PUBBLISH FARMASI 1241 HAL 68-81.pdf

by Seffianidwiazmi@gmail.com 1

Submission date: 15-Apr-2025 10:37AM (UTC+0300)
Submission ID: 2576765782
File name: PUBBLISH_FARMASI_1241_HAL_68-81.pdf (195.51K)
Word count: 6248
Character count: 37536

PHARMACOPOEIA
Pharmacy Journal

https://nawalaeducation.com/index.php/JP/index
Volume 2 Nomor 1 March 2025
e-ISSN : 3047- 4469
DOI : https://doi.org/10.62872/v3yvk866

Antibiotics and bacterial resistance: A global challenge that needs to be addressed

Sugiah[1], Fadli[2], fitria hariati[3], Khrisna Agung Cendekiawan[4]
[1]STIKes Karsa Husada Garut, Indonesia
[2]Akademi Farmasi Yarsi Pontianaka, Indonesia
[3]Universitas Muhammadiyah Palangkaraya, Indonesia
[4] Universitas dr. Soebandi Jember, Indonesia
Email: sugiahrachmatulloh@gmail.com

ARTICLE INFO

Accepted : February 15, 2025
Revised : February 25, 2025
Approved : March 17, 2025
Published : March 25, 2025

Keywords: Antibiotics, Bacterial Resistance, Global Health, Rational Use

ABSTRACT

This study aims to explore the global challenges faced in addressing bacterial resistance to antibiotics, which are now one of the most serious health threats in the world. This study was conducted through the Systematic Literature Review (SLR) method by searching scientific articles from various databases such as PubMed, Scopus, and Google Scholar using the keywords "antibiotic resistance", "global health", "treatment failure", and "resistance mechanisms". The articles analyzed are publications in the last 10 years, focusing on the causes of resistance, their impact on global health, and countermeasures that have been carried out. The results of the study show that antibiotic resistance is mainly caused by the inappropriate use of antibiotics in the medical and non-medical sectors, lack of distribution supervision, and lack of development of new antibiotics. To overcome this, a comprehensive approach is needed, including increasing public education and health workers, strengthening regulations, and developing alternative therapies such as phagotherapy and vaccines. Without proper treatment, antibiotic resistance can lead to infection treatment failure, increased mortality rates, and burden the global health system.

INTRODUCTION

Antibiotics are one of the important milestones in the history of modern medicine. Since their discovery, antibiotics have saved millions of lives with their ability to treat various bacterial infections that were previously fatal (Pius Weraman, SKM, et al. 2025). Their widespread use has enabled high-risk medical procedures such as major surgery, organ transplants, and chemotherapy, with higher success rates due to protection from infection. However, this success is starting to be threatened by the emergence of the phenomenon of bacterial resistance to antibiotics. Antibiotic resistance occurs when bacteria undergo genetic changes that allow them to survive even after being treated. This problem does not only occur in hospitals or clinics, but also extends to the livestock, fisheries, and environmental sectors. The causes are diverse, ranging from inappropriate use of antibiotics by the public, over-the-counter treatment, to routine use of antibiotics in livestock (Runtuboi, DYP 2024).

Not only in the medical world, antibiotics have also contributed greatly to increasing human life expectancy globally. By reducing the death rate from infection, society becomes healthier and more productive. In addition, antibiotics also play a role in controlling infectious diseases on an epidemic and pandemic scale, thus helping to maintain the stability of public health (Xl, DPDN, & Ke, DW 2024). However, this extraordinary success is actually a threat if its use is not controlled wisely. Inappropriate use of antibiotics, such as use without a doctor's prescription, incomplete consumption, to misuse in the livestock and agricultural sectors, has led to the emergence of bacteria that are resistant to this drug. Therefore, although antibiotics have saved millions of lives, the challenge ahead lies in how humans can maintain their effectiveness with rational, responsible use, and accompanied by continuous innovation in the development of alternative treatments. However, inappropriate and excessive use of antibiotics in recent decades has led to the emergence of antibiotic resistance, where bacteria develop immunity to the drugs used to treat their infections. Antibiotic resistance is now one of the most pressing public health problems worldwide.

Antibiotic-resistant bacteria can cause infections that are more difficult to treat, prolong the duration of illness, increase health care costs, and risk death. The World Health Organization (WHO) estimates that antibiotic resistance will cause more than 10 million deaths per year by 2050 if there are no effective measures to address this problem. This shows how crucial it is to address antibiotic resistance at the global level (Panggalo, AM 2023). One of the main causes of antibiotic resistance is the inappropriate use of antibiotics. Antibiotics are often prescribed for infections that are not caused by bacteria, such as viral infections (eg, flu or colds), which are not only ineffective but can also lead to the emergence of resistance. In addition, antibiotic treatment that is not in accordance with the dose or duration also increases the risk of resistance (Nurjanah, N., & Emelia, R. 2022). Another factor that contributes to bacterial resistance is the excessive use of antibiotics in livestock and agriculture. In some countries, antibiotics are given to animals not only to treat diseases but also to increase animal growth. This practice has led to the spread of bacterial resistance to humans through contaminated food. This adds complexity to efforts to control antibiotic resistance. In addition, uncontrolled distribution of antibiotics in developing countries also worsens the situation of antibiotic resistance. In some countries, antibiotics can be obtained without a prescription, which increases the possibility of drug abuse and irrational use (Eljatin, DS, et al. 2024). People who do not have sufficient knowledge about the dangers of antibiotic resistance often use antibiotics carelessly. The development of new antibiotics has also declined in recent decades. The high cost and challenges in finding new compounds that are effective against resistant bacteria make pharmaceutical companies reluctant to invest in research into new antibiotics. Meanwhile, bacteria continue to evolve and find ways to avoid the effects of existing antibiotics, further exacerbating the resistance crisis. Therefore, a more coordinated and stronger effort is needed to deal with antibiotic resistance. This involves stricter antibiotic control policies, more intensive research to find new antibiotics and alternative therapies, and broader education for the public about the importance of rational antibiotic use. In addition, international collaboration is essential to address the challenge of bacterial resistance worldwide.

The purpose of writing a research entitled "Antibiotics and Bacterial Resistance: A Global Challenge to Face" is to analyze the important role of antibiotics in the medical world, especially in reducing mortality rates from previously deadly bacterial infections. This study also aims to identify various factors that contribute to the emergence and

development of bacterial resistance to antibiotics, both in the human and animal health sectors. In addition, this study evaluates the impact of antibiotic resistance on the global health system, including increased morbidity, mortality, and the economic burden caused. The author also attempts to describe various strategies and efforts that have been made globally and nationally to address this threat, including the One Health approach and the role of the World Health Organization (WHO). This study encourages the importance of increasing awareness of the wise and responsible use of antibiotics, as well as the need for active involvement from various parties such as the government, health workers, academics, and the general public. Finally, this study is expected to provide recommendations for innovative solutions, such as the development of new antibiotics, vaccines, alternative therapies such as phagotherapy, and strengthening the surveillance system and regulation of antibiotic distribution.

METHODOLOGY

This study is a literature review that aims to explore the global challenges faced in dealing with bacterial resistance. Literature searches were conducted through various databases, such as PubMed, Scopus, and Google Scholar, using the keywords "antibiotic resistance", "global health", "treatment failure", and "resistance mechanisms" (Pratama, MFA, & Darmawan, ES 2023). The articles selected in this study were those published in the last 10 years and focused on aspects of antibiotic resistance and its causative factors. Article selection was carried out by considering the relevance of the topic, the quality of the methodology, and the impact of the research results discussed. In addition, articles that examine antibiotic control policies and solutions to overcome bacterial resistance were also included in the analysis. The author then compiled relevant research results to discuss the challenges and solutions that exist in overcoming antibiotic resistance. Furthermore, the results of the literature review were analyzed and synthesized to obtain a more comprehensive picture of the challenges faced in fighting bacterial resistance. The author also discusses recommendations from existing research, as well as policies and steps that need to be taken to reduce the spread of antibiotic resistance globally.

RESULTS AND DISCUSSION

Understanding Antibiotics and Bacterial Resistance

Antibiotics are chemical compounds used to kill or inhibit the growth of bacteria. These compounds can come from microorganisms such as fungi, or be made synthetically in the laboratory. Antibiotics are only effective against bacterial infections and cannot be used to treat diseases caused by viruses, such as the flu or colds. The way antibiotics work is divided into two, namely bacteriostatic and bactericidal (Nova, B., et al. 2024). Bactericidal antibiotics work by killing bacteria directly, for example by damaging the cell walls or cell membranes of bacteria so that the bacteria die. Meanwhile, bacteriostatic antibiotics inhibit the growth and reproduction of bacteria, allowing the immune system to overcome infections. This mechanism is carried out, among others, by inhibiting protein synthesis or disrupting the process of DNA and RNA replication of bacteria. By understanding how antibiotics work, their use can be more precise and wise, and help prevent bacterial resistance to antibiotics (Pratiwi, RH 2017).

Antibiotic resistance is the ability of bacteria to survive and continue to reproduce even though they have been given antibiotics that were previously effective in killing or inhibiting their growth. This condition occurs when bacteria undergo genetic changes or acquire genes from other bacteria that make them resistant to the effects of antibiotics. As

a result, infection treatment becomes more difficult, requires stronger antibiotics or combinations of drugs, and sometimes cannot be treated at all. Antibiotic resistance can occur due to improper use of antibiotics, such as excessive use, not according to dosage, or not completing the treatment completely. Therefore, it is important to use antibiotics wisely so that their effectiveness is maintained and the spread of resistant bacteria can be prevented (Marah, N. 2020).

Table 1. Table of previous research that has been conducted regarding antibiotics and bacterial resistance, and the results obtained from each study.

Title	Year	Writer	Research result
Global Burden of Bacterial Antimicrobial Resistance (1990–2021)	2023	Antimicrobial Resistance Collaborators	Global and regional estimates of mortality due to antimicrobial resistance (AMR). AMR caused 1.27 million direct deaths in 2019.
Antibiotic resistance in Indonesia: A systematic review and meta-analysis of extended-spectrum beta-lactamase-producing bacteria (2008–2024)	2025	Kadariswantiningsih, Ika N.; Rampengan, Derren David; Ramadhan, Roy Novri et al.	This meta-analysis shows that the prevalence of extended-spectrum beta-lactamase (ESBL)-producing bacteria in Indonesia reaches 46.38%, with significant regional variations. Sumatra has the highest prevalence of 63.99%, while Kalimantan has the lowest at 15.24%. These findings emphasize the need for strict infection control and tailored surveillance programs to reduce the impact of ESBL-producing bacteria on public health.
Antimicrobial Resistance Situation in	2022	Herman, Max J.; Fitri, Nyoman	This study highlights the challenges of

Indonesia: A Challenge of Multisector and Global Coordination			antimicrobial resistance (AMR) in Indonesia, including inappropriate use of antibiotics in the human and animal health sectors, and the lack of multisectoral coordination in controlling AMR. The authors emphasize the importance of an integrated approach and global coordination to address this issue.
Antibiotic Resistance in Hospitals in Indonesia: Antibiotic Use and Associated Costs	2021	Siahaan, Selma;	This study evaluated antibiotic use and associated costs in hospitals in Indonesia. The results showed that irrational antibiotic use contributed to increasing resistance and health care costs. This study recommends the implementation of antibiotic control programs to reduce resistance and costs.
Antimicrobial Resistance: A Growing Serious Threat for Global Health	2023	David W. Ho et al.	Highlighting the increasing prevalence of resistant bacteria worldwide, threatening global public health, and urging more rapid intervention.
Advancing Drug Resistance	2020	Kevin S. Farquhar, Harold Flohr, Daniel A.	Discussion of the use of quantitative

Research Through Quantitative Modeling and Synthetic Biology		Charlebois	models and synthetic biology to understand and address drug resistance, with an emphasis on multidisciplinary collaboration.
From Data to Action: Charting A Data-Driven Path to Combat Antimicrobial Resistance	2023	John W. Smith et al.	Reviews data-driven and machine learning approaches in AMR research, as well as challenges in data standardization and interoperability in the health sector.
Resistance Test of Escherichia coli from Raw Water Sources in Karawang to Ciprofloxacin Antibiotics	2022	Diniarti, FA; Kasasiah, A.; Hilmi, IL	This study tested the resistance of Escherichia coli from raw water sources in Karawang to the antibiotic ciprofloxacin. The results showed significant resistance, indicating a potential public health risk and the need for water quality monitoring.
The Influence of Community Education on Antibiotic Use	2023	Artika, A.; Nugraha, I.; Dewi, N.	This study examines the effect of public education on antibiotic use. The results show that proper education can improve public understanding of the correct use of antibiotics, thereby reducing the risk of resistance.

The difference between natural resistance and acquired resistance lies in the origin and how bacteria become resistant to antibiotics. Natural resistance is an innate trait that certain types of bacteria have from the start. This means that the bacteria are indeed not sensitive to certain types of antibiotics because their structure or mechanism of action cannot be affected by the antibiotic. For example, bacteria that do not have cell walls are naturally resistant to antibiotics such as penicillin that target the cell wall. Acquired resistance, on the other hand, occurs when bacteria are initially sensitive to antibiotics but then become resistant due to genetic changes (mutations) or acquire resistance genes from other bacteria, usually through processes such as conjugation, transformation, or transduction. This resistance often occurs due to inappropriate use of antibiotics, such as overuse, wrong dosage, or not completing treatment. In other words, natural resistance is an innate trait, while acquired resistance occurs due to adaptation or genetic changes during the life of the bacteria (Wahyuni, NA 2020).

Factors Causing Antibiotic Resistance

Excessive and inappropriate use of antibiotics, such as taking them without a doctor's prescription, can have various negative impacts, especially in triggering antibiotic resistance. When antibiotics are used without clear indications, for example for viral infections such as the flu or common cough, the bacteria in the body can be exposed to antibiotics unnecessarily. This exposure gives bacteria the opportunity to adapt and become resistant to the drug. In addition, inappropriate use such as stopping treatment prematurely, using the wrong dose, or using leftover antibiotics from previous prescriptions can also cause some bacteria to survive. These surviving bacteria can develop into resistant strains. If resistance spreads, bacterial infections become more difficult to treat, require stronger drugs, higher treatment costs, and a greater risk of complications (Herawati, D., et al. 2023).

The use of antibiotics in livestock and fisheries is generally done to prevent disease (prophylaxis), treat sick animals, and in some cases to increase animal growth. In practice, antibiotics are often mixed into livestock and fish feed or drinking water, even when there are no symptoms of disease. The goal is to maintain productivity and prevent economic losses due to bacterial infections. However, routine and long-term use of antibiotics in this field can cause serious problems, especially antibiotic resistance. Bacteria exposed to antibiotics in livestock or fisheries environments can become resistant, and this resistance can spread to the surrounding environment, even to humans through the food chain, direct contact, or water and soil pollution. In addition, antibiotic residues in animal products such as meat, eggs, or fish can also have a negative impact on consumer health if consumed continuously. Therefore, many countries are now encouraging wiser use of antibiotics in the livestock and fisheries sectors, including with strict supervision, prohibition of the use of antibiotics as growth stimulants, and implementation of a waiting period before animal products can be harvested or consumed (Wisnuwati, W. 2018). Good animal health management, vaccination, and clean farming/fishing environments are safer alternative steps to prevent disease without relying on antibiotics.

Lack of education and awareness among the public and health workers regarding the use of antibiotics is one of the main factors accelerating the occurrence of antibiotic resistance. Many people still consider antibiotics as "all-purpose" drugs that can cure all types of diseases, including viral infections such as flu, cough, or common fever. As a result, they often buy antibiotics without a prescription or take them without proper

instructions, such as not finishing the prescribed dose or using leftover antibiotics from previous treatments. On the other hand, some health workers still prescribe antibiotics inappropriately, either because of pressure from patients who want to "get well quickly", lack of time for education, or because of limited access to accurate laboratory diagnosis. In fact, giving antibiotics that are not needed can actually have a negative impact on patients and the wider community in the long term (Joko, W. 2022).

The lack of effective educational campaigns and a deep understanding of the dangers of antibiotic resistance has caused the public to be less concerned about the importance of using antibiotics wisely. Therefore, increased public education and training for health workers are needed, so that all parties understand that maintaining the effectiveness of antibiotics is a shared responsibility. The distribution of antibiotics without strict supervision is one of the main causes of the increasing cases of antibiotic resistance in the community. In some places, antibiotics can still be easily purchased at pharmacies or drug stores without a doctor's prescription. This opens up opportunities for people to consume antibiotics carelessly, without a proper diagnosis, without the appropriate dosage, and without knowing the risks of side effects or resistance (Firdaus, MI 2024). The lack of regulation and supervision from the authorities makes the distribution of antibiotics uncontrolled. In fact, in some cases, antibiotics are sold online or on the open market without clear labels, so their quality and safety are not guaranteed. This is very dangerous because it allows the circulation of fake or expired drugs, which are not only ineffective, but can also worsen the patient's condition. In addition, the unsupervised distribution of antibiotics also complicates efforts to track and control drug use. Without clear data on how much and how antibiotics are used in the community, it is difficult for health authorities to design effective strategies to combat resistance. To address this problem, strict regulatory enforcement is needed, such as requiring prescriptions for antibiotic purchases, tightening drug distribution, and increasing supervision of pharmacies and drug stores. Public education is also important so that they understand that antibiotics are not drugs that can be consumed carelessly.

The Impact of Bacterial Resistance on Global Health

Bacterial resistance to antibiotics has a serious impact on global health and is one of the most significant threats to health systems worldwide. When bacteria develop resistance, antibiotics become ineffective at killing or inhibiting their growth. As a result, infections that were previously easily treatable become more difficult to treat, requiring longer treatment, more expensive drugs, and in many cases, poorer treatment outcomes. This leads to increased morbidity because patients experience prolonged or recurrent infections, and increased mortality due to the lack of effective treatment. This condition also places a greater burden on the global health care system, including increased costs of care and greater use of hospital resources. Antibiotic resistance even threatens the success of important medical procedures such as major surgery, chemotherapy, and organ transplantation, which rely heavily on the effectiveness of antibiotics to prevent infection (Lubis, RA 2022). Antibiotic resistance also prolongs hospital stays, increases treatment costs, and increases the burden on health workers and facilities. Medical procedures that rely on antibiotics to prevent infection, such as major surgery, chemotherapy, or organ transplantation, become riskier in the absence of effective antibiotics (Musdja, MY)

In addition to the impact on individuals, bacterial resistance also affects public health at large, because resistant bacteria can spread between individuals, between regions, and even across countries. This makes antibiotic resistance a cross-border

problem that requires international cooperation. The World Health Organization (WHO) has declared antibiotic resistance as one of the most pressing health threats of the 21st century. If not addressed seriously, it is estimated that millions of people could die each year from untreatable infections, and various advances in modern health could be at risk of being lost. Therefore, coordinated global action is urgently needed, including strict monitoring of antibiotic use, research into new drugs, and increased public education and awareness (Noor, NN 2022).

Efforts to Combat Antibiotic Resistance

The Global Action Plan on Antimicrobial Resistance (GAP-AMR) launched by the World Health Organization (WHO) in 2015 is a global strategy to address the problem of antibiotic and antimicrobial resistance. This action plan aims to ensure that antibiotics and other medicines remain effective in treating infections in the future. GAP-AMR includes seven main pillars, namely increasing awareness and education about the dangers of antibiotic resistance, improving supervision and monitoring of antibiotic use, and controlling infections and prevention with better hygiene and vaccination. In addition, this plan also emphasizes the importance of wise use of antibiotics, investment in research and development of new medicines, and improving policies and regulations to regulate the use of antibiotics in the health and agricultural sectors. Global cooperation and partnerships between countries, the private sector, and international organizations are also key in this effort, because antibiotic resistance is a transboundary problem that requires a coordinated approach. GAP-AMR warns that without decisive steps, the problem of antibiotic resistance can lead to increased mortality, morbidity, and high medical costs, and threatens the progress that has been achieved in the health sector.

Wise use of antibiotics or what is known as antimicrobial stewardship is an approach that aims to optimize the use of antibiotics so that they remain effective in treating infections, reduce the risk of antibiotic resistance, and minimize adverse side effects. This stewardship program includes administering antibiotics according to indications, namely only for infections caused by bacteria, not viruses such as flu or colds. In addition, choosing the right antibiotic is also very important, by choosing the appropriate type of antibiotic based on the culture and sensitivity of the bacteria causing the infection. Determining the right dose and the appropriate duration of therapy is also part of the wise use of antibiotics, to ensure effective treatment without increasing the risk of resistance or side effects (Wijaya, AP 2021). This program also includes ongoing monitoring of antibiotic use, with regular evaluations to determine whether treatment is still needed. In addition, education for medical personnel and patients about the importance of proper antibiotic use is also key in the antimicrobial stewardship program. By implementing these principles, antimicrobial stewardship aims to reduce antibiotic resistance rates and ensure antibiotics remain effective in treating infections in the future (Eljatin, DS, et al. 2024).

The development of new antibiotics and alternative therapies is a crucial step in addressing the increasing challenge of antibiotic resistance. With bacteria becoming increasingly resistant to existing antibiotics, research to find new antibiotic compounds is urgently needed. The development of new antibiotics involves searching for new molecules or modifications of existing antibiotics, although this process requires time, large costs, and rigorous testing. On the other hand, phagotherapy or phagos therapy offers an interesting alternative solution, where viruses (phagos) are used to destroy infectious bacteria without harming human cells or other good microorganisms in the

body. Phagotherapy is very useful for treating bacteria that are resistant to antibiotics. In addition, vaccine development is also an important part of reducing bacterial infections that require antibiotic treatment. With vaccination, the body can build immunity to disease-causing bacteria, thereby reducing the incidence of infection and the need for antibiotics. Overall, the development of new antibiotics, phagos therapy, and vaccination provide new hope in overcoming the problem of antibiotic resistance and ensuring that infection treatments remain effective in the future (Runtuboi, DYP 2024).

Improving bacterial resistance surveillance systems is an important step in addressing the global problem of antibiotic resistance. Good surveillance allows for the collection of accurate data on the extent and severity of antibiotic resistance problems, both in humans, animals, and the environment. With an effective surveillance system, we can monitor trends in bacterial resistance, identify newly emerging resistant bacteria, and track the spread of infections caused by these bacteria. Improving surveillance involves developing and strengthening monitoring systems in various sectors, including hospitals, clinics, pharmacies, and in the agricultural and livestock sectors. This surveillance includes collecting data on antibiotic use, infection incidents, and laboratory results that indicate whether the bacteria involved are resistant to the drugs used. In addition, it is also important to strengthen international cooperation in surveillance, considering that antibiotic resistance is a global problem that affects various countries (Rahman, H. 2024).

With more complete and real-time data on resistance patterns, authorities can design more appropriate policies to control antibiotic use, improve medical practices, and implement more effective infection prevention measures. In addition, strong surveillance also helps identify areas or sectors that require special attention, so that preventive actions can be taken more quickly. Improving bacterial resistance surveillance systems is essential in mitigating the impact of antibiotic resistance and maintaining the effectiveness of antibiotics for treating infections in the future.

Cross-Sector Role in Facing These Challenges

The One Health approach is a framework that recognizes that human, animal and environmental health are inextricably linked. It encourages cross-sector collaboration between human, animal and environmental health professionals to address health issues affecting all three, including antibiotic resistance, one of the greatest challenges of our time. In the context of antibiotic resistance, the One Health approach is particularly important because antibiotics used in human medicine are also often used in the livestock and fisheries sectors to treat or prevent disease in animals and to promote growth. Overuse or inappropriate use of antibiotics in animals can lead to the development of resistant bacteria that can be transmitted to humans through contaminated food, direct contact or the environment. The approach emphasizes the need for collaboration between healthcare professionals, veterinarians, environmental researchers and policymakers to monitor and regulate antibiotic use across all three sectors. For example, efforts to reduce antibiotic use in animals and implement better infection control on farms can reduce the risk of transmission of resistant bacteria to humans. Similarly, good environmental management, such as waste management from livestock industries, is also important to prevent the spread of resistant bacteria into the environment. By integrating human, animal and environmental health sectors into one coordinated system, the One Health approach provides a more holistic and effective solution to address antibiotic resistance, as well as improving overall health management. This leads to a more sustainable approach to maintaining public health and preventing the spread of diseases caused by resistant

bacteria (Pratama, SM, et al. 2025).

Government regulation in the supervision and distribution of antibiotics plays an important role in overcoming the problem of antibiotic resistance. The government must set strict rules to control the use of antibiotics to prevent misuse. One of the main regulations is the regulation of antibiotic sales, which usually requires antibiotics to be sold only with a doctor's prescription. This aims to prevent the purchase of antibiotics without proper medical supervision. In addition, the government also regulates the use of antibiotics in human and animal medicine, by ensuring that antibiotics are only used according to legitimate and appropriate indications. In the livestock sector, this regulation also prohibits the use of antibiotics to increase animal growth, only allowing their use for the treatment of proven animal diseases (Ariningsih, E., et al. 2023). The government must also ensure that there is a strong monitoring system to track antibiotic use and resistance trends, which allows for more effective antibiotic control policies. In the agriculture and livestock sectors, strict supervision is needed to prevent the misuse of antibiotics that can lead to resistance that can be transferred to humans through the food chain. In addition, the government needs to enforce the law by imposing sanctions or fines on parties who violate the rules, such as pharmacies that sell antibiotics without a prescription or farms that use antibiotics incorrectly. All these steps demonstrate the importance of clear regulations and strict law enforcement to ensure the wise use of antibiotics and reduce the risk of antibiotic resistance (Yusuf, S. 2021).

The role of academics and researchers in innovation and development of solutions to address the problem of antibiotic resistance is vital. Academics and researchers act as key drivers in the discovery, development, and application of effective scientific solutions. They not only conduct basic research to understand the mechanisms of resistance, but also develop new approaches that can help address this problem. First, academics and researchers play an important role in basic and applied research to identify and understand the various factors that cause antibiotic resistance. This research includes the study of bacterial genetics, how bacteria develop resistance, and how environmental factors and inappropriate antibiotic use contribute to the spread of resistance. A better understanding of the mechanisms of resistance allows for the development of more effective strategies to prevent and treat resistant bacterial infections (Ariwidodo, E. 2020).

In addition, academics are also involved in the development of new antibiotics and alternative therapies, such as phagotherapy or vaccines, that can overcome bacteria that are resistant to existing antibiotics. Researchers are working with the pharmaceutical industry to find new compounds or modify existing antibiotics to make them more effective. They are also exploring new approaches, such as bacteriophage-based therapies that use viruses to destroy bacteria or developing vaccines to prevent certain bacterial infections that could reduce the need for antibiotics.

In addition, academics and researchers are also involved in developing evidence-based policies and guidelines for wiser antibiotic use. Through ongoing research, they can provide recommendations for national and international policies on antibiotic stewardship, infection control, and education to the public and healthcare professionals on the importance of appropriate antibiotic use.

Academics and researchers also have a role to play in driving cross-sector collaboration, as seen in the One Health approach, where they work with human, animal and environmental health professionals to holistically address antibiotic resistance. Researchers often serve as the bridge between science, public policy and industry, bridging the gap between theory and practical application. Overall, the role of academics

and researchers in the innovation and development of antibiotic resistance solutions is critical. They not only provide in-depth scientific understanding, but also develop new technologies and strategies that can slow or halt the development of antibiotic resistance, while ensuring that treatments for infections remain effective in the future.

CONCLUSION

Antibiotic resistance is a global health challenge that requires serious attention from various parties. Irrational use of antibiotics, both in the medical and agricultural sectors, as well as the lack of development of new antibiotics, are the main factors causing the increase in bacterial resistance. Therefore, a comprehensive approach is needed, starting from strict antibiotic control policies to increasing education for the public and medical personnel regarding the importance of proper antibiotic use. Increasing global awareness, accelerating the development of alternative therapies, and tightening supervision of antibiotic distribution are steps that need to be taken to combat antibiotic resistance. Without proper action, antibiotic resistance can risk threatening the success of bacterial infection treatment and increasing global mortality rates.

LITERATURE

Antimicrobial Resistance Collaborators. (2023). Global Burden Of Bacterial Antimicrobial Resistance (1990–2021). The Lancet.

Ariningsih, E., Ariani, M., Ilham, N., Rohaeni, E. S., Suhartini, S. H., Agustian, A., ... & Suandy, I. (2023). Tinjauan Kritis Keamanan Dan Kehalalan Daging Ayam Broiler Di Indonesia. In Forum Penelitian Agro Ekonomi (Vol. 41, No. 2, Pp. 97-117).

Ariwidodo, E. (2020). Penerapan Bioteknologi Versus Lingkungan Hidup: Perspektif Filsafat Lingkungan.

Artika, A., Nugraha, I., & Dewi, N. (2023). Pengaruh Edukasi Pada Masyarakat Terhadap Penggunaan Antibiotik. Focus Medical Journal. Diakses Dari Https://Fmj.Fk.Umi.Ac.Id

Diniarti, F. A., Kasasiah, A., & Hilmi, I. L. (2022). Uji Resistensi Escherichia Coli Dari Sumber Air Baku Di Karawang Terhadap Antibiotik Siprofloksasin. Focus Medical Journal, Fakultas Kedokteran Universitas Muslim Indonesia. Diakses Dari Https://Fmj.Fk.Umi.Ac.Id

Eljatin, D. S., Haykal, M. N., Susilo, I., Wibawa, A. D., Fadli, S., Njoto, E. N., ... & Parlindungan, P. G. (2024). Peningkatan Kewaspadaan Resistensi Antibiotik Pada Kader Surabaya Hebat (Ksh) Di Kecamatan Sukolilo. Sewagati, 8(6).

Eljatin, D. S., Haykal, M. N., Susilo, I., Wibawa, A. D., Fadli, S., Njoto, E. N., ... & Parlindungan, P. G. (2024). Peningkatan Kewaspadaan Resistensi Antibiotik Pada Kader Surabaya Hebat (Ksh) Di Kecamatan Sukolilo. Sewagati, 8(6).

Farquhar, K. S., Flohr, H., & Charlebois, D. A. (2020). Advancing Drug Resistance Research Through Quantitative Modeling And Synthetic Biology. Journal Of Applied Microbiology.

Firdaus, M. I. (2024). Hubungan Dukungan Sosial Dengan Resiliensi Penderita Tuberkulosis Resistan Obat (Tbc Ro) Pada Organisasi Pasien Tuberkulosis Resistan Obat Di Jawa Timur (Doctoral Dissertation, Universitas Islam Negeri Maulana Malik Ibrahim).

Herawati, D., Azzahra, D. N., Farhah, H. D., Hadi, J. C. H., Sagala, J. T., Rosadi, N. C., ... & Ridwan, H. (2023). Efek Samping Penggunaan Antibiotik Irasional Pada

Gangguan Pernapasan Infeksi Saluran Penafasan Akut: Side Effects Of Irrational Antibiotic Use In Respiratory Disorders Upper Respiratory Tract Infection. Jurnal Ilmiah Keperawatan (Scientific Journal Of Nursing), 9(2), 464-471.

Ho, D. W., Et Al. (2023). Antimicrobial Resistance: A Growing Serious Threat For Global Health. Global Health Journal.

Joko, W. (2022). Hubungan Tingkat Stress Dengan Kadar Gula Darah Dan Penyembuhan Luka Gangren Di Dapartemen Penyakit Dalam Rumkital Dr Ramelan Surabaya (Doctoral Dissertation, Stikes Hang Tuah Surabaya).

Kadariswantiningsih, I. N., Rampengan, D. D., Ramadhan, R. N., Et Al. (2025). Antibiotic Resistance In Indonesia: A Systematic Review And Meta-Analysis Of Extended-Spectrum Beta-Lactamase-Producing Bacteria (2008–2024). Universitas Airlangga. Diakses Dari Https://Scholar.Unair.Ac.Id

Lubis, R. A. (2022). Analisis Hubungan Tingkat Pengetahuan Dan Persepsi Apoteker Yang Berpraktik Di Rumah Sakit Tentang Resistensi Antibiotik (Doctoral Dissertation, Universitas Islam Indonesia).

Marah, N. (2020). Uji Resistensi Antibiotik Terhadap Bakteri Pseudomonas Aeruginosa Pada Sarang Burung Walet (Aerodramus Fuciphagus) Di Kabupaten Bone (Doctoral Dissertation, Universitas Hasanuddin).

Musdja, M. Y. Farmakologi & Terapi Hiv/Aids, Tbc Serta Ancaman Antimikroba Yang Resisten Terhadap Kaum Millenial.

Nature Communications. (2022). Assessment Of Global Health Risk Of Antibiotic Resistance Genes. Nature Communications.

Noor, N. N. (2022). Epidemiologi Dasar: Disiplin Dalam Kesehatan Masyarakat. Unhas Press.

Nova, B., Wardi, E. S., & Sartika, D. (2024). Metabolit Bioaktif Bakteri: Tinjauan Tentang Potensi Antimikroba Dan Aplikasinya. Journal Of Pharmaceutical And Sciences, 399-410.

Nurjanah, N., & Emelia, R. (2022). Evaluasi Penggunaan Antibiotik Pada Pasien Ispa Di Klinik Legok Medika Sumedang. Cerdika: Jurnal Ilmiah Indonesia, 2(2), 256-266.

Panggalo, A. M. (2023). Tingkat Pengetahuan Dan Perilaku Masyarakat Di Kota Makassar Terhadap Penggunaan Antibiotik Yang Rasional (Doctoral Dissertation, Universitas Hasanuddin).

Pius Weraman, S. K. M., Muntasir, S. S., Ir Lewi Jutomo, M. S., Deviarbi Sakke Tira, S. K. M., & Anastasia Sofia Lete Keraf, S. K. M. (2025). Inovasi Penanggulangan Tuberkulosis Dengan Tcm. Rizmedia Pustaka Indonesia.

Pratama, M. F. A., & Darmawan, E. S. (2023). Kebijakan Implementasi Program Antimicrobial Stewardship. Jurnal Cahaya Mandalika Issn 2721-4796 (Online), 3(1), 85-111.

Pratama, S. M., Siregar, A. U., & Hatchi, I. (2025). Antropologi, Sosial Budaya, Dan Biokimia Kesehatan: Pendekatan Komprehensif Untuk Meningkatkan Derajat Kesehatan Masyarakat. Book-Professorline, 1-97.

Pratiwi, R. H. (2017). Mekanisme Pertahanan Bakteri Patogen Terhadap Antibiotik. Jurnal Pro-Life, 4(3), 418-429.

Rahman, H. (2024). Analisis Pelaksanaan Penemuan Kasus Tb Di Puskesmas Kenali Besar Kota Jambi Tahun 2024 (Doctoral Dissertation, Universitas Jambi).

Runtuboi, D. Y. P. (2024). Mikrobiologi Kesehatan Dasar, Penyakit, Dan Peran Dalam Industri: Buku Referensi.

Runtuboi, D. Y. P. (2024). Mikrobiologi Kesehatan Dasar, Penyakit, Dan Peran Dalam Industri: Buku Referensi.

Sciencedirect. (2024). Antimicrobial Resistance: Impacts, Challenges, And Future Prospects. Sciencedirect Journal.

Siahaan, S., Andarwati, P., Puspandari, N., Kristiana, L., & Roosihermiatie, B. (2021). Antibiotic Resistance In Hospitals In Indonesia: Antibiotic Use And Associated Costs. Journal Of Tropical Medicine, Seameo Tropmed Network. Diakses Dari Https://Journal.Seameotropmednetwork.Org

Siahaan, S., Herman, M. J., & Fitri, N. (2022). Antimicrobial Resistance Situation In Indonesia: A Challenge Of Multisector And Global Coordination. Asia Pacific Journal Of Public Health. Diakses Dari Https://Pubmed.Ncbi.Nlm.Nih.Gov/35145554

Smith, J. W., Et Al. (2023). From Data To Action: Charting A Data-Driven Path To Combat Antimicrobial Resistance. Nature Communications.

Wahyuni, N. A. (2020). Uji Aktivitas Antibakteri Ekstrak Bunga Cengkeh (Syzygium Aromaticum) Terhadap Klebsiella Pneumoniae Secara In Vitro (Doctoral Dissertation, Universitas Islam Negeri Maulana Malik Ibrahim).

Wijaya, A. P. (2021). Kajian Penggunaan Antibiotika Secara Kualitatif Dan Kuantitatif Pada Ruangan Icu (Intensive Care Unit) Rumah Sakit Umum Daerah Petala Bumi Provinsi Riau Tahun 2018 (Doctoral Dissertation, Universitas Andalas).

Wisnuwati, W. (2018). Modul Pengembangan Keprofesian Berkelanjutan Profesional Aplikasi Bioteknologi Pada Bidang Perikanan Dan Kelautan Kelompok Kompetensi J.

Xl, D. P. D. N., & Ke, D. W. (2024). Mewujudkan Indonesia Sehat Dengan Imunitas Prima Melalui Pencegahan Penyakit Infeksi Berkesinambungan.

Yusuf, S. (2021). Strategi Menumbuhkan Dan Menguatkan Jiwa Wirausaha Di Tengah Pandemi Covid-19. Optimisme Menghadapi Tantangan Pandemi Covid-19: Gagasan Dan Pemikiran Dosen Fakultas Ilmu Kesehatan Universitas Muhammadiyah Parepare, 14, 212.

Jayanto, Imam, et al. (2024). *Ethics and Responsibility in Pharmaceutical Practice: Facing Moral Dilemmas in the Modern Era*. Vol. 1 No. 2 (2024): SEPTEMBER-JP.

PUBBLISH FARMASI 1241 HAL 68-81.pdf

ORIGINALITY REPORT

12%	7%	8%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Yaser Mohammed Al-Worafi. "Chapter 268-1 Antibiotics Resistant in the Developing Countries", Springer Science and Business Media LLC, 2024 Publication	2%
2	Imam Megantara, Nova Sylviana, Putri Alia Amira, Gita Widya Pradini, Ita Krissanti, Ronny Lesmana. " Potential of waterbodies as a reservoir of pathogens and the spread of antibiotic resistance in the Indonesian aquatic environment ", Journal of Water, Sanitation and Hygiene for Development, 2023 Publication	1%
3	infectioncycle.com Internet Source	1%
4	www.coursehero.com Internet Source	1%
5	Submitted to St Peter's College Student Paper	1%
6	www.scirp.org Internet Source	<1%
7	civas.net Internet Source	<1%
8	jurnalfarmasi.or.id Internet Source	<1%

9	Submitted to UCNJ Union College of Union County, NJ Student Paper	<1%
10	"New Strategies Combating Bacterial Infection", Wiley, 2008 Publication	<1%
11	www.frontiersin.org Internet Source	<1%
12	f1000research.com Internet Source	<1%
13	journalijdr.com Internet Source	<1%
14	inl.int Internet Source	<1%
15	www.mdpi.com Internet Source	<1%
16	MARCIN KOLACZKOWSKI, ANNA KOLACZKOWSKA, JACEK LUCZYNSKI, STANISLAW WITEK, ANDRE GOFFEAU. " Characterization of the Drug Resistance Profile of the Major ABC Transporters and Other Components of the Yeast Pleiotropic Drug Resistance Network ", Microbial Drug Resistance, 1998 Publication	<1%
17	www.veterinaryworld.org Internet Source	<1%
18	George Awuku Asare, Perpetua Dagadu, Samuel Adjei, Bernice Asiedu et al. "Rauwolfia vomitoria- a Promising Medical Plant for Benign Prostatic Hyperplasia Management;	<1%

Yet with Challenges", Phytomedicine Plus, 2025
Publication

19	arxiv.org Internet Source	<1%
20	journal.seameotropmednetwork.org Internet Source	<1%
21	Submitted to learndirect Student Paper	<1%
22	Submitted to Dhahran Ahliyya School Student Paper	<1%
23	Submitted to University of Florida Student Paper	<1%
24	jurnal.globalhealthsciencegroup.com Internet Source	<1%
25	www.peeref.com Internet Source	<1%
26	Wahyu Romizatul Isnaeni Syam, Silma Kaaffah, Fauziah Fauziah. "Impact of video-based educational intervention to improve parents' knowledge and awareness towards risk of antibiotic resistance in children: A pre-post interventional design", BIO Web of Conferences, 2025 Publication	<1%
27	Submitted to Tata Institute of Social Sciences Student Paper	<1%
28	academicjournal.yarsi.ac.id Internet Source	<1%
29	www.onlinescientificresearch.com Internet Source	<1%

30	www.sciencegate.app Internet Source	<1%
31	Mohsen Naghavi, Stein Emil Vollset, Kevin S Ikuta, Lucien R Swetschinski et al. "Global burden of bacterial antimicrobial resistance 1990–2021: a systematic analysis with forecasts to 2050", The Lancet, 2024 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		