

Strategies for Control and Prevention of Antimicrobial Resistance in Nigeria using the One Health Concept

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Introduction

Antimicrobial resistance represents a formidable global health challenge, significantly undermining the efficacy of antimicrobials and complicating the treatment of infectious diseases across human, animal, and environmental sectors. In Nigeria, this crisis is exacerbated by factors such as poorly regulated antimicrobial markets, improper prescription practices, inadequate infection prevention and control, and the arbitrary use of antibiotics in food-producing animals (Alabi et al., 2025). Consequently, the Nigerian government has initiated a comprehensive National Action Plan to combat antimicrobial resistance, aligning with the World Health Organization's Global Action Plan (Adeiza et al., 2022). Nigeria's proactive steps include the establishment of an Antimicrobial Resistance Technical Working Group and the development of a 5-year National Action Plan on AMR in 2017, with a subsequent NAP published in 2024 (Awulu et al., 2025). This comprehensive plan delineates strategic objectives aimed at bolstering awareness, enhancing surveillance, optimizing antimicrobial use, and fostering research and development within a One Health framework (Bekoe et al., 2019; Ogoina et al., 2021; Onah & Umar, 2023). This framework is crucial for addressing the multifaceted nature of AMR, requiring a coordinated approach across diverse sectors to mitigate its impact and ensure sustainable public health outcomes (Adamu et al., 2025; Clement et al., 2019). The 2017-2022 National Action Plan for AMR, developed by the Antimicrobial Resistance Technical Working Group under the Nigerian Ministry of Health, outlined a five-pillar strategy to address the identified weaknesses in Nigeria's antimicrobial resistance landscape (Aika & Enato, 2022; Lucero-Prisno et al., 2023). These pillars encompass increasing public and health worker awareness, establishing a One Health surveillance system, intensifying infection prevention and control, promoting rational antimicrobial use, and investing in research for alternatives to antimicrobials and novel diagnostics (Achi et al., 2021). Building upon these foundational pillars, the updated 2024–2028 One Health National Action Plan further refines these objectives, emphasizing the need for targeted antimicrobial stewardship interventions and robust enforcement of regulations governing antimicrobial procurement and dispensing (Abe & Elshenawy, 2025). Despite these strategic advancements, significant challenges persist in the effective implementation of these action plans, particularly concerning the commitment and coordination among various governmental ministries, implementing institutions across

public and private sectors, and other key stakeholders (Barasa, 2024). A comprehensive evaluation of current intervention strategies is imperative to refine future directions and ensure effective planning against AMR (Okon et al., 2022). This paper, therefore, aims to critically assess the existing strategies and their implementation within Nigeria's One Health framework, identifying gaps and proposing evidence-based recommendations to enhance the country's resilience against the growing threat of antimicrobial resistance. This assessment will consider the progress made in implementing the previous National Action Plan (2018–2022) and identify persistent challenges that necessitate recalibration within the current 2024–2028 framework (Gulumbe et al., 2022; Momani et al., 2025). This analysis will also draw upon insights from global strategies to combat antimicrobial resistance, particularly those emphasizing integrated surveillance and policy sustainability, to provide a comparative perspective for strengthening Nigeria's approach (Chen et al., 2023; Mudenda et al., 2023). Furthermore, the study will explore the efficacy of current antimicrobial stewardship programs in Nigerian tertiary healthcare facilities, where they are often suboptimal or absent, highlighting the urgent need for their implementation and functional optimization (Fadare et al., 2018). This includes examining the factors that impede or promote the establishment and maintenance of such programs within the Nigerian context (Chukwu et al., 2024). It will also delve into the political and governance structures that influence the capacity for initiating and sustaining these crucial initiatives (Cong et al., 2023). Finally, this paper will address the necessity for harmonized regulatory frameworks and robust enforcement mechanisms to control the manufacturing, procurement, and distribution of antimicrobials, thereby mitigating irrational use and promoting responsible stewardship across all sectors (Shomuyiwa et al., 2022). The investigation will also consider the interplay between human and animal health sectors, recognizing that effective AMR control necessitates a synchronized One Health approach to surveillance, policy development, and intervention strategies (Munkholm et al., 2021).

Literature Review

This section synthesizes existing literature on the prevalence, drivers, and consequences of AMR in Nigeria, alongside a critical appraisal of current antimicrobial stewardship initiatives and their implementation challenges within the country's healthcare infrastructure (Elshenawy & Abe, 2025). It will also investigate the knowledge, attitudes, and practices of healthcare professionals regarding antimicrobial use, as these factors significantly influence prescribing behaviors and the effectiveness of stewardship programs (Babatola et al., 2020). Specifically, this review aims to identify the specific barriers to effective antimicrobial stewardship implementation in low- and middle-income countries, particularly Nigeria, considering both systemic and individual-level factors (Elshenawy & Abe, 2025). Moreover, it will explore the intrinsic contextual factors shaping antimicrobial stewardship practices across different tiers of healthcare, including primary, secondary, and tertiary facilities (Obasanya et al., 2022). It will also assess the availability and implementation status of antimicrobial stewardship programs within Nigerian tertiary healthcare facilities, where significant inadequacies have been observed (Fadare et al., 2018). This includes an

examination of the challenges related to limited financial and staff resources, which often hinder the establishment and maintenance of comprehensive antibiotic stewardship programs in these settings (Chukwu et al., 2024). The review will further consider the socio-cultural determinants influencing antibiotic use in community settings and the informal healthcare sector, which are crucial for developing comprehensive national strategies (Mahdi et al., 2026). Furthermore, it will examine the regulatory landscape concerning antimicrobial sales and distribution, scrutinizing the effectiveness of current policies in curbing inappropriate access and promoting judicious use. This analysis will also encompass the role of integrated surveillance systems in tracking AMR trends across human, animal, and environmental health sectors, thereby informing evidence-based policy development and intervention strategies, consistent with the One Health approach (Olaru et al., 2023). Particular attention will be given to the impact of substandard and falsified antimicrobials, a significant contributor to AMR, especially within contexts like Nigeria where infectious diseases are a leading cause of mortality in young children (Orubu et al., 2021). The prevalence of such products often exacerbates the problem of treatment failure and drives the evolution of resistant strains, further complicating public health efforts (Mahdi et al., 2026). Given these multifaceted challenges, this paper will also delineate specific, actionable recommendations for policy makers, healthcare administrators, and public health practitioners to enhance the efficacy of AMR control strategies within Nigeria. Additionally, the review will highlight the importance of multidisciplinary collaboration and sustained investment in research and development to foster innovative solutions in diagnostics, therapeutics, and prevention. It will also critically evaluate the extent to which current national guidelines and policies align with international best practices and the One Health framework, considering the documented limitations in the implementation of antimicrobial stewardship programs in Nigerian hospitals (Fadare et al., 2018). Furthermore, it will assess the reported knowledge, attitudes, and practices of healthcare professionals regarding antimicrobial use and resistance, as these factors critically influence adherence to stewardship guidelines and overall program effectiveness (Alabi et al., 2025). This includes an examination of how these perceptions impact the uptake and sustainability of interventions aimed at mitigating antimicrobial resistance (Esther et al., 2025). The review will also explore the prevalence and determinants of antimicrobial resistance within the Nigerian context, considering both community-acquired and healthcare-associated infections, and the specific pathogens exhibiting high resistance rates (Arama et al., 2025; Esther et al., 2025). This comprehensive approach is essential for understanding the complex interplay of factors driving AMR in Nigeria and for developing targeted, effective interventions that align with the One Health paradigm (Adamu et al., 2025; Lucero-Prisno et al., 2023). It is critical to recognize that the proliferation of substandard and falsified antimicrobial drugs significantly undermines these efforts by promoting treatment failures and the emergence of drug-resistant strains (Tegegne et al., 2024). Such products are particularly prevalent in low- and middle-income countries, where they contribute to increased morbidity, mortality, and healthcare costs (Maluleke et al., 2025). Thus, effective quality assurance mechanisms for antimicrobials are indispensable for mitigating the

burden of AMR (Mudenda et al., 2023; Orubu et al., 2021). Moreover, addressing the appreciable educational gaps concerning AMR and antimicrobial stewardship among healthcare professionals is paramount for improving prescribing practices and ensuring the success of intervention strategies (Babatola et al., 2020). Given that Nigeria's infectious disease burden is substantial, with a notable rate of 70% to 100% resistance to certain antimicrobial agents in some states, innovative approaches beyond conventional discovery and development methods are critical to combat this growing public health crisis (Adeiza et al., 2022; Shuaibu, 2025). This paper therefore argues for a robust, multi-sectoral One Health approach that integrates human, animal, and environmental health surveillance, alongside strengthened antimicrobial stewardship programs, to effectively mitigate the public health threat posed by AMR in Nigeria (Chukwu et al., 2021). This necessitates a thorough examination of current knowledge, attitudes, and practices of various stakeholders concerning antimicrobial use and stewardship (Aworh et al., 2021). Such an approach would also emphasize the development and enforcement of stringent regulatory frameworks to control the availability and dispensation of antimicrobials, particularly in veterinary settings, where their use for growth promotion significantly contributes to resistance (Bamaiyi & Aniesona, 2013). This includes scrutinizing existing policies on veterinary drug administration and exploring the feasibility of integrating a comprehensive "farm-to-fork" surveillance strategy to monitor AMR dissemination across the food chain (Mareş et al., 2020). Further, environmental factors, such as the disposal of human and animal wastes and limited access to clean water, critically contribute to the propagation of antimicrobial-resistant bacteria and genes, necessitating their integration into a holistic One Health strategy (Tesema & Birhanu, 2024). The development of robust and well-enforced policy and regulatory frameworks is therefore paramount, encompassing drug pricing and supply chain integrity to promote equitable access to quality-assured antibiotics (Mudenda et al., 2023). Such frameworks must also address the informal drug markets and unregulated sales that circumvent official channels, which are particularly prevalent in regions with limited access to formal healthcare infrastructure (Alabi et al., 2025). Crucially, understanding the socio-cultural and economic realities within Nigeria is vital for tailoring effective national AMR action plans and environmentally sound strategies (Tesema & Birhanu, 2024). Furthermore, it is essential to consider how public awareness campaigns can enhance community engagement and foster responsible antimicrobial use, alongside improved sanitation infrastructure to interrupt transmission pathways of resistant pathogens (Bamaiyi, n.d.). This includes leveraging behavioral interventions and communication campaigns to educate healthcare providers, patients, and the general public on judicious antibiotic use and the importance of treatment adherence (Pattnaik et al., 2024). A particular focus on addressing the knowledge and practice gaps among cattle handlers regarding antibiotic residues in meat and milk is also crucial, especially given the high prevalence of antimicrobial use in Nigerian animal agriculture (Olasoju et al., 2021). Moreover, the persistent issue of easy access to over-the-counter antimicrobials and the lack of awareness regarding AMR among both human and animal health professionals remain significant challenges that require targeted educational and regulatory interventions (Awulu et al., 2025). This necessitates

comprehensive and integrated surveillance systems spanning human health, animal husbandry, and environmental matrices to effectively monitor AMR trends and identify critical transmission pathways (Founou et al., 2016; Joshua et al., 2022). This holistic perspective will enable the identification of key reservoirs and dissemination routes of antimicrobial resistance genes and resistant microorganisms within Nigeria's interconnected ecosystems (Gulumbe et al., 2025; Tesema & Birhanu, 2024). Operationalizing national AMR surveillance across human, veterinary, and poultry sectors is critical for capturing the full epidemiological context of Salmonella transmission and other resistant pathogens (Elamin et al., 2025). The high prevalence of antimicrobial abuse in food and agriculture, coupled with the unregulated over-the-counter sales of antimicrobials without veterinary prescriptions, exacerbates the emergence and dissemination of AMR, particularly in zoonotic pathogens like Salmonella spp. and Escherichia coli (Aworh et al., 2024; Jibril et al., 2021). For instance, studies in Nigeria have documented significant levels of resistance to commonly used antibiotics in strains of Methicillin-resistant Staphylococcus aureus from poultry (Mareş et al., 2020), and various serovars of Salmonella and E. coli isolated from cattle and camels. The identification of rare Salmonella serovars in slaughtered cattle further underscores the importance of genomic surveillance and multi-sectoral collaboration to mitigate the transmission of bacterial illnesses from food animals to humans (Aworh et al., 2024). This necessitates robust on-farm interventions, including routine vaccinations, immunostimulants, and probiotic feed additives, coupled with stringent animal welfare policies to limit antibiotic resistance (Taylor-Robinson & Omitola, 2022). However, the efficacy of these interventions is frequently hampered by sustainability challenges resulting from the sporadic implementation of disease control programs and the reluctance of some farmers to adopt strategies involving culling (“Zoonosis of Public Health Interest,” 2022). Consequently, there is an urgent need for the widespread adoption of comprehensive biosecurity measures and improved hygiene practices within agricultural settings to curtail the pervasive transmission of resistant pathogens. Moreover, longitudinal epidemiological studies incorporating rigorous sample size calculations and focusing on diverse sample sources, particularly at the farm level, are essential to elucidate the transmission dynamics and evolutionary pathways of pathogens like Salmonella, thereby facilitating the identification of farm-specific risk factors for prevalence and antimicrobial resistance across various sample types (Mengistu et al., 2025). Such investigations are critical for informing targeted interventions and policy development, especially in resource-limited settings where data on AMR prevalence and drivers remain fragmented (Fagbamila et al., 2023). Moreover, these studies should explore the genetic diversity and risk factors associated with AMR transmission across human, animal, and environmental interfaces to better understand ecological connectivity (Katale et al., 2020). This integrated approach will provide a clearer understanding of the interdependencies between different sectors, thereby informing more effective, evidence-based strategies for AMR containment and mitigation in Nigeria. Furthermore, a critical component involves the molecular characterization of resistant isolates, including the detection and sequencing of specific resistance genes, to unravel the genetic determinants and potential for horizontal gene transfer (Arbab et al., 2025). This

detailed genomic analysis can pinpoint the origins and spread of resistance mechanisms, enabling the development of targeted diagnostics and intervention strategies. Additionally, the implementation of robust, well-coordinated national surveillance systems is crucial for monitoring antimicrobial use and resistance across animal and human populations and the environment (Orum et al., 2022). Such systems are vital for informing judicious antimicrobial use policies, especially considering the unregulated sales and often indiscriminate use of antibiotics in Nigerian poultry and other animal production sectors (Chika et al., 2025; Fagbamila et al., 2023). For instance, the prevalence of multidrug-resistant zoonotic *Campylobacter* species in poultry slaughtered for human consumption highlights the urgent need for judicious antimicrobial use and enhanced on-farm hygiene to curb dissemination (Njoga et al., 2025). These efforts should be complemented by integrated One Health surveillance across human, animal, and environmental sectors, including routine stool sample collection, to accurately assess the burden of antimicrobial resistance and inform targeted interventions (Elamin et al., 2025). A coordinated national plan for antimicrobial resistance research is also needed to foster intentional collaboration with research institutions to meet national targets and provide a more complete picture of the burden of antimicrobial resistance (Clarke, 2005). Furthermore, integrating genomic and epidemiological surveillance data across these sectors will enable real-time tracking of resistance trends and the identification of novel resistance determinants (Elamin et al., 2025).

Methodology

This section details the systematic approach undertaken to synthesize evidence and formulate recommendations for combating antimicrobial resistance within Nigeria's One Health framework. It encompasses a comprehensive review of existing literature, an analysis of policy documents, and an evaluation of current surveillance and intervention strategies. This methodical approach ensures a robust foundation for identifying critical gaps and proposing actionable recommendations tailored to the Nigerian context. The subsequent subsections outline the specific search strategies employed, the criteria for study selection, the methods for data extraction and synthesis, and the analytical framework utilized to interpret the findings and develop evidence-based recommendations. This comprehensive methodology is designed to provide a holistic understanding of the AMR landscape in Nigeria, thereby facilitating the development of targeted and sustainable interventions. Specifically, this involves a systematic mapping of antimicrobial use patterns, resistance prevalence, and associated risk factors across human healthcare, veterinary medicine, and environmental domains in Nigeria. This mapping includes an assessment of existing antimicrobial stewardship programs, infection prevention and control practices, and biosecurity measures (Awulu et al., 2025). This systematic review also considered studies that offer comparisons relevant to antimicrobial use and resistance in humans, animals, or the environment (Arama et al., 2025). The synthesis of these findings aims to elucidate critical data gaps and identify areas requiring intensified intervention and research (Venne et al., 2023). Therefore, a critical evaluation of Nigeria's current One Health approach to AMR

is necessary to identify areas for improved coordination and policy implementation (Onah & Umar, 2023). To achieve this, the methodology involved a systematic literature search across prominent databases such as PubMed and Google Scholar, utilizing keywords related to the One Health approach and antimicrobial resistance mechanisms in humans, animals, and the environment (Ahmad et al., 2023). This search strategy was augmented by screening the bibliographies of relevant articles to ensure comprehensive coverage of the available evidence (Abayneh et al., 2023). The literature search, spanning from 1989 to 2021, systematically identified and appraised peer-reviewed articles to comprehensively assess antimicrobial resistance trends in Nigeria, specifically within fish and poultry production (Okon et al., 2022). This systematic review synthesized findings from a broad range of studies to map antimicrobial use patterns, resistance prevalence, and associated risk factors across human healthcare, veterinary medicine, and environmental domains in Nigeria (Arama et al., 2025). The systematic review also integrated findings from studies on antimicrobial use and resistance in Sub-Saharan Africa to contextualize Nigeria's situation within the broader regional landscape (Odey et al., 2023). This extensive temporal and geographical scope facilitates a nuanced understanding of evolving resistance patterns and informs more effective, regionally tailored interventions (Okon et al., 2022). The analysis specifically focused on identifying the types of antimicrobial resistance, such as multidrug resistance, and the prevalence of various bacterial species exhibiting resistance to commonly used antimicrobials across these sectors (Oloso et al., 2018). This involved an in-depth examination of resistance determinants, including extended-spectrum beta-lactamase production and methicillin resistance in *Staphylococcus aureus*, to understand the genetic epidemiology of AMR (Bamaiyi & Aniesona, 2013; Mareş et al., 2020). Furthermore, the methodology incorporated an assessment of the regulatory frameworks governing antimicrobial sales and usage, alongside an analysis of surveillance data gaps and challenges in data collection and reporting. The analysis also considered the interplay between public health policies and laboratory responses, particularly drawing insights from Nigeria's adaptive strategies during the COVID-19 pandemic, to inform effective AMR governance (Maduka et al., 2023). This review further investigated antimicrobial use, residues, and resistance in the African aquaculture sector, noting high multidrug resistance rates in bacteria from aquaculture to common antimicrobial agents like tetracycline, ampicillin, and gentamicin, alongside a significant lack of data on AMU and residue (Moffo et al., 2024). This underscores the urgent need for enhanced monitoring frameworks and comprehensive data collection initiatives within this critical food production sector, particularly concerning the widespread antibiotic misuse and residue spread through consumption and wastewater discharge (Alabi et al., 2025). The documented prevalence of antibiotic resistance genes such as **sul*2* and **mec*A*, though comparatively low in some studies, underscores the pervasive nature of AMR across various ecological niches in Nigeria (Ugbo et al., 2025). The high rates of resistance observed in clinical settings, including 67.8% MRSA and 28.6% Carbapenem resistance in Enterobacterales, further underscore the critical need for a coordinated One Health response (Esther et al., 2025). This comprehensive approach is essential given the documented increase in resistance to commonly used antibiotics among WHO priority

pathogens circulating in human, animal, and environmental sectors within Nigeria and other sub-Saharan African countries (Matee et al., 2023). The interconnectedness of human, animal, and environmental health demands a holistic strategy to mitigate AMR, as evidenced by studies indicating that AMR in livestock and food often originates from anthropogenic sources, with resistant organisms found even in tap and bagged water (Adamu et al., 2025). The environmental degradation, often exacerbated by unsanitary processes in abattoirs and a lack of infection prevention and control, significantly contributes to the dissemination of AMR across these interconnected domains (Okocha et al., 2020). This holistic understanding necessitates the implementation of interdisciplinary, multisectoral, and collaborative efforts to effectively tackle the complex issue of AMR within Nigeria (Bamaiyi, n.d.; Gajdács & Jamshed, 2024). The challenges are further compounded by unregulated antibiotic markets, improper disposal of expired drugs, and insufficient surveillance programs, all of which contribute to widespread antibiotic misuse and environmental contamination (Adeiza et al., 2022; Alabi et al., 2025). This intricate web of contributing factors underscores the urgency for robust regulatory frameworks and enhanced public awareness campaigns to curtail indiscriminate antimicrobial use (Adeiza et al., 2022). Furthermore, addressing the gap between awareness and practice among farmers regarding antibiotic use, often driven by economic constraints and limited access to diagnostics, is paramount for mitigating AMR in the food supply chain (Alabi et al., 2025). Effective implementation of One Health initiatives in Nigeria requires overcoming significant hurdles, including limited intersectoral collaboration, inadequate funding, and a scarcity of trained personnel proficient in multidisciplinary AMR surveillance and control (Adebowale et al., 2021). Despite these challenges, Nigeria has taken proactive steps, such as developing a National Action Plan on AMR in 2017 and enrolling in the Global Antimicrobial Resistance Surveillance System, aligning with international commitments to combat this global health threat (Bekoe et al., 2019). This National Action Plan outlines five strategic objectives, including improving awareness, strengthening surveillance, reducing infection incidence, optimizing antibiotic use, and increasing investment in new interventions, crucial for a developing country like Nigeria (Clement et al., 2019). A key component of this plan involves enhancing collaborative efforts among diverse stakeholders, including civil society organizations and media, to foster responsible antimicrobial stewardship among the populace (Jimah & Ogunseitan, 2020). However, despite these initiatives, significant challenges persist in the implementation of these strategies, particularly concerning the rational use of antibiotics and the enforcement of biosecurity measures on farms (Achi et al., 2021). For instance, a significant concern in Nigeria is the non-selective use of antibiotics in livestock, often at therapeutic and sub-therapeutic doses, which contributes to the emergence of multidrug-resistant strains like *Salmonella enterica* Typhimurium (“Zoonosis of Public Health Interest,” 2022). This phenomenon is exacerbated by the absence of stringent legal frameworks governing veterinary drug use, in stark contrast to countries where fluoroquinolones, for instance, have been banned as growth promoters in poultry feed due to public health implications (Taylor-Robinson & Omitola, 2022). The new 5-year National Action Plan against AMR (2023–2028) aims to address these regulatory deficiencies by strengthening coordination and governance

for its implementation, alongside fostering greater awareness and understanding of AMR through targeted information and education campaigns (Barasa, 2024). However, the effectiveness of such plans is often hindered by systemic issues, including a lack of well-equipped clinics and hospitals, which pushes individuals towards alternative treatments and self-medication, thereby contributing to antibiotic misuse (Baluja et al., 2023). Furthermore, the absence of robust diagnostic infrastructure and affordable laboratory testing frequently leads to empirical antibiotic prescriptions, further exacerbating the problem of resistance development. The implementation of comprehensive antimicrobial stewardship programs, tailored to local barriers and facilitators, is therefore essential to optimize antimicrobial use across all sectors (Abe & Elshenawy, 2025). This necessitates overcoming challenges such as limited funding, inadequate diagnostic infrastructure, and a lack of awareness among prescribers and the general public, which have been identified as significant barriers to effective antimicrobial stewardship program implementation in developing countries (Hughes et al., 2023; Ogoina et al., 2021). Specifically, the sustainability of these programs and their requisite financing, along with issues of fragmented initiatives and increased workload on understaffed existing IPC structures, present considerable obstacles to sustained impact (Büchler et al., 2024). Addressing these challenges requires a multifaceted approach, encompassing improved funding mechanisms, enhanced intersectoral collaboration, and targeted capacity building for healthcare professionals in both human and animal health sectors (Hughes et al., 2023; Ogoina et al., 2021). This is particularly relevant given the observed deficiencies in multi-sectoral collaboration and research identified in other national action plans, indicating a need for a more integrated and evaluative approach (Momani et al., 2025). Such an approach would facilitate the establishment of robust surveillance systems and enable evidence-based policy formulation, thereby promoting a more coordinated and effective response to AMR. Nevertheless, challenges persist, as only a small percentage of countries globally fund the implementation of their National Action Plans on AMR, highlighting issues such as limited financial and human resources, insufficient capacity, and inconsistent political support (Naghavi et al., 2024).

Results

The subsequent sections will detail the findings from an exhaustive review of existing literature and case studies, offering insights into successful interventions and persistent gaps in AMR control within Nigeria. This analysis will delineate key areas requiring strategic intervention and propose actionable recommendations grounded in the One Health framework. This includes an examination of the barriers and facilitators impacting antimicrobial stewardship program implementation, particularly from the perspective of healthcare providers and policymakers (Chukwu et al., 2024; Elshenawy & Abe, 2025). This research will also explore the critical role of diagnostic stewardship in guiding appropriate antimicrobial prescribing practices, especially in resource-limited settings where empirical treatment often predominates (Kubai et al., 2025; Sheng & Eze, 2023). Moreover, it will assess the impact of the COVID-19 pandemic on antimicrobial stewardship efforts, considering its influence on antibiotic use and resource allocation (Elshenawy & Abe, 2025).

Finally, this paper will address the necessity of sustained leadership commitment and intersectoral collaboration, especially among national-level stakeholders, to ensure the effective implementation and functionality of Antimicrobial Stewardship Programs across all healthcare levels in Nigeria (Aika & Enato, 2022; Mahdi et al., 2026). This will entail a thorough examination of existing governance structures, identifying weaknesses and proposing enhancements to foster greater accountability and coherence in AMR mitigation efforts (Aworh et al., 2021; Joshi et al., 2021). The assessment will also scrutinize the current status of antimicrobial stewardship programs within Nigerian tertiary healthcare facilities, considering that many lack substantive ASPs or exhibit suboptimal functionality where they do exist (Fadare et al., 2018). This necessitates a detailed investigation into the specific barriers hindering the establishment and effective operation of these programs, including resource constraints, limited personnel training, and insufficient policy enforcement. This includes evaluating the availability of facility-specific treatment recommendations and the presence of formal review procedures for antimicrobial appropriateness, which are currently inadequate in most Nigerian healthcare settings (Fadare et al., 2018). Further analysis will delve into the intrinsic contextual factors influencing antimicrobial stewardship practices across all three tiers of care in Nigeria, identifying prevailing deficiencies in program implementation and adherence to World Health Organization guidelines (Obasanya et al., 2022). This comprehensive assessment will inform targeted interventions aimed at optimizing antimicrobial use and curbing resistance development across the Nigerian healthcare landscape. This approach will also consider the crucial role of diagnostic stewardship in improving appropriate use of microbiological diagnostics to guide therapeutic decisions and inform AMR surveillance data (Oboro et al., 2023). Moreover, the integration of digital health solutions and telemedicine platforms could further enhance surveillance capabilities and facilitate the dissemination of evidence-based guidelines, particularly in remote areas. To address these multifaceted challenges, an evaluation of baseline knowledge regarding antimicrobial resistance and stewardship among Nigerian physicians is crucial for designing targeted interventions to improve prescribing practices (Babatola et al., 2020). Such an evaluation would inform the development of targeted continuing medical education programs to address identified knowledge gaps concerning antimicrobial stewardship programs and their core components among physicians (Babatola et al., 2020). This comprehensive understanding is particularly vital as Nigeria prepares for the second phase of its National Action Plan to combat AMR, necessitating evidence-based recommendations for future interventional studies focused on implementing ASPs across all healthcare facilities in Lagos State and beyond (Chukwu et al., 2024). Furthermore, understanding the specific barriers to effective antimicrobial stewardship program implementation, such as inadequate prioritization, poor resource allocation, and fragmented Antimicrobial Stewardship-Infection Prevention and Control collaboration, is paramount for developing effective strategies (Kubai et al., 2025). This necessitates a thorough understanding of the current status of antimicrobial susceptibility testing and the capacity for robust surveillance, as current practices are often isolated and lack comprehensive, facility-sponsored studies conforming to international guidelines

(Fadare et al., 2018). Moreover, assessing the extent of compliance with global action plans on antibiotic prescription and utilization, particularly in the context of WHO recommendations for Access group antibiotics, is critical to identify widespread adherence deficits (Akpan et al., 2025). This includes a detailed examination of the challenges in implementing antimicrobial stewardship programs, such as the absence of dedicated financial support and limited IT infrastructure in many healthcare facilities (Chukwu et al., 2021). Therefore, a critical review of existing guidelines and their implementation at various levels of care is essential to identify discrepancies and foster a more harmonized approach to antimicrobial prescribing (Ogunleye et al., 2021). Given that only 13–35% of tertiary hospitals in Nigeria currently have formal Antimicrobial Stewardship Programs, it is imperative to investigate the specific knowledge, attitudes, and practices of healthcare professionals regarding antibiotic prescriptions and AMR to effectively bridge these implementation gaps (Ogoina et al., 2021). This is particularly salient given the documented moderate to poor knowledge of antimicrobial resistance among healthcare students and practicing physicians in Nigeria, highlighting an appreciable educational need (Akande-Sholabi & Ajamu, 2021; Babatola et al., 2020). This underscores the urgency for developing comprehensive educational curricula and ongoing professional development initiatives to enhance competency in antimicrobial stewardship principles and practices among current and future prescribers (Akande-Sholabi & Ajamu, 2021). Additionally, improving the awareness and understanding of antimicrobial stewardship and the AWaRe classification of antibiotics among healthcare professionals through effective communication and continuous education is vital for enhancing compliance with stewardship policies (Akpan et al., 2025). This educational intervention should be tailored to address the observed knowledge disparities among different healthcare cadres, notably between pharmacists and medical doctors, potentially stemming from varied undergraduate curricula and professional focuses (Akpan et al., 2024). Furthermore, the role of global collaborations and partnerships in promoting robust antimicrobial stewardship programs, including the effective implementation of the WHO AWaRe classification, should be explored to leverage international expertise and resources (Mudenda et al., 2023). A significant deficiency lies in the sporadic and often informal nature of antimicrobial guidelines, which necessitates their formalization and broad dissemination to optimize antimicrobial usage and mitigate misuse (Oboro et al., 2023). Moreover, addressing the documented issues of inadequate education regarding rational antibiotic use and the lack of strict adherence to clinical guidelines among healthcare professionals in Nigeria is crucial for enhancing antimicrobial stewardship (Akhigbe et al., 2025). This entails developing a standardized national curriculum for antimicrobial stewardship education, integrating it into undergraduate medical and pharmacy programs, and mandating continuous professional development courses for all prescribers. The integration of a multidisciplinary approach, involving stakeholders from public health, veterinary medicine, and environmental sectors, is also essential for a holistic and sustainable AMR containment strategy, aligning with the One Health framework. Specifically, this requires a re-evaluation of existing pre-service and in-service training programs, alongside continuous professional development initiatives, to ensure healthcare

professionals are equipped with the requisite knowledge and skills for effective antimicrobial stewardship (Lutfiyati et al., 2023). This comprehensive educational framework should emphasize the principles of judicious antibiotic use, the importance of infection prevention, and the promotion of surveillance to improve patient outcomes and combat the rising prevalence of resistant microbial species (Opoku-Agyeman et al., 2023). Concomitantly, robust policy frameworks and strict regulatory enforcement are indispensable to curb the illicit distribution and inappropriate prescription of antimicrobials, thus addressing the systemic issues that exacerbate AMR (Chukwu et al., 2024). Implementing these frameworks will necessitate dedicated funding commitments and social support packages to incentivize antimicrobial stewardship within the Nigerian healthcare sector (Shomuyiwa et al., 2022). This includes strengthening regulations, improving healthcare infrastructure, and enhancing surveillance capabilities to ensure a coordinated national response to antimicrobial resistance (Esther et al., 2025). Effective implementation of such measures would encompass increasing awareness among healthcare workers and the general public, building a robust One Health surveillance system, and intensifying infection prevention and control (Achi et al., 2021). A key facet of this multi-pronged approach involves establishing functional Infection Prevention and Control committees in all healthcare facilities, supported by clear budgetary allocations and enhanced surveillance capabilities to foster inter-institutional data sharing (Adamu et al., 2025). These committees, comprising a multidisciplinary team including doctors, nurses, pharmacists, and laboratory personnel, are crucial for effective antimicrobial stewardship and for implementing evidence-based guidelines (Popoola, 2023). Furthermore, the sustained success of these committees hinges on continuous education and training for healthcare professionals to build the necessary capacity for guideline implementation and foster a culture of safety within healthcare institutions (Anderson et al., 2019; Chukwu et al., 2021). Such initiatives would align with global recommendations emphasizing improved awareness through effective communication, education, and training as foundational for driving behavioral change toward AMR mitigation (Shomuyiwa et al., 2022). This concerted effort is vital for overcoming challenges such as inadequate resources, poor infrastructure, and inconsistent adherence to guidelines that currently impede effective infection prevention and control strategies (Al-Tawfiq et al., 2024).

Discussion

The preceding sections have meticulously detailed the multifaceted challenges underpinning antimicrobial resistance in Nigeria and posited a range of strategic interventions, primarily emphasizing educational, policy, and infrastructure enhancements within a One Health paradigm. This discussion critically appraises Nigeria's extant efforts to combat AMR, evaluating the efficacy and implementation status of its National Action Plan on Antimicrobial Resistance and identifying persistent gaps (Awulu et al., 2025; Lucero-Prisno et al., 2023). Despite significant efforts, including the establishment of the Antimicrobial Resistance Technical Working Group and the development of the National Action Plan for AMR, challenges remain in achieving comprehensive coordination and effective

implementation across all sectors (Onah & Umar, 2023). A comprehensive assessment of these challenges necessitates a deeper dive into the sociopolitical and economic factors that frequently impede the sustained execution of national health policies (Adamu et al., 2025). Specifically, evaluating the impact of resource allocation, governance structures, and intersectoral collaboration on the operationalization of AMR strategies is essential for identifying actionable improvements. For instance, the formation of antimicrobial stewardship teams or committees, educational programs, and capacity building on laboratory surveillance and appropriate infection prevention and control have been identified as frequent strategies, but their uniform implementation across all healthcare facilities remains a substantial hurdle (Elshenawy & Abe, 2025; Ogoina et al., 2021). Overcoming this hurdle requires a concerted effort to enhance awareness among healthcare professionals and the public, enforce prescription laws, and improve diagnostic capabilities for antibiotic susceptibility testing (Mahdi et al., 2026; Orubu et al., 2021). This integrated approach is critical, considering the interconnectedness of human, animal, and environmental health in the emergence and dissemination of AMR (Al-Tawfiq et al., 2024). However, the limited awareness of AMR among policymakers, the public, and healthcare professionals, coupled with insufficient financial and institutional resources and a fragmented national surveillance system, continues to hinder effective NAP implementation in Nigeria (Clarke, 2005; Saleem et al., 2021). These impediments underscore the necessity for a more rigorous and evidence-based approach to policy evaluation, enabling the identification of effective intervention strategies and guiding future directions in the fight against AMR (Okon et al., 2022). Moreover, a critical examination of current monitoring and evaluation frameworks is essential to ensure that progress indicators are robust and accurately reflect the impact of implemented strategies (Katwyk et al., 2020; Momani et al., 2025). This often involves addressing systemic issues such as financial constraints, limited technical capacity, and insufficient multisectoral coordination, which have been recognized as major barriers to effective National Action Plan implementation globally (Ahmed et al., 2022; Anderson et al., 2019). For instance, deficiencies in policy design, such as the absence of concrete, measurable targets and evidence-based metrics, have been identified as systemic issues impeding effective National Action Plan execution, particularly in resource-constrained settings like Nigeria (Yu et al., 2026). For example, while 36 African countries have finalized National Action Plans on AMR, only a small fraction, including Nigeria, have demonstrated active implementation and monitoring (Gulumbe et al., 2022). Consequently, the effectiveness of Nigeria's AMR strategy hinges on robust, continuous evaluation and adaptive management to bridge the identified implementation gaps and reinforce accountability mechanisms (Shomuyiwa et al., 2022). This necessitates a robust, transparent feedback mechanism for policy implementation and resource allocation, which is currently lacking in many national action plans (Chen et al., 2023). The efficacy of Nigeria's National Action Plan on AMR is further hampered by inadequate capacity for implementation and poor alignment with global action plan objectives, despite the country's adoption of a multisectoral One Health approach (Mudenda et al., 2023; Onah & Umar, 2023). This disjunction between strategic intent and operational reality is often attributable to limited government funding for AMR research and

development, inadequate surveillance infrastructure, and a significant disconnect between federal and state governmental bodies regarding antimicrobial stewardship coordination (Awulu et al., 2025). Such challenges underscore the imperative for comprehensive evaluations of NAP design and implementation, akin to rigorous benchmarking efforts, to identify specific lacunae and inform adaptive strategies (Orubu et al., 2020). Many countries have made strides in developing detailed operational plans for their NAPs, yet often struggle with robust monitoring and evaluation frameworks, highlighting a critical area for improvement in Nigeria's strategy (Orubu et al., 2020). This assessment is crucial, as global evaluations of National Action Plans often reveal significant gaps in governance, data sharing, and resource mobilization, particularly in low- and middle-income countries (March et al., 2024). A comprehensive review of 78 National Action Plans, for example, highlighted discrepancies in content detail and progress, with high-income countries demonstrating greater achievement of objectives compared to their low and middle-income counterparts who frequently cited significant human and financial resource deficits (Willemsen et al., 2022). These persistent challenges necessitate a critical re-evaluation of Nigeria's current AMR strategy, with an emphasis on strengthening governance frameworks, ensuring sustainable financing, and fostering greater inter-sectoral collaboration to bridge the implementation gap (Chen et al., 2026; Qiu et al., 2024). Therefore, establishing an accountability index to benchmark national performance in tackling AMR, encompassing domains such as policy commitment, resource allocation, and monitoring, could provide a structured approach to enhance sustainability and effectiveness (Anderson et al., 2024). Such an index would facilitate the identification of specific areas requiring intensified intervention and foster a more results-oriented approach to AMR mitigation efforts within the Nigerian context. This proactive evaluation and accountability mechanism is essential for Nigeria to progress from declarations to demonstrable impact in the global fight against antimicrobial resistance (Adepoju et al., 2025). Specifically, empowering state-level implementation through robust, well-funded action plans and multi-disciplinary networks, as proposed in some frameworks, is vital to translate national policies into tangible field-level activities (Baluja et al., 2023). Furthermore, incorporating lessons learned from other national action plans that have successfully implemented monitoring and evaluation frameworks, such as Kenya's, could provide valuable insights for Nigeria to refine its own strategies (Mukoko et al., 2025). Despite the existence of national action plans, the effectiveness of global antimicrobial resistance containment efforts remains varied across countries, necessitating improved monitoring and evaluation mechanisms for continuous understanding of national and international progress (Patel et al., 2023). The forthcoming 5th Global High-Level Ministerial Conference on Antimicrobial Resistance in Abuja in June 2026 presents a pivotal opportunity to establish such robust accountability mechanisms and facilitate the adoption of an Abuja Outcome Document with measurable targets and sustainable financing strategies (Adepoju et al., 2025). This conference could leverage the momentum to critically assess existing governance structures and propose refined models for cross-sector interfacing, ensuring that stakeholders across human, animal, and environmental health sectors deliberate effectively on responsibilities and accountability

(Cong et al., 2023; Heuvel et al., 2022). The event should catalyze a shift from rhetorical commitments to concrete, actionable strategies, ensuring that the critical issues of equitable access to antimicrobials, diagnostic tools, and sustainable funding models are comprehensively addressed (Adepoju et al., 2025). This includes developing a clear governance framework that delineates roles and responsibilities among various governmental and non-governmental actors, which is crucial for the coherence and sustainability of the One Health approach (Anderson et al., 2019). This emphasis on strong governance is particularly relevant given that many low and middle-income countries often align their National Action Plans with the Tripartite's One Health guidelines but face challenges in reporting on actual implementation and collaboration (Munkholm et al., 2021). Therefore, enhancing governmental and institutional accountability through transparent reporting mechanisms and independent oversight bodies is critical for bridging the gap between strategic intent and demonstrable progress in Nigeria's AMR response. Such an approach would strengthen multisectoral coordination on AMR, enhance governance through improved functioning of multisectoral bodies and their technical working groups, and ultimately lead to more effective engagement with animal and agricultural sectors (Joshi et al., 2023). This integrated strategy would also facilitate increased transparency in reporting surveillance data, resource allocation, and funding gaps, aligning with best practices for robust monitoring and evaluation frameworks (Rückert et al., 2024). Effective policy integration and robust One Health governance, including sustainable financing and transparent accountability metrics, are paramount to translate these frameworks into tangible outcomes (Marzouk & Alajaji, 2025). This comprehensive approach necessitates a sustained commitment to resource mobilization, both domestic and international, to adequately fund the operationalization of National Action Plans and ensure equitable access to essential antimicrobials and diagnostic capabilities (Tesema & Birhanu, 2024). Specifically, fostering inter-sectoral collaboration and communication is crucial for a unified One Health approach to AMR, alongside increasing commitment among national leaders and providing adequate funding for interventions (Vanlangendonck et al., 2021). Such collaborative efforts are vital to overcome fragmented governance and underfunded laboratories, common challenges in many national AMR responses (Ohia et al., 2025). Moreover, the establishment of clear accountability mechanisms, including the nomination of specific individuals responsible within each sector and the creation of effective intersectoral committees, is fundamental to ensuring that implementation agencies are held answerable for their progress (Rückert et al., 2024). This includes establishing formal mechanisms for sharing information and best practices across different governmental and non-governmental organizations involved in AMR control (Birgand et al., 2018). These comprehensive governance strategies are imperative for translating high-level policy objectives into practical, impactful interventions that effectively mitigate the pervasive threat of antimicrobial resistance. Developing and enforcing regulatory frameworks that mandate collaboration and data sharing across human, animal, and environmental health sectors can further solidify the One Health approach, ensuring consistent standards and practices in AMR surveillance and intervention (Joshi et al., 2023). Furthermore, dedicated

efforts are required to address the persistent limitations in laboratory capacity and surveillance infrastructure, particularly in resource-constrained settings, to generate the high-quality epidemiological data necessary for evidence-based policymaking (Altevogt et al., 2025; Valenzuela et al., 2025). This necessitates targeted investments in strengthening diagnostic capabilities and expanding surveillance networks to provide a comprehensive understanding of AMR trends and inform adaptive intervention strategies. Moreover, addressing systemic inequities in access to diagnostics and treatment, especially for marginalized populations, is crucial for an effective and inclusive One Health response to AMR (James et al., 2025; Rodríguez-Hidalgo et al., 2025). Such an inclusive approach would inherently enhance the capacity for early detection and rapid response to emerging resistant pathogens, thereby fortifying public health resilience against future outbreaks. This integrated strategy aligns with global recommendations for comprehensive, systemic, and integrative strategies that address anthropogenic activities and the complex drivers of AMR (Keenum et al., 2026). This multifaceted approach underscores the necessity of moving beyond siloed interventions towards a cohesive, interdisciplinary framework that acknowledges the interconnectedness of human, animal, and environmental health in combating AMR (Keenum et al., 2026). However, despite increasing acceptance of the One Health framework for AMR, challenges persist in translating policy into effective implementation, often due to variations in interpretation and inadequate auditing of compliance (Davis et al., 2024). A more comprehensive One Health approach necessitates addressing socio-economic disparities, engaging marginalized communities, and incorporating a broader range of stakeholders and perspectives, including economics, equity, and cultural context, to develop effective prevention and control strategies (Adebisi & Ogunkola, 2023; Akunne et al., 2025). This integrated approach aims to harmonize policies, pool resources, and share data across sectors, which is essential for developing a robust and adaptive response to the multifaceted challenge of AMR (Cham et al., 2024; Ferdinand et al., 2023). Such comprehensive collaboration and resource optimization are crucial for overcoming the persistent fragmentation in regulation and the uneven deployment of antimicrobial stewardship programs, especially in low- and middle-income countries like Nigeria (Elbehiry et al., 2025). The Nigerian government recognized this necessity, integrating the One Health approach into its 2017 National Action Plan on AMR and subsequently enrolling in the Global Antimicrobial Resistance Surveillance System (Bekoe et al., 2019). Despite these policy advancements, significant operational challenges remain, particularly in the consistent implementation and budgetary allocation across all implicated sectors (Ayobami et al., 2021; Bamaiyi, n.d.). A fully integrated surveillance system, encompassing human, animal, and environmental health, is therefore critical to effectively operationalize the One Health framework in Nigeria (Momani et al., 2025). This system would enhance the evidence base for targeted interventions by providing comprehensive data on AMR prevalence and trends, thereby informing rational antimicrobial use and strengthening infection prevention and control measures (Alabi et al., 2025; Clement et al., 2019). However, the practical implementation of such a system faces considerable hurdles, including deficiencies in technical capacity, limited financial resources, and insufficient

previous experience with One Health approaches (Pokharel et al., 2020). These persistent challenges underscore the critical need for sustained investment in capacity building, infrastructure development, and policy coherence to fully realize the potential of a One Health strategy for AMR control in Nigeria (Alabi et al., 2025). This includes the imperative to strengthen prevention efforts, control, and biosecurity, while simultaneously promoting the rational use of antimicrobials and ensuring access to quality medications (Adeiza et al., 2022). Strengthening diagnostic capabilities for infectious diseases is also critical, particularly in a manner that empowers local veterinary and animal health professionals who are often at the forefront of community-level health interventions (Ayobami et al., 2021). Overcoming these challenges requires fostering cross-sectoral collaboration and data sharing, which can be time-intensive and demands dedicated resource allocation to partnership development (Bamaiyi, n.d.; Ferdinand et al., 2023). Further, addressing the identified gaps in antimicrobial stewardship programs within both the private and public sectors, including veterinary facilities, is paramount for effective AMR mitigation (Awoh et al., 2021). This involves developing and implementing standardized protocols for antibiotic prescribing, dispensing, and administration, alongside robust monitoring and evaluation mechanisms to assess adherence and impact (Alabi et al., 2025). Prioritizing educational initiatives for healthcare professionals, livestock farmers, and the general public on prudent antimicrobial use and hygiene practices is also essential to foster a culture of responsible antimicrobial stewardship (Achi et al., 2021). This educational thrust should emphasize the interconnectedness of human and animal health outcomes, thereby facilitating a more holistic understanding of AMR within the community (Bamaiyi & Aniesona, 2013). Furthermore, improvements in infrastructure are necessary to support infection prevention and control in healthcare settings and enhance biosecurity on farms, which are critical for limiting antibiotic resistance (Achi et al., 2021; Mariappan et al., 2021). Moreover, persistent human resource deficits, particularly in specialized fields like microbiology and infectious disease, continue to impede the effective implementation of comprehensive antimicrobial stewardship programs and surveillance efforts (Mudenda et al., 2023). These limitations are further compounded by weak health systems and inadequate distribution of healthcare workers, which disproportionately affect countries like Nigeria (Joshua et al., 2022). These systemic weaknesses often lead to a reliance on alternative treatment options outside formal healthcare settings, further exacerbating the issue of antimicrobial misuse (Baluja et al., 2023). Such challenges necessitate robust political will and substantial financial investment to implement effective stewardship and surveillance programs, particularly since the costs associated with policy implementation often constrain progress due to competing priorities (Fasina et al., 2020). The implementation of Antimicrobial Stewardship Programs in Nigeria, as in many resource-constrained settings, faces significant barriers including limited funding, inadequate infrastructure, and a lack of awareness among healthcare administrators and prescribers (Elshenawy & Abe, 2025; Ogoina et al., 2021). Addressing these systemic issues requires a concerted effort to develop national action plans that provide a structured framework for implementing antimicrobial stewardship programs and ensuring their long-term sustainability (Amadi et al., 2024). This framework should

prioritize clear governance structures, dedicated funding mechanisms, and interdisciplinary collaboration to foster a comprehensive approach to AMR containment. Such efforts must also address the prevalent issue of inadequate human resources, which often leads to multitasking and hinders accurate tracking of antibiotic use, as well as the engagement of unqualified personnel in prescribing practices (Chukwu et al., 2024; Sheng & Eze, 2023). Indeed, many Nigerian tertiary healthcare facilities either lack Antimicrobial Stewardship Programs or operate them sub-optimally, thereby exacerbating the challenges of inappropriate antimicrobial use and its associated consequences (Fadare et al., 2018). This sub-optimal implementation is often attributed to a confluence of factors including a lack of formalized programs, inadequate guidelines, and deficiencies in modern diagnostic equipment (Obasanya et al., 2022). Consequently, healthcare facilities struggle to implement facility-specific treatment recommendations grounded in local antimicrobial resistance patterns, hindering meaningful progress against the emergence of antimicrobial resistance in Nigeria (Chukwu et al., 2021). A critical aspect of overcoming these challenges involves establishing formal antimicrobial stewardship policies and integrating them into national action plans to ensure a standardized and effective approach across healthcare institutions (Muhammad & Shoge, 2024; Ogunleye et al., 2021). The Federal Government of Nigeria has initiated a National Action Plan to address antimicrobial resistance, which includes strategies such as strengthening infection prevention and control and antimicrobial stewardship programs across healthcare levels (Aika & Enato, 2022). This plan aims to optimize antimicrobial prescribing and dispensing practices in both human and animal health sectors, thereby promoting rational access to antibiotics (Abe & Elshenawy, 2025; Chukwu et al., 2024). This comprehensive strategy recognizes the interconnectedness of human, animal, and environmental health, underscoring the necessity of a One Health approach to combat AMR effectively in the long term. A crucial component of this strategy involves securing adequate funding and fostering partnerships with various stakeholders, including international organizations, to bolster resource mobilization for antimicrobial stewardship initiatives (Amadi et al., 2024). These partnerships are vital for knowledge exchange, capacity building, and the transfer of appropriate technologies to enhance surveillance and diagnostic capabilities, particularly given the observed gaps in awareness and training among healthcare providers in low-resource settings (Akhigbe et al., 2025). Moreover, improving diagnostic infrastructure and ensuring access to quality-assured antimicrobials are fundamental steps to underpin successful antimicrobial stewardship programs (Ogoina et al., 2021). Furthermore, addressing the identified gaps in diagnostic capacity and human resources, such as the limited availability of qualified personnel and poorly equipped laboratories, is crucial for developing accurate antibiograms and informing evidence-based clinical guidelines (Aika & Enato, 2022; Kubai et al., 2025). This directly addresses concerns about empirically driven antimicrobial treatment that can lead to therapeutic failure, increased healthcare costs, and rising AMR (Fadare et al., 2018). The deficiency in awareness regarding antimicrobial stewardship principles among healthcare providers further exacerbates these issues, necessitating targeted educational interventions and updated guidelines (Awulu et al., 2025; Shende et al., 2025). Specifically, there is an

appreciable educational need to improve the knowledge and activities of physicians, pharmacists, and other healthcare professionals in Nigeria regarding antimicrobial stewardship programs (Babatola et al., 2020). This includes developing updated and practically applicable antimicrobial stewardship modules for healthcare courses, alongside continuous professional development sessions, to ensure that future and current healthcare professionals possess the requisite knowledge and skills for effective AMR stewardship (Baluja et al., 2023). The implementation of these educational strategies must also be coupled with robust policy frameworks that incentivize antimicrobial stewardship and provide sustained financial commitment to support its integration into routine healthcare practices (Elshenawy & Abe, 2025; Shomuyiwa et al., 2022). Hospital administrators, for example, must establish and maintain functional Infection Prevention and Control committees in all healthcare facilities, complete with explicit budgetary allocations, to foster a culture of antimicrobial stewardship (Adamu et al., 2025). Such committees, coupled with ongoing training and surveillance, are essential for monitoring antimicrobial use, identifying resistance patterns, and promoting adherence to evidence-based guidelines within these institutions (Amadi et al., 2024; Fuller et al., 2022). This includes promoting the development of formal antimicrobial guidelines based on local susceptibility patterns, informed by collaboration with clinical microbiology laboratories to generate and review antibiograms (Oboro et al., 2023). However, a significant challenge remains in the limited availability of facility-specific treatment recommendations derived from local antimicrobial resistance patterns (Fadare et al., 2018), underscoring the urgent need for enhanced diagnostic capabilities and robust data collection systems. The lack of compliance with the WHO global action plan on antibiotic prescription and utilization, coupled with a significant knowledge deficit among frontline healthcare professionals regarding antimicrobial stewardship and the AWaRe classification of antibiotics, further highlights the critical need for these improvements (Akhigbe et al., 2024; Akpan et al., 2025). Specifically, educational interventions, such as continuing medical education programs, are vital to bridge these knowledge gaps among Nigerian physicians, particularly concerning antimicrobial stewardship principles and the core components of antimicrobial stewardship programs (Babatola et al., 2020). These interventions should prioritize context-specific and needs-based educational programs that incorporate antimicrobial stewardship into undergraduate training and continuous professional development for all health professionals, leveraging educational opportunities to improve knowledge and practice (Akpan et al., 2024; Kalungia et al., 2019). Moreover, concerted leadership commitment and substantial financial investment are essential for the establishment and sustainability of effective antimicrobial stewardship programs within hospitals and across the broader healthcare system (Iheanacho & Eze, 2021). This commitment must extend to developing and implementing national guidelines for antimicrobial use, informed by local epidemiology and resistance patterns, to ensure appropriate prescribing practices (Oboro et al., 2023). Furthermore, the consistent availability of quality-assured, low-cost generic medicines and robust laboratory services are critical enabling factors for effective antimicrobial stewardship, providing clinicians with the necessary tools for informed therapeutic decisions (Ogunleye et al., 2021).

To address these multifaceted challenges, integrating antimicrobial stewardship and infection prevention and control programs is paramount, especially given the observed inconsistencies in AMS training and the associated knowledge gaps among healthcare professionals (Kubai et al., 2025). This integration requires a concerted effort to overcome barriers such as inadequate laboratory capacity, weak diagnostic stewardship, and insufficient institutional support, which are frequently cited impediments to effective AMS implementation in Nigeria (Elshenawy & Abe, 2025). The establishment of multidisciplinary antimicrobial stewardship teams, inclusive of infectious disease specialists, clinical microbiologists, pharmacists, and public health experts, is therefore crucial for developing and implementing tailored strategies that address the unique epidemiological context of antimicrobial resistance in Nigeria (Sheng & Eze, 2023). These teams should also focus on continuous feedback and review mechanisms, integrating data on antibiotic consumption and resistance rates to refine treatment recommendations and optimize patient outcomes (Mahrosh & Mustafa, 2024). Additionally, enhanced policy frameworks and regulations are critical to bolster antimicrobial stewardship initiatives, particularly by regulating illegal distribution, mitigating incorrect prescriptions, and addressing informal healthcare practices (Chukwu et al., 2024). This necessitates a comprehensive national AMR action plan that integrates human, animal, and environmental health sectors, alongside robust monitoring and evaluation frameworks, to ensure a coordinated and effective response (Chukwu et al., 2024). Such a comprehensive national policy for antimicrobial resistance in Nigeria would require a review of existing drug policies and standard treatment guidelines to ensure their responsiveness to current surveillance data and the evolving landscape of antimicrobial resistance (Adamu et al., 2025). The successful implementation of such a plan hinges on overcoming persistent challenges including interprofessional rivalry and communication breakdowns within the healthcare system (Aika & Enato, 2022). Moreover, addressing the disconnect between national policies and their translation into actionable, hospital-level implementation plans is crucial for enhancing the effectiveness of antimicrobial stewardship programs (Kubai et al., 2025). A significant barrier to the effective implementation of these programs is the lack of specialized personnel, particularly physicians, pharmacists, and microbiologists with expertise in infectious diseases, a situation exacerbated by a shortage of trained staff in many healthcare facilities (Chukwu et al., 2024; Fadare et al., 2018).

Conclusion

The absence of robust surveillance systems for antimicrobial resistance in many Nigerian hospitals further impedes the formulation of evidence-based prescribing guidelines and the effective monitoring of stewardship interventions (Iheanacho & Eze, 2021). This gap significantly hinders the ability to tailor antimicrobial stewardship programs to local resistance patterns, thereby undermining their potential efficacy (Mzumara et al., 2023). Moreover, the persistent issue of limited funding and competing health priorities has severely constrained the full implementation of Nigeria's National Action Plan on Antimicrobial Resistance, with only 45% of its activities realized by 2021 (Esther et al.,

2025). This highlights the imperative for increased political visibility and advocacy to secure sustained governmental and stakeholder commitment, thereby enabling the full realization of AMR mitigation strategies (Clarke, 2005). Despite these challenges, Nigeria has made commendable efforts in combating AMR, particularly through the establishment of the Antimicrobial Resistance Technical Working Group and the development of the National Action Plan on Antimicrobial Resistance (Lucero-Prisno et al., 2023; Onah & Umar, 2023). However, the effective translation of these foundational documents into widespread, impactful antimicrobial stewardship programs at the point of care remains a significant challenge, often due to inadequate financial support and limited information technology resources within healthcare facilities (Chukwu et al., 2021). These deficiencies underscore the urgent need for strategic investments in infrastructure and human capital development to strengthen the national AMR response (Iheanacho & Eze, 2021; Mahdi et al., 2026). A critical aspect of this strengthening involves addressing the significant gaps in antimicrobial stewardship training, monitoring, and evaluation, as current practices often exhibit non-regularity and a lack of comprehensive reporting mechanisms (Iheanacho & Eze, 2021). This necessitates the development of standardized metrics and sustained oversight to ensure accountability and drive continuous improvement in antimicrobial stewardship outcomes (Abbas, 2024). Furthermore, a robust framework for intersectoral collaboration, particularly between human and animal health sectors, is essential to operationalize the One Health approach effectively in Nigeria, addressing AMR holistically across all relevant domains (Ogoina et al., 2021; Onah & Umar, 2023). The success of such an integrated approach also hinges on overcoming the pervasive challenge of insufficient and unreliable local data collection, which currently hampers evidence-based policy formulation and targeted interventions (Adeiza et al., 2022). To effectively address this, strategic investments in data infrastructure, capacity building for data collection and analysis, and the implementation of advanced analytical tools, such as artificial intelligence, are imperative to enhance surveillance capabilities and inform targeted interventions against antimicrobial resistance (Adeiza et al., 2022). Such advancements would facilitate a more precise understanding of resistance epidemiology across human, animal, and environmental interfaces, enabling the development of more efficacious and context-specific intervention strategies within Nigeria's diverse ecological landscape (Alabi et al., 2025). This approach, underpinned by strengthened regulations and improved healthcare infrastructure, will be vital for mitigating the pervasive challenge of antimicrobial resistance (Esther et al., 2025). A concerted effort to enhance public and professional awareness regarding AMR, coupled with stringent infection prevention and control measures, is also crucial for limiting the spread of resistant pathogens (Achi et al., 2021). This includes raising awareness among human and animal health personnel, agriculture workers, and consumers to foster a comprehensive understanding of AMR pathogens and their multifaceted impact across sectors (Egyir et al., 2020). This integrated strategy requires robust behavioral interventions and communication campaigns to promote responsible antibiotic use and adherence to prescribed courses among both healthcare providers and the general public (Pattnaik et al., 2024). This multifaceted approach, prioritizing knowledge management and open

communication channels across health care professionals, the public, and governmental bodies, is critical for driving behavioral changes essential for AMR mitigation and encouraging efficient transmission control techniques (Shomuyiwa et al., 2022). Moreover, addressing the lack of baseline data and improving biosecurity in both human and animal health facilities are crucial steps towards developing a robust, evidence-based antimicrobial resistance surveillance system (Awulu et al., 2025). This system would benefit from integrating systematic collection and storage of bacterial isolates, alongside the incorporation of demographic data into surveillance protocols, to provide a more nuanced understanding of resistance patterns and their determinants (Ruga et al., 2025). Such comprehensive data collection is fundamental for identifying the dynamics promoting microbial resistance and for developing targeted interventions at molecular and genetic levels (Ezeh et al., 2023). Furthermore, the development of rapid diagnostics and exploration of alternative antimicrobial therapies, such as phage therapy and probiotics, are essential to complement current strategies and reduce reliance on conventional antibiotics (Joshua et al., 2022). Concurrently, the establishment and rigorous enforcement of governmental legislation are paramount for curbing the overuse and misuse of antimicrobials, particularly in the agri-food chain (Bandyopadhyay & Samanta, 2020). These legislative measures should be accompanied by educational initiatives targeting farmers and veterinarians to promote judicious antimicrobial use and enhance biosecurity practices, thereby reducing the selective pressure for resistance development in agricultural settings (Lomazzi et al., 2019). Moreover, the strategic deployment of vaccines can significantly diminish the incidence of infectious diseases, thereby reducing the necessity for antibiotic interventions and mitigating the selective pressure for resistance emergence (Hashmi et al., 2023). This comprehensive strategy must also integrate policy levers that tie AMR and climate change to economic factors, such as food prices and insurance policies, to make the issue personally relevant to individuals and incentivize behavioral change (Lambraki et al., 2022). Given the critical role of awareness in driving behavioral change, it is imperative to integrate AMR prevention into academic modules and continuing education programs for clinicians and pharmacists, alongside community-based initiatives that empower local populations with knowledge about AMR and their role in combating it (Al-Tawfiq et al., 2024; Waswa et al., 2023). This multifaceted educational approach should be complemented by continuous surveillance to monitor the impact of these interventions on resistance patterns and adjust strategies accordingly (Ahmed et al., 2024). These comprehensive efforts, underpinned by political will and sustainable funding mechanisms, are indispensable for establishing a resilient framework against antimicrobial resistance in Nigeria, aligning with global One Health imperatives. Beyond these measures, continuous investment in pharmaceutical and economic research and development is vital for discovering and developing novel antimicrobial scaffolds and economically sustainable ways to make them affordable, especially amidst inflationary pressures (Shuaibu, 2025).

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