

Antimicrobial Resistance in Developing Countries: A Systematic Review [†]

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Abstract: Antimicrobial resistance is a challenge that threatens the whole global community. The burden of antimicrobial resistance is higher in developing countries than anywhere else. The effects of antimicrobial resistance are scantily reported in developing countries. Hence, we tend to pander to the reports from other parts of the world while neglecting the developing regions. This study aims to analyse the published literature on antimicrobial resistance in developing countries. A systematic review was carried out in PubMed and included recent studies (2013–2023). Article screening used relevant search strategies and strict inclusion and exclusion criteria. The initial search identified 18,958 studies, and after undergoing strict screening, 24 studies were included in the systematic review. Widespread cases of antimicrobial resistance were unearthed across developing nations. The most common pathogens reported for resistance were *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aureus*, and *Klebsiella pneumoniae*. The continued resistance of these pathogens is due to the overuse and misuse of antimicrobials in human and animal medicine practices. Different challenges worsen the threat of antimicrobial resistance in developing countries. Poor surveillance and diagnostic ability hinder the efficient analysis of resistance trends and patterns in these regions. Unregulated use of antibiotics and fragmented healthcare systems that promote self-diagnosis worsen the threat of antimicrobial resistance in developing countries. These challenges can be addressed by strengthening regulations on antimicrobial use, improving surveillance, collaboration between human and animal medical practices, and improving societal awareness. It is important to arrest the effect of antimicrobial resistance in developing countries by adopting a sustainable approach to safeguard the efficacy of these antimicrobials and prevent huge numbers of deaths due to resistance.

Keywords: Antimicrobial resistance; bacteria; developing countries; low-income countries; pathogens

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1. Introduction

Antimicrobial resistance (AMR) is a significant and complicated threat that poses a critical concern for humanity today (Prestinaci, Pezzotti, and Pantosti 2015). The consequences of this escalating threat are significant, extending well beyond the scope of individual patients (Naylor et al. 2018). Microorganisms have evolved antimicrobial resistance (AMR) to several pharmaceutical agents due to heightened selection pressure from the inappropriate use and application of antimicrobial substances (Salam et al. 2023). Antibiotics, once regarded as very effective medications, are progressively losing their efficacy against this persistent opponent.

Antimicrobial resistance (AMR) transcends being solely a medical concern since it poses a formidable challenge to the fundamental pillars of our worldwide public health

systems. The emergence of drug-resistant bacteria poses a significant threat to the efficacy of crucial medical interventions, therefore transforming commonplace illnesses into potentially life-threatening conditions, transcending geographical and cultural boundaries (Serwecińska 2020). However, in the middle of this worldwide battle, it is the developing nations who experience the most impact of this burden (Ayukekbong, Ntemgwa, and Atabe 2017).

Healthcare resources in these locations are limited, and the existing resources are frequently strained to their maximum capacity. Hospitals, clinics, and health centres are confronted with a limited supply of antibiotics, resulting in healthcare providers facing a diminishing array of choices to address illnesses (Fair and Tor 2014). The scarcity is exacerbated by insufficient infrastructure, wherein the absence of suitable sanitation and hygiene facilities creates an environment conducive to the proliferation of drug-resistant microorganisms (Ventola 2015; Chua et al. 2021). In settings where the threat of antimicrobial resistance (AMR) looms, routine medical operations, including surgery and deliveries, can transform into precarious undertakings (GOV.UK 2014).

However, the challenge has yet to conclude at this point. The complicated interplay of complex socioeconomic elements inside these nations further exacerbates the threat. The interplay between poverty, inadequate education, and restricted healthcare access engenders a pernicious loop wherein illnesses proliferate unabatedly, and the prevalence of antibiotic abuse reaches disconcerting levels (Alividza et al. 2018; Serrano 2022). In several developing countries, the accessibility of antibiotics without needing a prescription has resulted in improper use, hence playing a substantial role in the emergence of resistance strains (Ayukekbong, Ntemgwa, and Atabe 2017). The objective of this study is not only to measure the extent of antimicrobial resistance (AMR) in developing countries but also to comprehend the complex array of obstacles that contribute to its persistence. By employing rigorous data-gathering methods, doing extensive literature reviews, and conducting thorough analyses, this study aims to provide a complete understanding of the current state of antimicrobial resistance (AMR) in these regions.

2. Methods

2.1. Selection Criteria

During the process of conducting this systematic review, a set of stringent criteria was devised in order to guarantee the inclusion of papers that are both pertinent and of high quality. The examination of the subject was limited to publications published from 2013 to 2023, ensuring a contemporary perspective. The present study incorporated research conducted in developing regions, as per the World Bank's classification.

2.2. Database Search and Screening Process

The literature search mostly relied on PubMed. The researchers implemented a methodical search approach, including a blend of restricted vocabulary phrases (known as MeSH terms) and free-text keywords on antimicrobial resistance, developing countries, and drug-resistant diseases. The use of Boolean operators, namely AND and OR, was employed in order to enhance the search process and ascertain pertinent research papers.

The preliminary search resulted in a total of 18,958 articles that may potentially be related to the study. In order to guarantee the incorporation of research findings that specifically address the issue of antibiotic resistance in developing nations, a multi-stage screening procedure was devised. Initially, the titles and abstracts were subjected to a screening process in order to exclude works that were not pertinent to the research question. The articles that completed this step received a comprehensive evaluation of their full-text content, during which rigorous criteria for inclusion and exclusion were used. The inclusion criteria of this study comprised the selection of research articles that reported on the prevalence, trends, and contributing factors of antibiotic resistance, specifically in developing countries. Any studies that did not fulfil the defined criteria or were

done outside the designated time frame were eliminated from the analysis. After undergoing strict screening, 24 studies were included in the systematic review

2.3. Data Extraction and Synthesis

The process of data extraction was conducted with great attention to detail from the studies that were chosen. The essential details, such as the nation where the study was conducted, the study's design, the size of the sample, the detected drug-resistant microorganisms, the methods employed for antimicrobial usage, and the encountered problems, were systematically retrieved and arranged. Subsequently, the data that was retrieved underwent synthesis, enabling the attainment of a comprehensive overview of the findings across various research and areas.

This systematic review encompassed the examination and evaluation of publicly accessible data derived from previously published research. No ethical permission was necessary for this study as it did not include the participation of human participants. Furthermore, all data used in the analysis were anonymised and aggregated.

2.4. Limitations

Although extensive and systematic measures were taken to perform a thorough evaluation, several limitations were encountered in this work. The study depended on the accessibility and reliability of published research during the specified period, which may have resulted in the exclusion of more recent advancements. Furthermore, it should be noted that the review's scope was confined to the PubMed database, potentially resulting in the exclusion of pertinent research published in alternative databases or grey literature sources. This limitation may have introduced publication bias to the findings.

Notwithstanding these constraints, the meticulous approach used in this systematic review yields valuable perspectives on the obstacles and prevalence of antimicrobial resistance in developing nations, establishing the groundwork for evidence-based interventions and additional investigations in this pivotal domain of global health.

3. Results

The systematic research revealed a noteworthy trend of antimicrobial resistance (AMR) among developing countries. The occurrence of drug-resistant organisms, such as *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aureus*, and *Klebsiella pneumoniae*, exhibited a significantly extensive distribution. The study unveiled complex patterns of resistance demonstrated by the diseases that were detected. Furthermore, there have been instances where pan-resistant bacteria, which are resistant to all currently available antibiotics, have emerged.

The investigation uncovered significant geographical variations in the occurrence of antimicrobial resistance (AMR). While certain locations within developing nations reported greater resistance rates, other regions displayed comparatively lower levels. The observed discrepancies can be ascribed to differences in healthcare infrastructure, behaviours related to antibiotic usage, and socioeconomic variables.

4. Discussion

The most common pathogens reported for resistance were *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Pseudomonas aureus*, and *Klebsiella pneumoniae*. The findings highlight the pressing necessity for focused interventions aimed at mitigating the spread of resistant strains, which pose a significant risk to the efficacy of antimicrobial therapies in these specific areas. Multidrug resistance was observed as a prevalent pattern. This is comparable to the study conducted by Hassan (2020), which affirmed that the prevalence of antibiotic resistance among various bacteria, particularly *E. coli*, *Salmonella* spp., and *Staphylococcus* spp., is rapidly increasing in many agricultural production systems, habitats, and human populations inside developing nations. This alarming trend can be

attributed to inadequate management and practices. This is a notable obstacle for healthcare professionals since it restricts the range of therapy alternatives and heightens the likelihood of treatment ineffectiveness. This underscores the severity and urgency of the problem. Comprehending these resistance patterns is important in customising antimicrobial stewardship programs and guiding healthcare practitioners in selecting suitable treatment protocols.

The excessive and inappropriate use of antimicrobial agents in human and veterinary medicine has emerged as a primary causative element in the ongoing prevalence of antimicrobial resistance (AMR). The primary factors identified as contributing to the issue include suboptimal prescription procedures, self-administration of medication, and the extensive use of antibiotics in agricultural settings to promote growth and prevent animal diseases. Adetunji and Isola (2011) and Oloso et al. (2018) unveiled a substantial presence of antimicrobial medication residues in meat intended for human consumption. These findings provide more evidence that food animals serve as a significant reservoir of germs that are resistant to drugs, posing a substantial concern for the spread and transmission of bacteria that are resistant to antimicrobial agents in Africa and other developing nations. Ayukekbong, Ntemgwa, and Atabe (2017) in their study affirmed that the supply of antibiotics further exacerbates the situation without prescription in many underdeveloped nations. The results highlight the pressing necessity for rigorous rules regarding antimicrobials, highlighting the significance of appropriate prescription practices and increasing awareness among healthcare professionals, veterinarians, and the general population.

5. Recommendation and Conclusions

Mitigating antimicrobial resistance (AMR) in developing countries necessitates implementing a comprehensive and multidimensional strategy. It is of utmost importance to establish stringent restrictions for antimicrobial agents in both human and animal medicine practices. The implementation of improved diagnostic technologies is crucial in order to monitor resistance trends through enhanced surveillance systems efficiently. Establishing collaborative efforts between human and animal medical practices is of utmost importance in mitigating the proliferation of antimicrobial resistance (AMR) at the interface of humans, animals, and the environment. In addition, it is important to implement public awareness initiatives to educate communities on the prudent use of antimicrobials and the repercussions associated with antimicrobial resistance (AMR).

The results of this systematic review highlight the pressing necessity for implementing measures to address antimicrobial resistance (AMR) in developing nations. The mitigation of the effects of antimicrobial resistance (AMR) and the preservation of the efficacy of antimicrobial sustainable strategy is crucial to protect public health and mitigate a substantial number of therapies. This can be achieved by implementing better legislation, bolstering monitoring efforts, fostering multidisciplinary collaboration, and promoting public awareness.

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