ped-ER Guidelines	2023	GRADE	UTI-Ped-ER	Local	Autore et al. (2023)
		SITA-SIP COVID-19 Guidelines	2021	GRADE	SITA/SIP	National	Bassetti et al. (2021)
	Netherlands	SWAB CAP Guidelines	2024	GRADE	SWAB/ NVALT	National	Guideline Netherlands (2024)
		CDSS-Antibiotics-2022	2022	Developed CDSS for empirical antibiotic therapy, involving stakeholders	Erasmus MC and UMC	Local	Akhloufi et al. (2022)
	Russia	COPD Guidelines	2018	Evidence-based review and expert consensus	RRS	National	Aisanov et al. (2018)

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TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
	Scotland	CDI Guidelines	2014	Evidence-based recommendations and expert consensus	NHS, HPN, and HPS	National	Health Protection Scotland (2014)
	Slovenia	Slovenia Neurosurgical Guidelines	2014	Evidence-based recommendations for neurosurgical prophylaxis	SMA	National	Slovenian Guidelines (2014)
	Spain	MSF Clinical Guidelines	2024	Evidence-based, context-adapted protocols for resource-limited settings	MSF	International	MSF Clinical guidelines (2024)
		V Spanish Consensus Guidelines	2022	Systematic review of scientific evidence, Delphi process, and GRADE	VSCC	National	Gisbert et al. (2022)
	Sweden	Swedish CAP Guidelines	2012	Evidence-based review and expert consensus	SSID	National	Spindler et al. (2012)
	Switzerland	Swiss PAP Guidelines	2022	Evidence-based, database-informed surgical prophylaxis	PIGS	National	Paioni et al. (2022)
	Trinidad and Tobago	T&T ARI Guidelines	2020	GRADE	MOH	National	Nagassar (2020)
	UK	GMMMG Guidelines	2024	Evidence-based	GM HCCM	Local	Greater Manchester (2024)
		BSW ICB Guidelines	2024	Evidence-based	BSW-ICB	Local	BSW ICB Guidelines UK (2024)
		Pneumonia NICE Guidelines	2023	GRADE	NICE	International	NICE Guidelines (2023)
		BTS Guidelines	2020	GRADE	BTS	National	Smith et al. (2020)
		UK BASH HIV NG	2020	Evidence-based review and expert consensus	BASHH	National	Chirwa et al. (2021)
		AMP Dentistry-GPG	2020	GRADE	FDS-RCS	National	GP Guidelines UK (2020)
		HAP NICE Guidelines	2019	Evidence-based review and expert consensus	NICE	International	NICE HAP Guideline (2019)
		CAP-APG	2019	GRADE	NICE	International	NICE CAP Guideline (2019)
		BSAC Guidelines ED	2012	Evidence-based review, expert consensus	BSAC	National	Gould et al. (2012b)
UMIC	Georgia	GPAS CAP Guidelines	2023	Evidence-based review and expert consensus	Children's healthcare	National	Georgia Pediatric Antibiotic Stewardship (2023)
Region of the Americas							
HIC	Canada	CCPG-rhinosinusitis	2011	Evidence-based review and expert consensus	CSOHNS and CRWG	National	Desrosiers et al. (2011)
		CA-MRSA-2006	2006	Evidence-based review and expert consensus	CMA and CIDS	Local	Barton et al. (2006)
	United States	IDSA Guidelines	2024	GRADE	IDSA	International	Tamma et al. (2024)
		Sanford-VAP	2024	Evidence-based recommendations	Jay P. Sanford	International	Sanford Guideline (2024)
		CDC-Antibiotic-	2024	Evidence-based practices and expert consensus	CDC	National	CDC Guidelines (2024)
		SCCM-corticosteroids	2024	GRADE	SCCM	international	Chaudhuri et al. (2024)

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TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
		IWGDF/IDSA-DFI	2023	GRADE	IWGDF and IDSA	International	Senneville et al. (2024)
		Michigan UTI Guidelines	2021	Evidence-based review and expert consensus	MHHA	International	MHHA Guideline (2021)
		AAP-Red Book-	2021	GRADE	AAP	International	Red Book (2021)
		IWGDF/IDSA-DFI	2020	GRADE	(IWGDF/ IDSA	International	Lipsky et al. (2020)
		ATS CAP Guideline	2019	GRADE	ATS &IDSA	International	Jackson et al. (2020)
		IDSA OPAT Guidelines	2018	GRADE	IDSA	International	Norris et al. (2019)
		IDSA Diarrhea	2018	GRADE	IDSA	International	Randel (2018)
		IDSA/SHEA CDI Guidelines	2017	GRADE	IDSA/ SHEA	International	McDonald et al. (2018)
		Adult and pediatric APG	2017	Evidence-based and systematic review consensus	DOH	National	CDC (2017)
		AAO-HNS-OME	2016	Evidence-based review and expert consensus	AAO-HNS	International	Rosenfeld et al. (2016)
		ACG-diarrhea-	2016	Evidence-based review and expert consensus	ACG	International	Riddle et al. (2016)
		ACP/CDC-ARTI	2016	Evidence-based practices	ACP/CDC	National	Bredemeyer (2016)
		AAO-HNS Guidelines	2015	GRADE	AAO-HNS	International	Rosenfeld et al. (2015)
		IDSA-SSTI-Guidelines	2014	Evidence-based review and expert consensus	IDSA	International	Stevens et al. (2014)
		ASHP-surgical	2013	GRADE	ASHP, IDSA, SIS, and SHEA	International	Bratzler et al. (2013)
		IDSA ABRS Guidelines	2012	GRADE	IDSA	International	Chow et al. (2012)
		AAP-UTI	2011	GRADE	AAP	International	Roberts et al. (2011)
		CAP Guidelines PIDS/IDSA	2011	GRADE	PIDS and IDSA	International	Bradley et al. (2011)
		ACC/AHA-IE-	2008	Evidence-based and expert consensus	ACC/AHA	International	Nishimura et al. (2008)
		AAO-HNS-sinusitis-	2007	Evidence-based recommendations	AAO-HNS	International	Rosenfeld et al. (2007)
		ACCP CG	2006	GRADE	ACCP	International	Braman (2006)
		IDSA GAS-pharyngitis	2002	Evidence-based systematic review consensus	IDSA	International	Bisno et al. (2002)
		IDSA-ID-	2001	Evidence-based systematic review consensus	IDSA	International	Guerrant et al. (2001)
		AAP-CPG-sinusitis	2001	Evidence-based systematic review consensus	AAP	National	Pediatrics (2001)
		IDSA CAP Guidelines	1998	Expert consensus and literature review	CID and IDSA	International	Bartlett et al. (1998)
UMIC	Brazil	Brazilian CAP Guidelines	2009	Evidence-based recommendations, expert	BTS	National	Corrêa et al. (2009)

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TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
				consensus, and literature review			
		Brazilian CAP Guidelines	2004	Evidence-based recommendations and expert consensus	BSP	National	Nascimento-Carvalho and Souza-Marques (2004)
	Guyana	Guyana STG	2015	Evidence-based recommendations, expert consensus, and local AMR	MOH	National	Ministry of Health Guyana (2015)
	Jamaica	Jamaican UTI Guidelines	2018	Evidence-based review and expert consensus	JKKF	National	Young Peart et al. (2018)
Southeast Asia Region							
UMIC	Maldives	Maldives NAMSP	2020	National policy framework for antimicrobial stewardship and resistance control	MOH	National	Ministry of Health Maldives (2020)
	Thailand	Asthma Guidelines	2022	Evidence-based	TAC	National	Kawamatawong et al. (2022)
	Bangladesh	BSMMU Guidelines	2023	Evidence-based recommendations aligned with local antibiograms	BSMMU/ WHO	National	BSMMU Guideline Bangladesh (2023)
		Bangladesh STG	2021	Evidence-based protocols aligned with WHO standards	MOH	National	Ministry of Health Bangladesh (2021a)
		AP for BIRDEM Hospital	2021	Hospital-specific recommendations based on local AMR data and expert consensus	BGH	Local	BIRDEM Hospital Bangladesh (2021)
LMIC	Bhutan	Bhutan-ABG	2018	Evidence-based review and expert consensus	MOH	National	Ministry of Health Bhutan (2018)
	Timor-Leste	Antibiotic Guidelines HNG	2016	Evidence based guidelines	HNGV	National	Hospital Guidelines Timor Leste (2016)
	India	Indian ICU-IC Guidelines	2019	Evidence-based recommendations, systematic reviews, and expert consensus	ICMR/CCS	Local	Kulkarni et al. (2019)
		ICU Antibiotic Guidelines	2019	Evidence-based expert consensus aligned with local AMR data	ISCCM	National	Khilnani et al. (2019)
		India AMR Guidelines	2016	Evidence-based protocols aligned with WHO GAP	NCDC/MOH	National	Ministry of Health Guideline India (2016)
	Myanmar	Myanmar NOGTH Guidelines	2019	Evidence-based recommendations aligned with WHO standards to combat AMR	GTH and WHO	Local	Antibiotic Guidelines Myanmar (2019)
	Sri Lanka	Sri Lanka AMR Guidelines	2024	Evidence-based guidelines	SCM/ MOH/NIM	National	Ministry of Health Srilanka (2016)
		SLMA Guidelines	2014	Evidence-based guidelines	SLMA	National	SLMA Guidelines (2014)
Western Pacific Region							
HIC	Australia	TG Antibiotic Guidelines	2024	Evidence-based recommendations	TGL	National	Therapeutic Guidelines Australia (2024)

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TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
		CHQ-P Antibiocard	2024	Initial treatment recommendations, AS, daily review, and TDM.	CHQ-P	Local	CHQHospital. Children (2022)
		SAP Guidelines	2021	Evidence-based review and expert consensus	Govt. SAAGAR	Local	SAP Guideline Australia (2021)
		KHA-CARI UTI Guidelines	2015	GRADE	KHA-CARI	National	McTaggart et al. (2015)
	Brunei Darussalam	Brunei Darussalam GAPP	2019	Stewardship-focused recommendations and expert consensus aligned with WHO standards	MOH	National	Ministry of health Brunei Darussalam (2019)
	Cook Islands	Cook Islands-ABG	2023	Evidence-based local AMR data	MOH	National	Ministry of Health Cook Islands (2023)
	Japan	JGA CD Guidelines	2023	Evidence-based recommendations, expert consensus, and local data	JGA	National	Ihara et al. (2024)
		JSSI Guidelines	2021	GRADE Delphi method	JSSI	International	Ohge et al. (2021)
		Japan AMS Manual	2017	Evidence-based recommendations, expert consensus, and RCTS.	MOH/ LWHSBT/ IDCD	National	Ministry of Health Japan (2017)
		JRS CAP Guidelines	2006	Evidence-based recommendations, expert consensus, and local data	JRS	National	Miyashita et al. (2006)
	Korea	Korean AGE Guidelines	2019	GRADE	KSID/KSAD	National	Kim et al. (2019)
		Korean UTI Guidelines	2018	Evidence-based local resistance and expert consensus	KSID	National	Kang et al. (2018)
		KGU-CAP-	2018	Evidence-based review and expert consensus	KGU	National	Lee et al. (2018)
		KGU-ARTI	2017	Evidence-based review, expert consensus	KGU	National	Yoon et al. (2017)
		Korea BJI Guidelines	2014	GRADE	KSC	National	Korean Society for Chemotherapy et al. (2014)
	New Zealand	BPAC^{nz}primary care AG	2024	Evidence-based review, expert consensus, and local AMR	BPAC^{nz}	Local	bpacnz Guide New Zealand (2024)
		BPAC^{nz}-ABGuide	2017	Evidence-based review and expert consensus	BPAC	National	bpacnz Guide New Zealand (2017)
		ANZPID-ASAP Guidelines	2016	Evidence-based recommendations, expert consensus, and local AMR	ANZPID-ASAP	National	ANZPID-ASAP Guideline (2016)
	Singapore	Singapore SAP Guidelines	2022	ADAPTE method and evidence-based grading	NCID	National	Chung et al. (2022)
	Taiwan	Taiwan MDRO Guidelines	2022	Evidence-based recommendations, expert consensus, and local Ardita	TSM and iDST	National	Sy et al. (2022)
		Taiwan UP Guidelines	2011	Evidence-based consensus guidelines aligned with international standards and local AMR data	TUA	National	Chou et al. (2011)
		Taiwan CAP Guidelines	2008	Based on epidemiologic data, clinical studies,	TPA	National	Lee et al. (2007)

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TABLE 2 (*Continued*) Global variation in antibiotic prescribing guidelines.

Income level	Country	Guideline abbreviation	Publication date	Methodology	Prepared by	Scope	Reference
				laboratory investigations, and imaging studies			
		Taiwan Surgical Prophylaxis Guidelines	2004	Evidence-based recommendations, expert consensus, and local resistance data	IDSC/TSA	National	IDSC Taiwan Surgical Association (2004)
		Taiwan UTI Guidelines	2000	Based on expert consensus and review of the existing literature	IDSC/TSA	National	IDSC Taiwan Guidelines (2000)
UMIC	China	Chinese HAP/VAP Guidelines	2018	GRADE	CTS and CMA	National	Shi et al. (2019)
		CTS CAP Guidelines	2016	Evidence-based recommendations, expert consensus, and local data	CTS and CMA	National	Cao et al. (2018)
	Fiji	Fiji Antibiotic Guidelines	2019	Evidence-based expert opinion	MOH and MSGF	National	Ministry of Health Fiji (2019a)
	Malaysia	Malaysia NAG	2024	Evidence-based guidelines evolve over time	MOH	National	Ministry of Health Malaysia (2024)
		Malaysia NAG	2014	Aligns with the AMS Program and incorporates updated evidence on AMR	MOH	National	Ministry of Health Malaysia (2014)
		PPUKM Guidelines	2012	Interdisciplinary panel updates evidence-based guidelines	MOH	National	PPUKM Malaysia Guideline (2012)
		Malaysia NAG	2008	Based on current evidence, drug formulary, and AMR patterns	MOH	National	Ministry of Health Malaysia (2008)
LMIC	Cambodia	CPG SAT guidelines	2016	Revision of the original practice guidelines	SHCH/HMC	International	SHCH/HMC (2016)
	Papua New Guinea	PNG HIV Guidelines	2019	Evidence-based recommendations, expert consensus, and data	NDOH	National	National department of Health Papua New Guinea (2019)
		PNG Pediatric STGs	2016	Evidence-based expert review	PSPG	National	STGs Papua New Guinea (2016)
		PNG Adult STGs	2012	Evidence based scoping reviews, field research, and epidemiological principles	NDOH/WHO	National	NDOH/WHO Papua New Guinea (2012)
	Philippines	PIDS Antibiotic Guidelines	2017	Review of evidence-based local and international guidelines and literature	NAGCOM	National	NAGCOM Philippine Guideline (2017)
		PSMID UTI Guidelines	2015	Evidence-based recommendations, expert consensus, and local AMR	PSMID	National	PSMID UTI Guidelines Philippine (2015)
	Samoa	PIOA Guidelines	2017	Evidence-based guidelines	PIOA	Local	PIOA Guidelines Samoa (2017)
LIC	Tuvalu	TST Guidelines	2010	Evidence-based practice	MOH	National	Ministry of Health Tuvalu (2010)
	Solomon	Pacific Islands Pediatric STGs	2017	Evidence-based pediatric care protocols	UNICEF and WHO	National	STGs Solomon (2017)
		Solomon Islands NCD Guidelines	2011	Evidence-based, WHO recommendations and local and international input	MOH/MS and WHO	National	Ministry of Health Solomon (2011)

NB: HIC, high-income country; UMIC, upper-middle income country; LMIC, lower-middle income country; and LIC, low-income country.

4 Discussion

Since the development of antibiotic prescribing guidelines is usually an expensive and time-consuming process, requiring an expert' team developed on the basis of the best available evidence, systematic reviews, and sound clinical understanding, there are likely to be disparities among countries with different income levels. HICs generally had more extensive and consistently updated clinical practice guidelines (CPGs) compared to LMICs, largely due to greater demand for care and better access to the resources, infrastructure, and expertise required for the development of such guidelines (Owolabi et al., 2018). For example, guidelines from the UK's NICE, the US IDSA, and the Netherlands' SWAB are based on rigorous methodologies, frequent updates, and comprehensive AMR integration (Greater Manchester, 2024; Tamma et al., 2024; Guideline Netherlands, 2024). Meanwhile, guidelines from LMICs, such as Nigeria's National STGs and Ethiopia's Standard Treatment Guidelines, particularly those from LICs, fell short in terms of coverage, quality, and content (Ministry of Health Ethiopia, 2014; Ministry of Health Nigeria, 2016).

As evidence-based decision-making has become a global standard for health interventions, the GRADE framework is increasingly used for the development of clinical guidelines (Baral et al., 2012; Park et al., 2015; Boon et al., 2021). HICs, supported by robust infrastructure and expert panels, have extensively implemented GRADE to provide transparency and methodological strength in recommendations (Bayona et al., 2017). For example, guidelines developed by the Infectious Diseases Society of America (IDSA), the American Thoracic Society (ATS), and UK bodies such as NICE and the British Thoracic Society (BTS) used GRADE consistently to integrate high-quality evidence and improve the implementation of antibiotic prescribing protocols (Jackson et al., 2020; NICE Guidelines, 2023; Smith et al., 2020; Gould et al., 2012a). In contrast, LMICs often rely on expert consensus due to limited resources, training, and access to evidence (Mzumara et al., 2023). Although several LMICs, including Pakistan, Ghana, Timor-Leste, and Rwanda, have developed evidence-based national treatment guidelines, their development is typically challenged by limited surveillance data, restricted funding, and suboptimal laboratory infrastructure (MMIDSP Guideline, 2022; Ministry of Health Ghana, 2017a; Hospital Guidelines Timor Leste, 2016; Ministry of Health Rwanda, 2022). These limitations also impede the routine use of systematic reviews and localized AMR data to inform prescribing.

Strengthening national efforts to combat AMR requires the development of guidelines that are both globally informed and locally applicable, as emphasized by the WHO. However, many LMICs lack the necessary infrastructure to support such efforts, particularly in terms of robust AMR surveillance systems. In these countries, either there is no routine national antibiogram reporting or the systems are fragmented and limited to isolated institutions (Gandra et al., 2020; Peters et al., 2024; Iskandar et al., 2021). A strong surveillance system typically includes nationwide coverage alongside standardized data collection, timely reporting, and integration with treatment guideline development (Nsubuga et al., 2011; Yang et al., 2020). The absence of these features in several LMICs undermines the ability to track resistance patterns and update empiric treatment guidelines accordingly (Gandra et al., 2020). Consequently, prescribers might find it challenging to match their practices with the WHO AWaRe book guidance; however, the AWaRe system provides a good starting point, particularly given its increasing use to monitor antibiotic use, including among LMICs, and the ongoing efforts to strengthen surveillance systems in these settings (Do et al., 2023; Iskandar et al., 2021; Tawfick et al., 2023). As a result, many LMICs are now working to implement more effective resistance surveillance in line with WHO goals. Local adaptation of the AWaRe guidance is key to support its use and enhance the effective management of infectious diseases. Local resistance trends contained within national and regional AMR surveillance data must inform first-line treatment choices, ensuring that guideline recommendations reflect local resistance profiles rather than relying merely on global trends (Mastrangelo et al., 2021). For instance, Rwanda's susceptibility-guided empiric therapy and Kenya's formulary mapping provide an example of how national guidance can be customized based on local data (Ministry of Health Rwanda, 2022; Gitaka et al., 2020). However, many LMICs lack comprehensive antibiograms, resulting in empiric overuse of broad-spectrum antibiotics, which should now be limited under the WHO AWaRe framework and guidance. This was evident in several guidelines included in our review. This included those from Nigeria, Ethiopia, and Malawi, which provided syndromic treatment recommendations without referencing local resistance data (Ministry of Health Ethiopia, 2014; Ministry of Health Malawi, 2015; Ministry of Health Nigeria, 2016). Addressing this gap involves investment in laboratory infrastructure and the training of healthcare professionals to correctly interpret and apply surveillance (Nishimura et al., 2008). This is important if LMICs are to achieve their AMR goals within their NAPs.

In HICs, AMS initiatives usually involve EHR audits, rapid diagnostics, and multidisciplinary stewardship teams to enhance appropriate antibiotic use. These technologies and institutional structures are usually lacking in LMICs. Scaling up such efforts across sectors will be critical to limiting unnecessary empiric antibiotic use and enhancing treatment outcomes (Bankar et al., 2022).

Financial barriers may also restrict the implementation of guidelines in LMICs as appreciable resources are typically needed in guideline development and adaptation (Baral et al., 2012). Technical requirements, ethical considerations, infrastructural barriers, and overburdened health systems, coupled with the lack of sufficient funding, typically prevent effective and meaningful implementation of clinical trials and other studies in LMICs to improve future antibiotic use. Consequently, it can be difficult to make conclusions regarding the applicability of guidelines that are applicable in HICs but could be a problem among LMICs (Stokes et al., 2016). To achieve success, strategies need to be adapted to overcome local resistance profiles, invest in AMS activities and diagnostics, and develop global partnerships to turn theory into practical and equitable solutions to address AMR in LMICs.

Educating key stakeholders, including prescribers and patients, about WHO AWaRe principles, including the importance of prioritizing Access over Watch antibiotics and avoiding unnecessary broad-spectrum antibiotic use, can strengthen AMS efforts at the population level (Saleem et al., 2025c). This is because patient education and counseling play crucial roles in improving antibiotic use, especially in LMICs, and enhancing healthcare

outcomes (Saleem et al., 2025c). Counseling interventions often incorporate practical tools and follow-up care to support adherence. The British Thoracic Society's 2020 Long-Term Macrolide Guidelines suggest written materials on therapy risks/benefits, whereas the ACCP 2006 Chronic Cough Guidelines advise patients on symptom relief and the self-limiting nature of viral bronchitis (Smith et al., 2020; Braman, 2006). Post-discharge instructions, including those in the SCCM 2020 Sepsis Guidelines, incorporate monitoring for secondary infections and corticosteroid-related side effects (Weiss et al., 2020). Effective counseling not only reduces unnecessary antibiotic use but also educates patients to engage in stewardship efforts, which include reducing requests and expectations for antibiotics for self-limiting viral infections for themselves or their children (Saleem et al., 2025c). In combination, these strategies connect clinical practice and community education, creating a unified front to reduce unnecessary antibiotic use and associated AMR, which is particularly important in LMICs (Mastrangelo et al., 2021).

We acknowledge that our study has limitations. We considered only English-language guidelines that were openly accessible, potentially leading to an overrepresentation of guidelines from HICs, particularly those in the European Region. There were also several countries for which we could not find guidance documents, and we encourage these countries to make their guidelines open-access and readily available to key stakeholder groups, including the general public. Similarly, our research might have missed documents depending on the search queries and engines used. However, we sought to include as many guiding documents as possible. Consequently, we believe our findings are robust and provide valuable direction for future work.

5 Conclusion

We found significant disparities in the availability, structure, and methodological rigor of guidelines across countries with different income levels. HICs commonly apply evidence-based frameworks such as GRADE, incorporate local AMR data, and have embedded stewardship strategies in the development of their antibiotic guidelines. This contrasts with many guidelines from LMICs, which remain generalized, outdated, and often rely on expert opinion due to limited resources, diagnostic capacity, and surveillance infrastructure. The incorporation of WHO AWaRe Book recommendations, as well as the extent to which current guidelines addressed patient education, AMR surveillance, and stewardship strategies, was also more evident in guidelines from HICs. In contrast, these components were often lacking in guidelines from LMICs, with patient education and surveillance data particularly underrepresented. The WHO AWaRe framework and Book provide a vital stepping stone, especially for LMICs; however, its successful implementation in LMICs relies on equity-led reforms. By prioritizing context-specific guidelines, increasing funding for diagnostics and stewardship, and fostering global partnerships, LMICs can transform the AWaRe framework and the associated guidance into practical and effective solutions to combat rising AMR rates. This approach will not only addresses current disparities but also help preserve the efficacy of antibiotics for future generations.

Author contributions

EJ: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review and editing. ZS: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing. BG: Conceptualization, Formal Analysis, Methodology, Validation, Visualization, Writing – original draft, Writing – review and editing. MU: Conceptualization, Data curation, Investigation, Methodology, Validation, Writing – review and editing. AA: Data curation, Formal Analysis, Investigation, Methodology, Writing – review and editing. AH: Conceptualization, Formal Analysis, Methodology, Supervision, Validation, Writing – review and editing. JM: Conceptualization, Formal Analysis, Methodology, Visualization, Writing – original draft, Writing – review and editing. MQ: Conceptualization, Data curation, Investigation, Methodology, Visualization, Writing – original draft, Writing – review and editing. SA: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review and editing.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fphar.2025.1600787/full#supplementary-material

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