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ANALYSIS OF ANTIBIOTIC PRESCRIBING PRACTICES IN PRIMARY HEALTH CARE SETTINGS. PART II. LITERATURE REVIEW

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Abstract

Introduction: Antimicrobial resistance (AMR) poses a major global health threat that requires coordinated international strategies to limit its spread and impact. Scientific approaches, including surveillance, innovative drug development, and stewardship programs, are essential to address the biological complexity of resistance. At the same time, economic and social dimensions—such as healthcare costs, access to medicines, and public awareness—must be integrated into global efforts to achieve sustainable solutions.

Objective: To describe the global strategies, scientific approaches, socioeconomic aspects of AMR

Materials and Methods: A systematic review of the literature was carried out, drawing on peer-reviewed publications from medical and public health databases such as PubMed, Google Scholar, and EBSCO, along with WHO reports, epidemiological data, and recent studies on AMR patterns and antibiotic prescribing practices. The analysis centered on global developments, with particular attention to Central Asia, especially Kazakhstan and its neighboring states.

Results: Limited surveillance systems and inconsistent data collection hinder accurate assessment of AMR trends in Kazakhstan and neighboring countries. Socioeconomic factors, such as self-medication, over-the-counter antibiotic sales, and low public awareness, exacerbate the problem. Strengthening stewardship programs, improving diagnostics, and enhancing international collaboration are critical for reducing the spread of AMR.

Conclusion: Findings emphasize the urgent need for coordinated global strategies, evidence-based policies, and context-sensitive interventions to address inappropriate antibiotic use and strengthen resistance surveillance.

Keywords: *antimicrobial resistance, global strategy, stewardship*.

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Резюме

АНАЛИЗ ПРАКТИК НАЗНАЧЕНИЯ АНТИБИОТИКОВ В ПЕРВИЧНОМ ЗВЕНЕ ЗДРАВООХРАНЕНИЯ. ЧАСТЬ II. ОБЗОР ЛИТЕРАТУРЫ

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Введение: Антимикробная резистентность (AMP) представляет собой серьёзную глобальную угрозу для здоровья, требующую скоординированных международных стратегий для ограничения её распространения и последствий. Научные подходы, включая эпидемиологический надзор, разработку инновационных препаратов и программы рационального использования антибиотиков, имеют ключевое значение для решения биологической сложности резистентности. В то же время экономические и социальные аспекты — такие как расходы на здравоохранение, доступ к лекарствам и информированность населения — должны быть интегрированы в глобальные усилия для достижения устойчивых решений.

Цель: Охарактеризовать глобальные стратегии, научные подходы и социально-экономические аспекты AMP.

Материалы и методы: Был проведён систематический обзор литературы с использованием рецензируемых публикаций из медицинских и общественно-здравоохранительных баз данных (PubMed, Google Scholar, EBSCO), а также отчётов ВОЗ, эпидемиологических данных и современных исследований по динамике AMR и практике назначения антибиотиков. Анализ был сосредоточен на глобальных тенденциях с особым акцентом на Центральную Азию, включая Казахстан и сопредельные страны.

Результаты: Ограниченные системы надзора и непоследовательный сбор данных препятствуют точной оценке тенденций AMR в Казахстане и соседних государствах. Социально-экономические факторы, такие как самолечение, продажа антибиотиков без рецепта и низкая информированность населения, усугубляют проблему. Усиление программ рационального использования, совершенствование диагностики и расширение международного сотрудничества имеют решающее значение для снижения распространения AMR.

Заключение: Полученные данные подчёркивают острую необходимость в согласованных глобальных стратегиях, основанных на доказательной политике и адаптированных к региональному контексту мерах для предотвращения нерационального применения антибиотиков и укрепления системы надзора за резистентностью.

Ключевые слова: *антимикробная резистентность, глобальная стратегия, рациональное использование антибиотиков.*

Для цитирования:

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Түйіндеме

БАСТАПҚЫ ДЕНСАУЛЫҚ САҚТАУ БУЫНЫНДА АНТИБИОТИК ТАҒАЙЫНДАУ ТӘЖІРИБЕСІН ТАЛДАУ. II БӨЛІМ. ӘДЕБИЕТТІК ШОЛУ.

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Кіріспе: Антимикробтық резистенттілік (АМР) – оның таралуын және салдарын шектеу үшін үйлестірілген халықаралық стратегияларды талап ететін денсаулыққа төнген маңызды жаһандық қатер. Ғылыми тәсілдер, соның ішінде эпидемиологиялық қадағалау, инновациялық препараттарды әзірлеу және антибиотиктерді ұтымды пайдалану бағдарламалары резистенттіліктің биологиялық күрделілігін еңсеруде шешуші рөл атқарады. Сонымен бірге денсаулық сақтау шығындары, дәрі-дәрмекке қолжетімділік және халықтың хабардарлығы сияқты экономикалық және әлеуметтік қырлар тұрақты шешімдерге қол жеткізу үшін жаһандық күш-жігерге енгізілуі тиіс.

Мақсат: АМР-дың жаһандық стратегияларын, ғылыми тәсілдерін және әлеуметтік-экономикалық қырларын сипаттау.

Материалдар мен әдістер: Әдебиетке жүйелі шолу жүргізіліп, медициналық және қоғамдық денсаулық сақтау дерекқорларынан (PubMed, Google Scholar, EBSCO) рецензияланған жарияланымдар, сондай-ақ ДДСҰ есептері, эпидемиологиялық деректер және АМР динамикасы мен антибиотик тағайындау тәжірибесіне қатысты заманауи зерттеулер пайдаланылды. Талдау жаһандық үрдістерге бағытталып, ерекше назар Орталық Азияға, оның ішінде Қазақстан мен көршілес елдерге аударылды.

Нәтижелер: Қадағалау жүйелерінің шектеулілігі және деректерді жинаудың бірізді еместігі Қазақстан мен көрші мемлекеттердегі АМР үрдістерін дәл бағалауға кедергі келтіреді. Өзін-өзі емдеу, антибиотиктердің рецептсіз сатылуы және халықтың төмен хабардарлығы сияқты әлеуметтік-экономикалық факторлар мәселені күрделендіреді. Антибиотиктерді ұтымды пайдалану бағдарламаларын күшейту, диагностика сапасын арттыру және халықаралық ынтымақтастықты кеңейту АМР таралуын төмендетуде шешуші мәнге ие.

Қорытынды: Алынған деректер антибиотиктерді ұтымсыз қолдануды болдырмау және резистенттілікке қадағалауды күшейту үшін дәлелді саясатқа негізделген және өңірлік контекстке бейімделген үйлестірілген жаһандық стратегиялардың аса қажет екенін көрсетеді.

Түйінді сөздер*: антимикробтық резистенттілік, жаһандық стратегия, антибиотиктерді ұтымды пайдалану.*

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Background

Antimicrobial resistance (AMR), defined as the ability of microorganisms to adapt and survive exposure to antimicrobial agents, poses a major global public health threat. Its emergence is driven by a wide range of human, animal, and environmental factors. Human-related contributors include the excessive and inappropriate use of antimicrobials in healthcare, the application of antibiotics in cosmetics and biocides, and inadequate sanitation and hygiene in community settings. Additional drivers of AMR include agricultural practices, environmental contamination, and the use of antibiotics in animals [55]. Importantly, these elements are interconnected in complex ways. For example, *Ljungqvist et al.* (2025) emphasize the multifaceted links between socioeconomic determinants across sectors, underscoring the need for multisectoral approaches [30, 33]. Similarly, finance, governance, and disease management have been shown to be strongly associated with AMR risks [7], while Chan et al. (2022) demonstrate the role of multisectoral factors in the spread of AMR in Pacific Asia [10]. Rather than being attributable to a single cause, AMR arises from multiple, overlapping drivers, including behavioral, managerial, and institutional governance factors [59]. Moreover, several studies suggest that these multisectoral influences are insufficiently recognized by the public, even though experts increasingly acknowledge the broader and more complex determinants of resistance [20,46]. This highlights the necessity for collaboration across diverse fields, integrating knowledge and skillsets not only as translational tools but also as fundamental to understanding AMR [25]. Therefore, **the aim** of this study was to identify key factors affecting antibiotic prescription practices in clinical setting.

Search strategy. A systematic literature search was carried out using predefined key terms and their synonyms. Searches were conducted in English-language databases such as PubMed, Google Scholar, and EBSCO, along with an additional review of resources from the World Health Organization (WHO) website. To maintain relevance, only publications from the past decade were considered. Following the identification of suitable publications, the authors reviewed all bibliographic references cited within these works, as well as studies that had cited them. Abstracts were then screened to select the most pertinent research, after which the literature was organized according to established inclusion and exclusion criteria, and full-text articles were obtained for detailed evaluation. Ultimately, only validated and reliable sources were included in the final analysis.

Inclusion and Exclusion Criteria. The inclusion criteria were as follows: (a) thematic relevance to the study's scope; (b) availability English. Conversely, publications that did not satisfy these predefined standards were consequently excluded from the review.

The main part

Global Strategies and Initiatives

Global strategies and initiatives play a crucial role in addressing antimicrobial resistance (AMR). The WHO “Global Action Plan on AMR” provides a structured framework to support countries in developing surveillance systems, infection prevention strategies, and national policies (WHO, 2023) [57, 62]. In addition to the WHO, international organizations such as the United Nations (UN), the Food and Agriculture Organization (FAO), the World Organisation for Animal Health (WOAH), and the U.S. Centers for Disease Control and Prevention (CDC) have made significant contributions to global AMR control efforts. Evidence from national programs in the United States, Sweden, the Netherlands, and Thailand demonstrates that AMR action plans—when reinforced by effective policy enforcement, education, and investment in research—can substantially reduce resistance rates. These experiences highlight the necessity of global collaboration to address AMR as a long-term public health challenge.

AMR has emerged as a major global health crisis that threatens the foundations of modern medicine. The widespread misuse of antibiotics in human healthcare, veterinary medicine, and agriculture has accelerated the development of resistant strains [11]. Tackling AMR therefore requires coordinated international cooperation that involves governments, health organizations, and regional initiatives (Centers for Disease Control and Prevention) [8]. To address this, the WHO launched the “Global Action Plan on Antimicrobial Resistance (GAP-AMR)” in 2015, providing a comprehensive, multisectoral strategy for combating resistance through global cooperation and national-level implementation. The WHO strategy emphasizes raising public awareness through education campaigns, strengthening surveillance systems to monitor resistance patterns, and promoting responsible antimicrobial use across sectors such as healthcare and agriculture [57].

One of the WHO’s key initiatives, the “Global Antimicrobial Resistance and Use Surveillance System (GLASS)”, was established to standardize the collection and analysis of AMR-related data, thereby guiding evidence-based policymaking and improving treatment outcomes [16]. Addressing AMR requires a multidisciplinary perspective, often conceptualized within the “One Health framework”, which integrates human, animal, and environmental health [14]. The UN has recognized AMR as a critical global health security issue, advocating for international cooperation and policy development across nations [58]. In this regard, the Interagency Coordination Group on Antimicrobial Resistance (IACG) was formed to provide best-practice recommendations to mitigate AMR’s economic and healthcare burdens [62]. Similarly, the FAO has strengthened antibiotic use regulations in food production and livestock farming, promoting sustainable agricultural practices and biosecurity measures to reduce infections [4]. The WOAH has developed international guidelines to standardize antibiotic use in veterinary medicine and restrict excessive administration [63]. Together, these initiatives promote responsible antibiotic stewardship in humans, animals, and agriculture, thereby curbing the spread of resistant pathogens.

At the regional level, the European Centre for Disease Prevention and Control (ECDC) has played a central role in developing AMR surveillance systems and providing policy recommendations based on resistance trends. Its “European Surveillance of Antimicrobial Consumption Network (ESAC-Net)” monitors antibiotic consumption patterns to inform national strategies [48]. There are different strategies depending on the countries. For example, one of the strategies of UK to fight AMR is a room

improvement [1,2]. It is also suggested that raising awareness is one of the key strategies to tackle AMR [23] because one of the main drivers of antimicrobial resistance is inappropriate antibiotics use [13]. Several countries have implemented successful national action plans (NAPs). For example, the U.S. "CARB Strategy" was established to slow AMR by expanding antibiotic stewardship programs in hospitals and outpatient clinics, improving laboratory capacity for AMR detection, and supporting the development of new antibiotics. It also includes measures to limit non-therapeutic antibiotic use in agriculture and reduce the consumption of medically important antibiotics in animals [3]. Since its implementation, declines in hospital-acquired infections caused by resistant bacteria have been reported, illustrating the strategy's effectiveness.

In the European Union (EU), strict prescription regulations and coordinated surveillance initiatives have made AMR a policy priority. Sweden's "Strama Program" is a particularly successful national strategy, involving collaboration between healthcare professionals and policymakers to optimize antibiotic use, resulting in some of the lowest resistance rates in Europe [49]. The Netherlands has achieved similar success through stringent hospital infection control programs and national antibiotic restriction policies, significantly lowering resistance rates [4].

In Asia, Thailand has emerged as a regional leader in AMR control. According to Sumpradit (2021), the Thai NAP on AMR aimed to reduce antibiotic use in agriculture by 50% and in human medicine by 20%, while strengthening hospital infection control measures [39]. The government also introduced electronic prescription systems to monitor antibiotic consumption and launched public awareness campaigns to educate citizens on the risks of AMR and the importance of adhering to prescribed treatments [10]. These combined efforts have contributed to measurable progress, including reductions in colistin-resistant bacteria, further demonstrating the effectiveness of multisectoral interventions.

Scientific Approaches and Innovations

Antimicrobial resistance (AMR) represents one of the most critical global health challenges, threatening the effectiveness of antibiotics and the treatment of infectious diseases. The emergence of resistant microorganisms reduces therapeutic options and leads to higher morbidity and mortality. In response, modern medicine is adopting innovative scientific approaches to prevent, diagnose, and treat AMR more effectively. These approaches include artificial intelligence (AI), alternative drug delivery systems, and cross-sectoral collaboration. A notable initiative is the "Vivli Antimicrobial Resistance Register", which compiles susceptibility data from pharmaceutical companies, governments, and researchers into an open-access platform. By providing real-time observation of resistance trends and patterns, this database fosters innovation and informs evidence-based medicine and policy. Mori et al. (2025) emphasize that open-access AMR databases enable early trend detection and enhance data-driven interventions [34, 21].

Artificial intelligence has emerged as a transformative tool in combating AMR. Machine learning algorithms can predict resistance patterns, optimize treatment strategies, and estimate the likelihood of drug effectiveness. AI-based platforms such as "DeepARG" and "ARIBA" have demonstrated the ability to accurately identify resistance genes in metagenomic data, thereby improving diagnostic precision and guiding clinical decisions [6]. Moreover, Stokes et al. (2020) report that AI models have been used to predict novel antibiotic classes, including halicin, identified using neural networks trained on the features of bioactive compounds. Despite its promise, the clinical integration of AI remains constrained by challenges in data standardization, privacy, and regulatory approval [39].

Innovative drug delivery systems also play a critical role in addressing AMR. Nanotechnological approaches, including liposomes and metallic nanocarriers, have been designed to improve drug targeting and bioavailability, thereby minimizing adverse effects. *Zhou et al.* (2015) argue that nanocarriers can penetrate bacterial cell walls—one of the primary defenses of resistant pathogens—allowing for direct drug release at infection sites [65]. Smart delivery systems, which respond to environmental stimuli such as pH, temperature, or enzymes, are under development to ensure targeted release exclusively in infected tissues. This strategy reduces systemic toxicity and improves therapeutic accuracy [29]. Combination therapies that co-deliver antibiotics with efflux pump inhibitors or β-lactamase blockers have also shown promise in reversing resistance, as demonstrated by *Zhang et al.* (2024) [54].

Rethinking innovation ecosystems has become increasingly important in light of lessons learned from the COVID-19 pandemic. Rapid funding mechanisms, public–private partnerships, and regulatory flexibility accelerated the development of diagnostics and therapeutics during the pandemic. Piot et al. (2012) argue that similar innovation systems should be applied to AMR, with a focus on aligning research ecosystems with societal health priorities rather than purely market-driven models [32, 39]. However, while human and veterinary health sectors have been relatively active in AMR surveillance and innovation, the environmental dimension remains underfunded and underrecognized [36, 37]. The "One Health" framework, which integrates human, animal, and environmental health, is essential to address this gap. Environmental reservoirs of resistance genes, including wastewater and soil, significantly contribute to AMR transmission, yet surveillance in these areas is limited. Expanding One Health research to encompass environmental microbiology and incorporating it into national AMR strategies is vital for comprehensive mitigation [7, 28]. It is suggested that surveillance may help to identify resistance genes as well as controlling them [44].

Antibiotic discovery and development continue to face major scientific and economic challenges. The process remains slow, costly, and burdened by high rates of clinical trial failure due to toxicity or inefficacy. Furthermore, antibiotics are less profitable than drugs for chronic diseases, discouraging pharmaceutical investment. According to WHO (2021), most antibiotics currently in development share mechanisms of action with older drugs and target similar pathways, with only a few representing true innovation [5]. Llewelyn et al. (2017) suggest that bacteriocins and antimicrobial peptides could provide alternative therapeutic approaches [31]. Similarly, Vivekanandan et al. (2025) highlight research into non-

antibiotic molecules that restore the activity of existing drugs, thereby extending treatment options [53].

To effectively combat AMR, scientific and technological innovations must be integrated with cross-disciplinary collaboration. Open-access initiatives should be expanded, and equitable access to innovation must be prioritized. Public engagement is equally important to increase awareness and encourage responsible antibiotic use. Ultimately, addressing AMR requires systemic collaboration in how research, data, and innovation are harnessed for global health.

The economic impact of antimicrobial resistance (AMR) is profound and far-reaching. A study by the World Health Organization (WHO) estimates that AMR could result in additional healthcare costs of up to US\$1 trillion by 2050, with global gross domestic product (GDP) losses ranging from US\$1 trillion to US\$3.4 trillion per year by 2030 [19]. These projections highlight the severe financial burden that AMR may impose on global economies. According to Prestinaci et al. (2015), the annual cost of AMR in the United States is approximately US\$55 billion, comprising US\$20 billion in direct healthcare costs and an additional US\$35 billion due to lost productivity [40]. Similarly, the European Union incurs around EUR 1.1 billion annually in excess healthcare expenditures attributable to AMR [61].

Despite this alarming threat, funding for AMR research and development remains inadequate. Education and research are critical for both healthcare systems and the general public, yet they are often constrained by underfunded infrastructure [24]. The pharmaceutical industry remains reluctant to invest in antibiotic development due to low profitability and high risk of inefficiency. To address this challenge, various initiatives have been proposed. “Push funding” mechanisms, such as grants and public-private partnerships, have been implemented in countries like the United Kingdom and Sweden [57]. However, these initiatives require sustained and adequate investment. A report by Lord Jim O’Neill (2016) suggests that the estimated cost to effectively combat AMR would be around US\$40 billion [42].

Several global initiatives have been established to stimulate antibiotic innovation. For example, the Combating Antibiotic Resistant Bacteria Biopharmaceutical Accelerator (CARB-X) supports the development of novel antibacterial products and has attracted significant funding. Similarly, the Global AMR Innovation Fund (GAMRIF) focuses on early-stage research in underfunded areas of AMR, with particular emphasis on developing countries. Collaborative organizations, such as the Joint Programming Initiative on Antimicrobial Resistance (JPIAMR), adopt a One Health approach by integrating human, animal, and environmental health strategies. In parallel, the Global AMR R&D Hub coordinates international research priorities, while the Global Antibiotic Research and Development Partnership (GARDP) advances new treatments for drug-resistant infections through international cooperation [31, 10].

Beyond research and development, public awareness and stewardship programs are critical in reducing the misuse of antimicrobials. Stewardship interventions have been shown to significantly decrease inappropriate antibiotic use [7]. Educational initiatives directed at healthcare professionals and the wider public are essential for encouraging responsible antibiotic practices and preventing the emergence of new resistance mechanisms. Addressing the economic and social challenges posed by AMR requires a multifaceted strategy, encompassing robust research investment, international collaboration, and sustained public education. Given the significant economic losses projected, greater investment in research and the development of alternative therapies is urgent. Scalable solutions, such as digital platforms, community-based programs, and curriculum integration in educational institutions, are being actively explored [26]. Through coordinated global action, it is possible to mitigate the impact of AMR and protect both public health and economic stability.

Challenges and Barriers to Implementing Global Approaches to Antimicrobial Resistance (AMR)

While international strategies such as the WHO Global Action Plan have been developed to address AMR, multiple barriers hinder their effective implementation across diverse contexts. Tiong et al. (2016) argue that the lack of efficient collaboration between sectors is a major impediment, with efforts often remaining uncoordinated and communication gaps between national priorities and global goals leading to inconsistent practices [50]. These challenges are particularly evident in low- and middle-income countries (LMICs), where implementation is further obstructed by weak governmental responses [43]. Raka et al. (2024) highlight that financial constraints frequently result in fragile healthcare systems, limited access to quality antimicrobials and diagnostic laboratories, and shortages of trained healthcare professionals, making even basic stewardship programs difficult to sustain [41]. Similarly, Ferreira et al. (2023) note that agricultural systems in regions with inadequate veterinary services and poor hygiene standards face parallel obstacles [15].

Regulatory weaknesses and market failures further exacerbate the situation. In many regions, antibiotics remain available without prescription, and weak enforcement mechanisms enable widespread misuse in both human and animal sectors. Compounding this issue, pharmaceutical industries have retreated from antibiotic development due to limited commercial incentives, leaving the global antibiotic pipeline fragile and heavily reliant on public or philanthropic funding [42]. The absence of comprehensive AMR surveillance systems poses another major barrier. Despite substantial investment, implementation remains uneven, and even among high-income countries data validity is compromised by inconsistent methodologies and reporting standards [2, 10]. This lack of standardized global surveillance makes it difficult to monitor AMR trends reliably.

Public awareness also remains insufficient. In many countries, low awareness contributes to self-medication, overprescription, and poor adherence to treatment protocols [45]. Cultural perceptions of antibiotics as “cure-all” remedies further exacerbate irrational use, while healthcare providers may resist stewardship protocols due to time constraints, lack of institutional support, or fear of patient dissatisfaction [15]. Weak water, sanitation, and hygiene (WASH) infrastructure amplifies the spread of resistant organisms, particularly in healthcare settings and food production systems [45]. In LMICs, insufficient laboratory

infrastructure limits diagnostic capacity, leading physicians to rely on empirical prescribing, thereby driving inappropriate antibiotic use. Ethiopia, for example, has identified weak laboratory systems, delays in reporting, and communication gaps as major obstacles to antimicrobial stewardship program (ASP) implementation [54, 36].

Economic and political barriers compound these technical challenges. High out-of-pocket healthcare costs reduce access to quality-assured antibiotics, while political instability and weak governance structures undermine the enforcement of AMR policies and divert resources away from health priorities. Cultural norms, patient expectations, and environmental contamination from poor pharmaceutical waste management further fuel the problem. Engaging the private healthcare sector and informal providers—who play a substantial role in service delivery in LMICs but are often excluded from AMR strategies—is also crucial [12].

Although many LMICs have developed national action plans (NAPs) for AMR, implementation is inconsistent and hindered by governance gaps. Assessments of NAPs highlight areas requiring strengthening, including accountability, sustained engagement, equity, behavioral economics, sustainability planning, transparency, international collaboration, and integration of the environmental sector [12]. This persistent gap between policy development and practical implementation underscores the need for robust governance, accountability mechanisms, and cross-sectoral collaboration to ensure the effectiveness of global AMR strategies.

Conclusion

Antimicrobial resistance (AMR) represents one of the greatest threats to global health, economics, and development, requiring urgent and coordinated action. Despite significant international strategies, such as the WHO Global Action Plan, challenges persist due to weak governance, limited resources, cultural factors, and inadequate surveillance systems, particularly in LMICs. At the same time, scientific and technological innovations - including artificial intelligence, nanotechnology, and open-access data platforms - show promising potential to strengthen prevention, diagnosis, and treatment. However, sustainable progress depends on overcoming economic disincentives, investing in research and development, and ensuring global collaboration across human, animal, and environmental health sectors. Ultimately, addressing AMR demands a unified, multidisciplinary, and equitable approach to safeguard the effectiveness of antimicrobials and protect global health security.

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Literature:

1. *Adeniji F.* Global analysis of strategies to tackle antimicrobial resistance. Int J Pharm Pract. 2017. Vol. 26(1). P. 85–89

2. *Ahmed S.K., Hussein S., Qurbani K., Ibrahim R.H., Fareeq A., Mahmood K.A., Mohamed M.G.* Antimicrobial resistance: Impacts, challenges, and future prospects. J Med Surg Public Health. 2024. Vol.2. P.100081

3. *Aljeldah M.M.* Antimicrobial resistance and its spread is a global threat. Antibiotics. 2022. Vol.11(8). P.1082

4. *Arango-Argoty G., Garner E., Pruden A., Heath L.S., Vikesland P., Zhang L.* DeepARG: a deep learning approach for predicting antibiotic resistance genes from metagenomic data. Microbiome. 2018 Vol.6(1). P.1.

5. *Awasthi R., Rakholia V., Agrawal S., Dhingra L.S., Nagori A., Kaur H, Sethi T.* Estimating the impact of health systems factors on antimicrobial resistance in priority pathogens. J Glob Antimicrob Resist. 2022. Vol.30. P.133–142.

6. *Azhar A.* What is Antimicrobial Stewardship? A Simple Guide. Core Prescribing Solutions. 2025 [cited 2025 Jan 23]. Available from: https://coreprescribingsolutions.co.uk/antibiotic-stewardship-antimicrobial-stewardship/

7. *Berendonk T.U., Manaia C.M., Merlin C., Fatta-Kassinos D., Cytryn E., Walsh F., Bürgmann H., Sørum H., Norström M., Pons M.N., Kreuzinger N., Huovinen P., Stefani S., Schwartz T., Kisand V., Baquero F., Martinez J.L.* Tackling antibiotic resistance: the environmental framework . Nat Rev Microbiol. 2015. Vol.13(5). P.310–317.

8. Centers for Disease Control and Prevention. Antimicrobial resistance. 2024 [cited 2025 Jan 23]. Available from: https://www.cdc.gov/drugresistance/index.html

9. *Chan Y.Q., Chen K., Chua G.T., Wu P., Tung K.T.S., Tsang H.W, Lung D., Ip P., Chui C. S. L..* Risk factors for carriage of antimicrobial-resistant bacteria in community dwelling-children in the Asia-Pacific region: a systematic review and meta-analysis. JAC Antimicrob Resist. 2022. Vol.4(2). dlac036.

10. *Chanvatik S., Kosiyaporn H., Lekagul A., Kaewkhankhaeng W., Vongmongkol V., Thunyahan A., Tangcharoensathien V.* Knowledge and use of antibiotics in Thailand: A 2017 national household survey. PLoS One. 2019. Vol.14(8). e0220990.

11. *Chua A.Q., Verma M., Hsu L.Y., Legido-Quigley H.* An analysis of national action plans on antimicrobial resistance in Southeast Asia using a governance framework approach. Lancet Reg Health West Pac. 2021. Vol.7-P.100084.

12. *Coque T.M., Cantón R., Pérez-Cobas A.E., Fernández-De-Bobadilla M.D., Baquero F.* Antimicrobial resistance in the Global Health Network: Known unknowns and challenges for efficient responses in the 21st century. Microorganisms. 2023. Vol.11(4). P.1050.

13. *Desai V., Kumar S., Patel B., Patel S. N., Patadiya H.H., Asawa D., Pathan M.S., Haque M.* Navigating Antimicrobials and Combating Antimicrobial resistance: Challenges, impacts, and strategies for global action. Cureus. 2025. Vol.17 (4). e82064.

14. *Endale H., Mathewos M., Abdeta D.* Potential causes of spread of antimicrobial resistance and Preventive measures in One Health Perspective-A Review Infect Drug Resist. 2023. Vol.16 P. 7515–7545.

15. *Ferreira A., Bastos C.R.V., Marques-Dos-Santos C., Acién-Fernandez F.G., Gouveia L.* Algaeculture for

agriculture: from past to future Front Agron. 2023. Vol.5 P.1064041.

16. *Ferri G., Buonavoglia A., Farooq M., Festino A.R., Ruffini F., Paludi D., Di Francesco C., Alberto V., Camilla S.* Antibiotic resistance in Italian poultry meat production chain: a one-health perspective comparing antibiotic free and conventional systems from the farming to the slaughterhouse Front Food Sci Technol. 2023. Vol.3 P.1168896.

17. Food and Agriculture Organization of the United Nations. Progress report on the implementation of FAO Action Plan on Antimicrobial Resistance (AMR) 2016–2020, and the proposal for a new FAO Action Plan on AMR 2021–2025 (COAG/2020/INF/6). 2020 [cited 2025 Sep 23]. Available from: https://openknowledge.fao.org/server/api/core/bitstreams/886c32f3-0aeb-4569-8404-496d66fb008a/content

18. Food and Agriculture Organization of the United Nations. Antimicrobial Resistance | www.fao.org. 2020 [cited 2025 Sep 23]. Available from: https://www.fao.org/antimicrobial-resistance

19. *Glover R.E.* Antimicrobial resistance in the United Kingdom: A mixed-methods dissertation on diagnostics, discourse, and decision-making [dissertation]. London: London School of Hygiene & Tropical Medicine; 2021.

20. Godman B., Egwuenu A., Haque M., Malande O.O., Schellack N., Kumar S., Saleem Z., Sneddon J., Hoxha I., Islam S., Mwita J., do Nascimento R.C.R.M., Dias Godói I.P., Niba L.L., Amu A.A., Acolatse J., Incoom R., Sefah I.A., Opanga S., Kurdi A., Chikowe I., Khuluza F., Kibuule D., Ogunleye O.O., Olalekan A., Markovic-Pekovic V., Meyer J.C., Alfadl A., Phuong T.N.T., Kalungia A.C., Campbell S., Pisana A., Wale J., Seaton R.A. Strategies to Improve Antimicrobial Utilization with a Special Focus on Developing Countries Life (Basel). – 2021. – Vol.11(6). – P.528.

21. *Graells T., Lambraki I.A., Cousins M., Léger A., Lillepold K., Henriksson P.J.G., Troell M., Carson C. A., Parmley E. J., Majowicz S. E., Wernli D., Jørgensen P. S.* Studying Factors Affecting Success of Antimicrobial Resistance Interventions through the Lens of Experience: A Thematic Analysis Antibiotics. 2022. Vol.11(5) P.639.

22. *Haenssgen M.J., Charoenboon N., Zanello G., Mayxay M., Reed-Tsochas F., Lubell Y., Wertheim H., Lienert J., Xayavong T., Khine Zaw Y., Thepkhamkong A., Sithongdeng N., Khamsoukthavong N., Phanthavong C., Boualaiseng S., Vongsavang S., Wibunjak K., Chai-In P., Thavethanutthanawin P., Althaus T., Greer R.C., Nedsuwan S., Wangrangsimakul T., Limmathurotsakul D., Elliott E., Ariana P.* Antibiotic knowledge, attitudes and practices: new insights from cross-sectional rural health behaviour surveys in low-income and middle-income South-East Asia BMJ Open. 2019. Vol.9(8) e028224.

23. *Hamers R. L., Dobreva Z., Cassini A., Tamara A., Lazarus G., Asadinia K. S., Burzo S., Olaru I. D., Dona D., Emdin F., Van Weezenbeek K., Bertagnolio S.* Global knowledge gaps on antimicrobial resistance in the human health sector: A scoping review // Int J Infect Dis. 2023. Vol.*134* – P.142–149. https://doi.org/10.1016/j.ijid.2023.06.004

24. *Hunt M., Mather A.E., Sánchez-Busó L., Page A.J., Parkhill J., Keane J.A., Harris S.R.* ARIBA: rapid antimicrobial resistance genotyping directly from sequencing reads Microb Genom. 2017. Vol.3(10) e000131.

25. Institute for Health Metrics and Evaluation (IHME). Kazakhstan: Antimicrobial resistance burden 2019. Seattle (WA): University of Washington; 2023.

26. Keenan K., Corrêa J.S., Sringernyuang L., Nayiga S., Chandler C.I.R. The social burden of antimicrobial resistance: what is it, how can we measure it, and why does it matter? JAC-Antimicrob Resist. 2025. Vol.7(2) dlae208.

27. *Khan M. S., Durrance-Bagale A., Mateus A., Sultana Z., Hasan R., Hanefeld J.* What are the barriers to implementing national antimicrobial resistance action plans? A novel mixed-methods policy analysis in Pakistan Health Policy and Plan. *2020*. Vol. *35*(8) P.973–982

28. *Koumaki V.* Combating Antimicrobial Resistance: Innovations and Strategies Microorganisms. 2025. Vo.*13*(8) – P.1869.

29. *Leonard A.F., Morris D., Schmitt H., Gaze W.H.* Natural recreational waters and the risk that exposure to antibiotic resistant bacteria poses to human health Curr Opin Microbiol. 2021. Vol.65. P.40–46.

30. *Ljungqvist G., Van Kessel R., Mossialos E., Saint V., Schmidt J., Mafi A., Shutt A., Chatterjee A., Charani E., Anderson M.* Mapping socioeconomic factors driving antimicrobial resistance in humans: An umbrella review One Health. 2025. Vol.20 P.100986

31. *Llewelyn M.J., Fitzpatrick J.M., Darwin E., SarahTonkin-Crine N, Gorton C, Paul J, Peto T.E.A.,* Yardley L., Hopkins S., Walker AS. The antibiotic course has had its day BMJ. 2017. Vol.358 - j3418.

32. *Makabenta J.M.V., Nabawy A., Li C., Schmidt-Malan S., Patel R., Rotello V.M.* Nanomaterial-based therapeutics for antibiotic-resistant bacterial infections. Nat Rev Microbiol. 2020. Vol.19(1). P.23–36.

33. Minssen T., Outterson K., Van Katwyk S. R., Batista P. H. D., Chandler C. I. R., Ciabuschi F., Harbarth S., Kesselheim A. S., Laxminarayan R., Liddell K., Osterholm M. T., Price L., Hoffman S. J. Social, cultural and economic aspects of antimicrobial resistance. Bulletin of the World Health Organization. 2020. Vol. 98(12). P.823-823A

34. *Mori V., Grant G., Hattingh L.* Evaluation of antimicrobial resistance surveillance data sources in primary care setting: a scoping review. Fam Pract. 2025. Vol.42(2) cmaf013.

35. *Mulchandani R., Tiseo K., Nandi A., Klein E., Gandra S., Laxminarayan R., Van Boeckel T.* Global trends in inappropriate use of antibiotics, 2000–2021: scoping review and prevalence estimates. BMJ Public Health. 2025. Vol.3(1). e002411.

36. *Nazir A., Nazir A., Zuhair V., Aman S., Sadiq S. U. R., Hasan A. H., Tariq M., Rehman L. U., Mustapha M. J., Bulimbe D. B.* The Global Challenge of Antimicrobial Resistance: Mechanisms, case studies, and mitigation approaches. Health Sci Rep. 2025. Vol. 8(7) e71077

37. *Nicholson A., Pavlin J., Buckley G., Amponsah E.* Systems approaches to spur innovations in tackling antimicrobial resistance. Exploring the Frontiers of Innovation to Tackle Microbial Threats. NCBI Bookshelf. 2020 https://www.ncbi.nlm.nih.gov/books/NBK560426/

38. *Nwobodo D.C., Ugwu M.C., Anie C.O., Al-Ouqaili M.T.S., Ikem J.C., Chigozie U.V., Saki M.* Antibiotic resistance: The challenges and some emerging strategies

for tackling a global menace. J Clin Lab Anal. 2022. Vol.36(9) e24655.

39. *Piot P.* Innovation and technology for global public health. Glob Public Health. 2012. Vol.7 Suppl 1 S46–53.

40. *Prestinaci F., Pezzotti P., Pantosti A.* Antimicrobial resistance: a global multifaceted phenomenon. Pathog Glob Health. 2015. Vol.109(7). P.309–318.

41. *Raka L., Kurti A.* Addressing barriers in antimicrobial stewardship: a guide from research to implementation. J Glob Antimicrob Resist. 2024. Vol.39. P.26.

42. Review on Antimicrobial Resistance. Jim O'Neill presents final international recommendations for the world to defeat superbugs: Press Notice. 2016 [cited 2025 Sep 23]. Available from: https://amr-review.org/sites/default/files/20160517_PRESS_NOTICE_CURRENT.PDF

43. *Rony M.K.K., Sharmi P.D., Alamgir H.M.* Addressing antimicrobial resistance in low and middle-income countries: overcoming challenges and implementing effective strategies // Environ Sci Pollut Res Int.- 2023. – Vol.30(45) - P.101896–902.

44. *Sakagianni A., Koufopoulou C., Koufopoulos P., Kalantzi S., Theodorakis N., Nikolaou M., Paxinou E., Kalles D., Verykios V. S., Myrianthefs P., Feretzakis G.* Data-Driven Approaches in Antimicrobial Resistance: Machine learning solutions. Antibiotics. 2024. Vol.13(11) P.1052.

45. *Sharma S., Chauhan A., Ranjan A., Mathkor D.M., Haque S., Ramniwas S., Tuli H.S., Jindal T., Yadav V.* Emerging challenges in antimicrobial resistance: implications for pathogenic microorganisms, novel antibiotics, and their impact on sustainability. Front Microbiol. 2024. Vol.15. P.1403168

46. *Shutt A. E., Ashiru-Oredope D., Price J., Padoveze M. C., Shafiq N., Carter E., Ghataure A., Shariq S., Holmes A. H., Charani E.* The intersection of the social determinants of health and antimicrobial resistance in human populations: a systematic review. BMJ Global Health. 2025. Vol.10(5) e017389

47. *Singer A.C., Shaw H., Rhodes V., Hart A.* Review of antimicrobial resistance in the environment and its relevance to environmental regulators. Front Microbiol.2016. Vol.7. P.1728.

48. *Stokes J.M., Yang K., Swanson K., Jin W., Cubillos-Ruiz A., Donghia N.M., MacNair C.R., French S., Carfrae L.A., Bloom-Ackermann Z., Tran V.M., Chiappino-Pepe A., Badran A.H., Andrews I.W., Chory E.J., Church G.M., Brown E.D., Jaakkola T.S., Barzilay R., Collins J.J.* A deep learning approach to antibiotic discovery. Cell. 2020. Vol.180(4). P.688-702.e13.

49. *Sumpradit N., Wongkongkathep S., Malathum K.., Janejai N, Paveenkittiporn W., Yingyong T., Chuxnum T., Vijitleela A., Boonyarit P., Akaleephan C., Manosuthi W., Thienthong V., Srinha J., Wongsrichai S., Laoprasert T., Athipunyakom P., Kriengchaiyaprug N., Intarukdach K., Numsawad S., Somjetanakul N., Punnin S., Kiatying-Angsulee N.* Thailand's national strategic plan on antimicrobial resistance: progress and challenges. Bull World Health Organ. 2021. Vol.99(9). P.661–673.

50. *Tiong J.J.L., Loo J.S.E., Mai C.* Global Antimicrobial Stewardship: A closer look at the formidable implementation challenges. Front Microbiol. 2016. Vol.7. P.1860.

51. *Topol E.J.* High-performance medicine: the convergence of human and artificial intelligence. Nat Med. 2018. Vol.25(1). P.44–56.

52. U.S. Centers for Disease Control and Prevention. National Action Plan for Combating Antibiotic-Resistant Bacteria. 2015 [cited 2025 Sep 23]. Available from: https://www.cdc.gov/antimicrobial-resistance/media/pdfs/national-action-plan-combating-ar-bacteria-P.pdf

53. *Vivekanandan K.E., Kumar P.V., Jaysree R.C., Rajeshwari T.* Exploring molecular mechanisms of drug resistance in bacteria and progressions in CRISPR/CAS9-Based genome expurgation solutions. Glob Med Genet. 2025. Vol.12(2). P.100042

54. World Bank Group. Antimicrobial resistance (AMR). World Bank. 2024 [cited 2025 Sep 23]. Available from: https://www.worldbank.org/en/topic/health/brief/antimicrobial-resistance-amr

55. World Health Organization. Antimicrobial resistance and the United Nations Sustainable Development Cooperation Framework. 2021 [cited 2025 Sep 23]. Available from: https://www.who.int/publications/b/58938

56. World Health Organization. (2014). Antimicrobial resistance: Global report on surveillance (ISBN 9789241564748). https://www.who.int/publications/i/item/9789241564748

57. World Health Organization. Antimicrobial resistance: global report on surveillance. 2014 [cited 2025 Sep 23]. Available from: https://www.who.int/publications/i/item/9789241564748

58. World Health Organization. Antimicrobial resistance. 2021 [cited 2025 Sep 23]. Available from: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

59. World Health Organization. Global Antimicrobial Resistance and Use Surveillance System (GLASS). [cited 2025 Sep 23]. Available from: https://www.who.int/initiatives/glass

60. World Health Organization. Global priority pathogens list on antimicrobial resistance (WHO/EMP/IAU/2022.1). Geneva: WHO; 2022.

61. World Health Organization. Surveillance of antimicrobial resistance in Europe, 2022 data. Stockholm: European Centre for Disease Prevention and Control; 2023.

62. World Health Organization. UN Interagency Coordination Group on Antimicrobial Resistance presents its report to the UN SG. 2019 [cited 2025 Sep 23]. Available from: https://www.who.int/news/item/28-04-2019-un-interagency-coordination-group-on-antimicrobial-resistance-presents-its-report-to-the-un-sg

63. World Organization for Animal Health (WOAH). Antimicrobial resistance. Global Initiatives. 2021 [cited 2025 Sep 23]. Available from: https://www.woah.org/en/what-we-do/global-initiatives/antimicrobial-resistance/

64. *Zhang S., Liao X., Ding T., Ahn J.* Role of B-Lactamase inhibitors as potentiators in antimicrobial chemotherapy targeting Gram-Negative bacteria. Antibiotics. 2024. Vol.13(3). P.260.

65. *Zhou G., Shi Q., Huang X., Xie X.* The Three Bacterial Lines of Defense against Antimicrobial Agents. Int J Mol Sci. 2015. Vol.16(9). P.21711–21733.

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