A review of antibiotic resistance in Sub-Saharan Africa: current analysis and future perspectives

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Abstract

Antimicrobial resistance (AMR) poses a global issue, affecting individuals across all age groups and influencing countries across all income brackets and regions. Modern medicine has been revolutionized by antimicrobials, significantly reducing morbidity, mortality, and disability. However, their widespread use has been paralleled by the rapid emergence of AMR. Although AMR poses a global health challenge, its impact is disproportionately severe in low – and middle–income (LMICs) countries, especially in sub–Saharan Africa, where populations face a high burden of bacterial AMR. This is exacerbated by inadequate sanitation, including weak healthcare systems, which increase reliance on antimicrobial treatment. This narrative review highlights the AMR state on the African continent, key drivers of the problem, and strategies to combat it.

Keywords: antimicrobial resistance, antibiotics, sub-Saharan Africa, surveillance, National Action Plans

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1. Introduction

Antibiotics are natural, synthetic, or semi-synthetic substances that inhibit the growth of, or kill, microorganisms such as bacteria, and are used to treat or prevent infections in humans and animals (Founou, Founou and Essack, 2016). Antimicrobial Resistance (AMR) refers to a phenomenon that occurs when microorganisms such as bacteria, viruses, fungi, and parasites adapt and grow in the presence of medications that once hindered their growth (Antimicrobial Resistance Collaborators, 2022; WHO, 2023). Resistance to antibiotics develops through mutations or acquisition of resistance genes via horizontal gene transfer (HGT), as well as through mechanisms such as modification of antimicrobial targets, enzymatic degradation, efflux pumps, and reduced permeability (Founou, Founou and Essack, 2017; Martínez and Baquero, 2014). This resistance is mediated by various resistance genes that evolve as a result of antimicrobial selection pressure exerted by the appropriate and inappropriate use of

antimicrobial drugs, and is exacerbated by the lack of development of new antimicrobials (Founou, Founou and Essack, 2017).

Data on AMR in the sub-Saharan Africa region is sparse as compared to other parts of the world where such information is more readily available. This discrepancy can be attributed to insufficient laboratory capacity, surveillance, and regulatory frameworks (Elton *et al.*, 2020). The available data suggests that the trends of AMR in sub-Saharan Africa mirror the global increase in drug resistance, potentially leading to increased morbidity and mortality rates in low and middle-income countries (LMICs), where bacterial infections are prevalent. Contributing factors include inadequate access to diagnostic tools and a shortage of second-line antibiotics (WHO, 2014).

Therapeutic guidelines for empirical treatment of common life-threatening infections depend on available information regarding microbial aetiology and antimicrobial susceptibility, however, sub-Saharan Africa has limited diagnostic capacity and antimicrobial resistance surveillance (Williams, Isaacs and Berkley, 2018). Since the effectiveness of antibiotics is reduced due to persistence in trends of AMR, physicians have no alternative but to use last-resort classes of medicine such as carbapenems and polymyxins, which are not necessarily readily available in developing countries, are expensive, and have many different side-effects (Dadgostar, 2019). The purpose of review is to examine the drivers of this public health issue within the sub-Saharan African Region, and to highlight the current measures in response to achieve sustained progress in tackling AMR in the region.

2. Resistance in common pathogens across sub-Saharan Africa: from first-line to last-resort antibiotics

Antibiotic treatment therapies are commonly categorized into three distinct groups, first-line, second-line, and last rest antibiotics; first-line antibiotics consist of narrow-spectrum drugs that are the initial choice for treating infections, providing greater clinical benefit than risk, a lower resistance potential, and are often administered empirically (Moja *et al*., 2024). Second-line antibiotics are characterized as broader spectrum drugs, exhibiting a higher resistance selection profile, and are typically used when first-line antibiotics fail to treat an infection or when the use of first-line antibiotics is not appropriate, due to allergies for instance (Moja *et al*., 2024). The last-resort antibiotics (also known as the ‘reserve group’) are mainly appropriate for use when treating infections caused by multidrug-resistant (MDR) pathogens (Zanichelli *et al*., 2025).

Trends of antimicrobial resistance to first-line, second-line, and last-resort antibiotics has been vastly documented, and includes common pathogens such as *Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa*, and *Enterobacter* (ESKAPE) species. For example, a systematic review study on African countries, majority of which are in sub-Saharan Africa, examined the distribution of ESKAPE pathogens; findings indicate that these pathogens are widely distributed with *S. aureus* and *K. pneumoniae* appearing most frequently, and emphasizes the public health importance of these species, as their frequent MDR makes infections more difficult and costly to manage (Khasapane *et al*., 2024). In a Rwandan study conducted between June 2022 and January 2023, a total of 744 clinical isolates were analyzed, and ESKAPE species accounted for 207 (30%) isolates, of which 63% exhibited resistance to third generation cephalosporins (second-line antibiotics), and 32% to carbapenems (last-resort antibiotics) (Muhinda *et al*., 2025). Similarly, a Ugandan study by Bazira *et al*. (2025) conducted between 2015 and 2022, revealed an overall high resistance of ESKAPE isolates (4822 out of 5733 study isolates) to

first-line antibiotics ampicillin, penicillin, and moderate resistance to a second-line antibiotic ciprofloxacin.

Among the ESKAPE pathogens *K. pneumoniae* is clinically significant as an AMR Bloodstream infection (BSI) pathogen accounting for 80.3% (98/122) of isolates recovered from blood cultures of two major neonatal units in Botswana and South Africa; exhibiting resistance to third-generation cephalosporins (Gezmu *et al*., 2021). The study also reported that extended-spectrum β-lactamase (ESBL)- producing *K. pneumoniae* was a leading cause of BSIs in the two neonatal units in 2017. A South African study by Mthombeniet *et al*. (2024) conducted between 2014 and 2019 exclusively analyzed blood culture isolates from patients with BSIs; 746 ESKAPE blood culture isolates were identified, dominated by *S. aureus* (n=268/746; 35.9%), *Acinetobacter baumannii* (n=200/746; 26.8%), and *K. pneumoniae* (n=188/746; 15.8%). In this study substantial resistance to second-line antibiotics such as third-generation cephalosporins (3GCR) *K. pneumoniae* was reported at an incidence of approximately 85% (84.7%; n=100/118) indicating an existing high prevalence of clinically significant AMR among one of the most frequent Gram-negative causes of BSIs (Mthombeniet *et al*., 2024).

Similarly, a Tanzanian study by Silago *et al*. (2025) conducted during 2019-2020 and 2023 also analyzed blood cultures (271/1842; 14.7% study isolates) from patients with BSIs, with Gram-negative ESKAPE-related pathogens, particularly *K. pneumoniae*, and including *Escherichia coli* predominating. In this study Tanzania documented an escalation of resistance in *K. pneumoniae* to cefotaxime (a second-line antibiotic), rising from about 65% to over 93% following implementation of the national AMR action plan, while resistance to other second line antibiotics such as gentamicin and ciprofloxacin in *K. pneumoniae* was also documented, with gentamicin resistance increasing from 63.3% to nearly 95% (Silago *et al*., 2025).

The impact of AMR extends beyond bacterial infections, undermining decades of progress in the management of diseases such as HIV, tuberculosis (TB), and malaria. People living with HIV (PLWH) experience a disproportionately higher burden of AMR due to their frequent interactions with healthcare services and greater exposure to antimicrobial agents (Olaru *et al.,* 2020). While co-trimoxazole prophylaxis has reduced mortality and hospital admissions in PLWH, the administration of this drug has also contributed to resistance across multiple antibiotic classes, including cephalosporins and fluoroquinolones (Olaru *et al.,* 2020; Suthar *et al.,* 2015). The evidence demonstrates that resistance in sub-Saharan Africa is no longer confined to first and second-line treatment options but increasingly extends to last resort antibiotics due to AMR which underscores the need for strengthened antimicrobial stewardship, surveillance and policies to preserve the remaining therapies.

3. Antibiotics in the veterinary sector

The use of antibiotics in the veterinary sector is a major contributor to antimicrobial resistance (Karwowska, 2024). In sub-Saharan Africa, this practice remains widespread due to the growing need for dietary protein consumption of animal-based foods coupled with weak monitoring, poor documentation and inadequate regulation of veterinary antibiotic use further exacerbate the problem (Azabo *et al.,* 2022). An investigation in the WHO African region addressed concerns about antibiotic residues in animal products, with prevalence in low- and middle-income countries (LMICs) varying from 4% to 90% attributed to low enforcement of antimicrobial regulatory measures (Mensah *et al., 2012*). A systemic review investigating antimicrobial use in the cattle and poultry industry in sub-Saharan Africa found that in countries

such as Nigeria, Tanzania, Zambia and South Africa antimicrobials such as tetracyclines, fluoroquinolones and aminoglycosides were used for prophylactic, therapeutic and growth purposes (Azabo *et al.,* 2022). Further evidence from Ghana, Zimbabwe and Eritrea demonstrates how antimicrobials and pesticides are often sold and administered without proper prescriptions, and typically at inappropriate doses or durations (Willemsen, Reid and Assefa, 2022). This misuse is partly driven by the economic importance of livestock as a primary source of income. In Namibia, a 2022 study revealed that there was no alignment between the antibiotic policies for human and animal use and a high consumption of medically important antibiotics was high among farmers as many of these antibiotics are available for purchase on the open market (Kaupitwa, 2022).

The environmental impact of these practices is also significant. Antibiotic residues persist throughout the "farm-to-fork" pipeline, increasing the reservoir of resistant bacteria in soil, water, and food chains. Such exposure maintains sub-inhibitory concentrations of antimicrobials in the environment, which in turn facilitates horizontal transfer of resistance genes among bacterial populations (Founou, Founou and Essack, 2016). Research indicates that prolonged exposure to low levels of antibiotics creates greater selective pressure for resistance than short term exposure to higher doses (Karwowska, 2024). The misuse of antibiotics in the veterinary sector not only threatens animal health but also puts human health at risk through food, environmental and zoonotic transmission pathways. Addressing these challenges requires improved regulation of antimicrobials, stronger monitoring systems framer education to promote rational use of antimicrobials and alternative strategies for disease prevention.

4. Policy challenges and legislative responses to AMR

Despite ongoing global and regional initiatives, antimicrobial resistance (AMR) continues to rise, showing little sign of slowing down (Dadgostar, 2019). Weak regulation has contributed to this trend by making antimicrobials more accessible, affordable and frequently misused (Iwu, Korsten and Okoh, 2020). Effective solutions require recognition that human, animal and environmental health are interconnected. Consequently, the One Health approach- advocated for by the World Health Organisation (WHO)- calls for coordinated efforts among policymakers, academics and professionals across all sectors to strengthen systems that address AMR (McEwen and Collignon, 2018). In sub-Saharan Africa the One Health approach has quickly spread across several regions with initiatives most prevalent in East Africa, followed by Southern Africa and Central Africa and West Africa, respectively. The main One Health initiatives include Afrique One, the Southern African Center for Infectious Disease Surveillance (SACIDS Foundation for One Health), and One Health Central and Eastern Africa (OHCEA) consortium (Gahamanyi *et al.,* 2023).

A major policy challenge in sub-Saharan Africa is the widespread practice of self-medication with antibiotics. Although antibiotics are considered prescription-only medicines in some sub-Saharan African countries, there are no effective controls to monitor their distribution (Moyo *et al.,* 2023). An East African study by Loza *et al*. (2025) on Kenya, Tanzania, and Uganda carried out in-depth interviews on 105 community pharmaceutical drug sellers on why antibiotics are often sold without prescription. This study revealed that most drug sellers are aware that purchase of antibiotics should include a prescription, however, they continue to sell antibiotics without prescription due to situational pressures that include weak enforcement of regulations, strong competition between pharmacies, customer demand for quick and

affordable treatment, and limited access to formal healthcare; and is not necessarily a case of the drug sellers lacking poor training or being ignorant (Loza *et al*., 2025). In Namibia, even though obtaining prescription antibiotics without a prescription violates the *Medicines and Related Substances Act 13 of 2003*, a study with 446 correspondent participants revealed that 15.47% of the correspondents still report obtaining antibiotics without prescription (Pereko, Lubbe and Essack, 2015). Similar gaps are observed across the sub- Saharan region, where counterfeit or unregulated antimicrobials remain widely available (Elton *et al.,* 2020).

The sale and dispensing of antibiotics without prescription despite regulatory frameworks can be attributed to a lack of awareness of best practices and a lack of knowledge about antibiotics in the general public (Moyo *et al.,* 2023). Mass health education campaigns are needed to educate the population, retailers and health care workers about appropriate antibiotic use as well as stricter enforcement of non-adherence to the current laws (Horumpende *et al.,* 2018).

5. National Action Plans and Surveillance

National Action Plans or NAPs have become a cornerstone of global strategies to address AMR. These policy frameworks allow governments to set out priorities, coordinate interventions, and mobilize resources across human, animal and environmental health sectors (Willemsen, Reid and Assefa, 2022). In sub-Saharan Africa, progress has been uneven but notable. For example, Elton *et al.,* (2020) detailed how East Africa had the highest percentage of countries reporting having AMR NAPs in place, as well as human and animal pathogen AMR surveillance programmes. Southern Africa reported advances in AMR stewardship and well-established NAPs exist in countries within the Southern African Development Community (SADC). South Africa's NAP is regarded amongst the most advanced NAPs in the region, and Namibia's NAP guides antimicrobial prescribing and surveillance activities in the country (Godman *et al.,* 2022). Furthermore, the Tanzanian NAP for AMR 2017 – 2022 outlined a comprehensive plan to tackle AMR; and Zambia's NAP includes awareness and education as a key strategic goal to be achieved by 2027 (Durrance-Bagale *et al.*, 2021; Nowbuth *et al.*, 2023). These efforts demonstrate that regional momentum is building, yet the implementation and sustainability of such plans remain a challenge.

One persistent gap is the lack of harmonized regulations across countries. The circulation of unregulated or prohibited antimicrobials continues to undermine national efforts, highlighting the need for stronger regional collaboration. Organizations such as the Africa Centres for Disease Control and Prevention (Africa CDC) have begun developing frameworks to support surveillance, regulation, and data sharing through initiatives such as the Africa CDC Framework for MAR Surveillance Network (AMRSNET) (Africa CDC, 2013; Katale *et al.,* 2020). These initiatives aim to integrate human, veterinary and environmental surveillance into a unified one health framework.

However, despite such initiatives, surveillance capacity remains weak. Williams, Isaacs and Berkley (2018) noted how only six (15%) of the 41 WHO Africa region member states conducted routine AMR surveillance for bacterial pathogens, while external quality assurance of laboratory procedures was rarely implemented. A significant constraint on the monitoring of antimicrobial resistance (AMR) in Africa is the scarcity of published research from specific nations, including Niger, Mali, Sierra Leone, and Burkina Faso, which rank among the poorest in the region. This lack of data complicates surveillance efforts, as highlighted by Bernabé *et al.* (2017). Consequently, there is a tendency to overrepresent certain countries, notably Nigeria and Senegal, while underrepresenting others, which raises concerns about the validity of the

conclusions drawn for the entire region. This observation is echoed by Williams, Isaacs, and Berkley (2018), who identified a geographical bias in AMR publications, highlighting that despite their substantial populations, countries in central and west Africa remain underrepresented—a concern previously noted in other reviews of antimicrobial data across the continent. Even within individual countries, AMR rates are unlikely to be homogenous and are likely to differ, particularly between urban and rural areas. A greater number of studies from a diversity of contexts within individual countries are also needed to construct the most accurate estimates of antibiotic resistance (Bernabé *et al.,* 2017). Global initiatives such as the WHO Global AMR Surveillance System (GLASS) are beginning to address these gaps by standardizing data collection and analysis and promoting regional and international data sharing (Olaru *et al.,* 2020). GLASS underscores the necessity for focusing on priority pathogens derived from clinical specimens and its adoption in sub-Saharan Africa is a promising step.

6. Antibiotic stewardship

The collection of strategies and policies aimed at enhancing the rational use of antimicrobials, particularly antibiotics, is referred to as antibiotic stewardship (Laxminarayan *et al.*, 2013). A study conducted by Elton *et al.* (2020) highlighted that among various categories related to antimicrobial resistance (AMR) in a thorough examination of AMR preparedness across sub-Saharan African nations, the category of 'Antimicrobial Stewardship' received the lowest score. This finding indicates that prioritizing this area could lead to significant advancements in combating AMR. Nations that have adopted comprehensive national strategies have demonstrated the greatest success in managing resistance. Countries with stronger stewardship typically have national AMR surveillance and use laboratory susceptibility data to guide policy, South Africa is one such example that has more consistent monitoring and stewardship-linked surveillance (Godman *et al.,* 2022). Evidence suggests that the implementation of culture and antimicrobial susceptibility testing for pathogens can enhance individual patient care by optimizing drug therapy, thereby supporting the judicious use of antibiotics, which is fundamental to antibiotic stewardship (Ashley *et al.*, 2019).

A recent investigation by Craig *et al.* (2022) revealed that merely one-third of African Union Member States possess standardized treatment guidelines pertinent to the management of prevalent bacterial infections or syndromes. Furthermore, Craig and colleagues observed that these guidelines were often informed by local disease burdens or resistance patterns. A potential reason for this situation may be the insufficient national laboratory and surveillance capabilities, which contribute to deficiencies in the local evidence base. A limited number of guidelines referenced published literature or clinical evidence to justify specific drug choices, dosages, and treatment durations. Additionally, few guidelines integrated principles of antimicrobial stewardship, culture, or antimicrobial susceptibility testing results into their treatment recommendations (Craig *et al.*, 2022; Gulumbe *et al.*, 2022). Consequently, there is a pressing need for concentrated national efforts to revise standard treatment guidelines into clear, straightforward, evidence-based, locally relevant, and accessible documents (Laxminarayan *et al.*, 2013). The implementation of antimicrobial stewardship has demonstrated effectiveness in certain nations and may serve as a model for others. However, it remains crucial for many countries to develop and enforce national guidelines regarding the appropriate distribution and utilization of antimicrobials within a One Health framework to mitigate the risk of resistance transmission (Elton, 2020).

7. Conclusion

Antimicrobial resistance (AMR) in sub-Saharan Africa represents both a challenge and an opportunity for strengthening health systems. Resistance to first-line and last-resort antibiotics has been documented across the region, likely attributed to association with weak regulations, and poorly regulated access to and misuse of antibiotics across various sectors. At the same time, growing political awareness, the development of national action plans with an emphasis on the one health approach demonstrate that important foundations have already been laid to tackle this issue.

To achieve sustained progress, urgent and coordinated action is required. First, strengthening regulation and enforcement is crucial in managing the unregulated over-the-counter sales of antibiotics while ensuring access to essential medicines. Second, improving surveillance capacity through investment in laboratory infrastructure, regional data harmonization and collaborative efforts across carious sectors will be essential in detecting and responding to resistance patterns across the region. Third, expanding antibiotic stewardship by revising and enforcing evidence-based treatment guidelines and training healthcare professionals can reduce inappropriate use in both clinical and agricultural contexts. Finally addressing the antibiotic misuse within the veterinary sector through stronger monitoring, farmer education and sustainable alternatives such as routine vaccinations and improved farming practices to try and reduce the environmental and zoonotic reservoirs of resistance.

With strong commitment, regional and national cooperation, more investments into health systems together with initiatives such as GLASS and AMRSNET, sub-Saharan Africa has the opportunity to not only slow the further spread of AMR across the region but also to safeguard the effectiveness of antibiotics for future generations.

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