

A REVIEW: ANTIBIOTIC RESISTANCE IN SOUTH ASIA

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Abstract

Antibiotic resistance, which makes treating bacterial infections more difficult, is a major public health concern. South Asia is especially vulnerable because of poor antibiotic use, self-medication, inadequate infection control, and inadequate surveillance. This review looks at the data available on antibiotic resistance in Pakistan, Nepal, India, Bangladesh, Maldives, Sri Lanka, and Bhutan. According to the reviewed studies, important bacteria like *Salmonella* spp., *Escherichia coli*, *Klebsiella* spp., and *Staphylococcus aureus* show notable resistance. Multidrug-resistant bacteria have been connected to aquaculture, food, livestock, healthcare, and environmental settings. One of the main causes of the emergence and spread of resistance in both humans and animals is the inappropriate use of antibiotics. Antimicrobial stewardship, laboratory monitoring, infection prevention, and appropriate antibiotic usage must all be strengthened. To lessen the increasing prevalence of antibiotic resistance in South Asia, a coordinated One Health approach, supported by regional cooperation and further research, is required.

1. INTRODUCTION

1.1 Antibiotic Resistance

The inability of bacteria to be treated or prevented by the antibiotics employed against them is known as antibiotic resistance. Antibiotic resistance in bacteria has been a continuous concern from the start of antibiotic discovery. It is one of the major risks caused by bacteria since it not only results in fatal infections but also causes prolonged illness, expensive costs, and higher morbidity (Bilal et al., 2021).

1.2 Usage of Antibiotics

Unfortunately, a significant portion of the world's antimicrobial use occurs in FPAs (food producing animals), either for medicinal purposes or as growth promoters, which raises serious worries about the rise of new, multidrug-resistant microorganisms. Pakistan, an agricultural country that ranks among the top ten producers of livestock, is currently transitioning to intensive farming techniques in which animals are usually given antibiotic supplements. Unfortunately, there is insufficient monitoring of antibiotic usage in FPAs. According to knowledge, the main sources of AMROs (antimicrobial-resistant

organisms) in the environment, aside from human use, are the adding antibiotics in agriculture and aquaculture (Mohsin, 2019).

1.3 Global threats of antibiotic resistance

The perception of antibiotic resistance as a catastrophic event capable of driving our society to the high mortality rates brought on by infectious diseases in the dark pre-antibiotic ages has been continuously growing for more than 50 years (Baquero, 2021). Antibiotics facilitate immunosuppression (such as cancer chemotherapy), permit surgery, and rise the survival of premature newborns. We are finally realizing that, despite their advantages, antibiotics are not faultless and might be more dangerous than beneficial if administered improperly. We face a severe threat to the future of worldwide healthcare due to antibiotic misapplication, a lack of successful new antibiotic development, and growing antibiotic resistance. The fact that many of the antibiotics we use today are broad spectrum, they kill mutually infection causing bacteria and advantageous gut bacteria, is one of the primary underlying issues. Resistant bacteria can proliferate. Over time bacteria can collect a variety of resistance features, making them MDR (multi-drug resistant) to several types of antibiotics (Graham, 2017).

2. MECHANISM

Drug resistance is provided by a resistant bacterium through one of the following main mechanisms: (i) reducing import and increasing export of antibacterial drugs (genetic alterations in porins, up regulated efflux pumps); (ii) modification of the drug target, mainly structural (enzymatic alteration, mutations); (iii) overexpression or increased biosynthesis of the drug target; or (iv) secretion of enzymes that modify, damage, or alter targeted antimicrobials (ur Rahman et al., 2018).

3. EFFECTS OF ANTIBIOTIC RESISTANCE

1. The apparent personal challenge in the setting of increasing antibiotic resistance is a declining QOL (quality of life) after infection and economic

hardship. 2. The bystander effect, which is more concerning, is the chance that antibiotics given to a child in a low-resource situation can cause infections that were not original target of drug to acquire resistance. These introductions are referred to as subclinical. 3. Overwhelming the healthcare organization; if these issues are not resolved, they will have an impact on the healthcare system. In the event that treatment costs increase, many Pakistanis will turn to less expensive quack remedies, which are fairly common, roughly 70,000 were identified in the 2019 census. 4. Such issues with the healthcare system will ultimately be a public relations catastrophe and have a significant impact on the country. The increased cost of ABRs, retrofitting hospitals with apparatus to deal with such issues, and other related costs will weigh severely on the globe (\$300 billion to \$1 trillion annually) (Mirha et al., 2024).

4. ANTIBIOTIC RESISTANCE IN SOUTH ASIA

4.1 Pakistan

Pakistan is a South Asian developing country with a high rate of antibiotic resistance, which poses a serious threat to the world and the region (Abrar et al., 2018). In current years Pakistan has seen the identification of both extensively drug resistant (XDR) and multi-drug resistant (MDR) microorganisms. Resistance in *Enterobacteriaceae* to quinolones has grown in Pakistan during the previous ten years (Yasmin et al., 2013). Fish and aquaculture in Pakistan were also shown to have a significant prevalence of multidrug resistant bacteria with antibiotic resistance genes (Phillips, 2000).

A study that revealed significant antimicrobial resistance among bacterial isolates obtained from three tertiary-care hospitals in Northern Punjab, Pakistan, found that methicillin resistance was found in 25% of *Staphylococcus aureus* isolates, while nearly 30% of *E. coli* isolates demonstrated resistance to third-generation cephalosporins. While meropenem, vancomycin, and linezolid continued to be mainly effective against the tested isolates, *Enterobacterales* responded differently to

fluoroquinolones (Noreen et al., 2025). Another study carried out in 2014 in Lahore found several species, including *E. coli*, *Shigella spp.*, *Klebsiella spp.*, *Enterobacter spp.*, and *Salmonella spp.* recovered from several marketplace foodstuff items, including yogurt, dahi bhallay, and fruit-chat. It was discovered that 46% of these isolates were resistant to widely used antibiotics (Saleem et al., 2014). Because bacteria have developed plasmid-mediated resistance to colistin and carbapenem due to their horizontal transferability, researchers advise clinicians to prescribe these medications appropriately (Martino et al., 2019).

4.2 Nepal

A research conducted in Nepal reported that significant bacteria may be growing more resistant to antibiotics. *Staphylococcus aureus* isolates (38.2%) are resistant to methicillin (MRSA), with nearly complete beta lactam antibiotics-resistant, according to a meta-analysis. Vancomycin and chloramphenicol, on the other hand, had high activity (about 98% and 91%, respectively) (Khanal et al., 2021). Meropenem sensitivity was 100% in isolates of ESBL-producing *K. pneumoniae* and 98.04% in isolates of *E. coli*. Therefore, carbapenem are now the recommended medication of choice for the treatment of ESBL infections (Mahaseth et al., 2019). In Kathmandu, Extended spectrum beta lactamase (ESBL)-producing *E. coli* is highly prevalent in environmental and human bloodstream infection (BSI) samples. Wastewater samples had the highest incidence of ESBL-producing *E. coli* between isolated 91% of *E. coli*, followed by 49% in human BSIs, 38.6% in poultry, and 15% in fecal carriage isolates from healthy pregnant females. The prevalence of MDR among ESBL producers was 52% and non-producers was 26%, showed a statistically significant association (Acharya et al., 2024).

4.3 India

Antimicrobial resistance (AMR) has become one of India's most urgent public health issue, due to widespread use of antibiotics, easy availability to these medications over-the-counter, and uneven

infection-control procedures in various healthcare settings. The Indian Council of Medical Research's AMR Surveillance and Research Network (ICMR-AMRSN), which was founded in 2013, is largely responsible for conducting national monitoring. It uses regional and nodal laboratories to monitor resistance patterns among key pathogens (Singh et al., 2024). The study found that *Klebsiella spp.* resistance rates were significantly higher in Indian states that performed poorer on health-related Sustainable Development Goals, suggesting a connection between AMR containment and a stronger overall health system (Kaur et al., 2024). Genomic surveillance work has demonstrated that resistance mechanisms vary by organism, with carbapenemases of the NDM and OXA types predominating in *Enterobacterales* and *Acinetobacter*, respectively (Gheewalla et al., 2026).

4.4 Bangladesh

In Bangladesh, antibiotics are utilized for medicinal as well as growth-promoting goals in veterinary practices (Kaur et al., 2024). Overuse of antibiotics is believed to be one of the primary reasons causing AMR in animals (Holmes et al., 2016). According to the study's findings, both healthy and unwell poultry flocks were frequently treated with higher classes of antibiotics by registered veterinarians (Sabuj et al., 2019). Gram-negative bloodstream infections in a tertiary-care hospital in Dhaka, Bangladesh, were shown to have significant antibiotic resistance. *Salmonella spp.* demonstrated resistance to ciprofloxacin, *Klebsiella spp.* demonstrated resistance to ceftazidime, ceftriaxone, and piperacillin-tazobactam, and *E. coli* demonstrated high resistance to ciprofloxacin (Tanni et al., 2025). The World Health Organization advises a reduction in the use of medically significant antibiotics in food producing animals for illness prevention and growth promotion. In 2010, the "Animal and Fish Feed Act 2010" was passed by the Government of Bangladesh, prohibiting the usage of antibiotics in fish as well as animal feed (Sarker et al., 2024).

4.5 Maldives

In the Maldives, antimicrobial resistance (AMR) is becoming a growing public health issue. Major bloodstream pathogens were shown to have widespread antibiotic resistance, with coagulase-negative *Staphylococcus* showing resistance to ampicillin and *Enterobacteriaceae* showing resistance to gentamicin, ampicillin, and cephalosporins (Maharath & Ahmed, 2021). According to a study, multidrug-resistant (MDR) bacteria were found to be prevalent in imported poultry products sold in the Greater Malé region. Nearly 70% of the recovered *Salmonella spp.* isolates were resistant to three or more antibiotic classes, *Escherichia coli* isolates demonstrated resistance, especially to ampicillin, and over one-quarter of the isolates were categorized as multidrug resistant. The authors stressed the critical need for enhanced food safety monitoring, increased microbiological surveillance, and the adoption of a One Health strategy to stop the spread of antimicrobial resistance (Kamil et al., 2026).

4.6 Sri Lanka

AMR problem in Sri Lanka is at a worrying level (Neiderud, 2015). The fact that *E. coli* (59.3%) isolates from blood cultures of hospitalized patients in Sri Lankan tertiary care hospitals were cefotaxime-resistant and 7.5% of isolates were meropenem-resistant serves as an example of the load in human domains. Methicillin-resistant *Staphylococcus aureus* (MRSA) accounted for 41.8% of all *Staphylococcus aureus* (Jayatilleke, 2014). According to another study, isolated *E. coli* (35%) were ampicillin-resistant and 25% streptomycin-resistant, indicating the prevalence of

antimicrobial resistance among wild animals in Sri Lanka (Clinical & Institute, 2020). Due to differences in right to use to healthcare, population density, and antibiotic usage, antimicrobial resistance trends as well as occurrence might change greatly between rural as well as urban locations (Gunasekara et al., 2024). Some explanations for this include the fact that urban areas usually have denser populations and larger healthcare facilities, which may boost the spread of resistant bacteria and the use of antibiotics (Neiderud, 2015). On the other hand, weak surveillance systems, limited diagnostic capabilities, and difficulties in accessing healthcare may cause AMR identification and management to be delayed in rural areas (Gandra et al., 2020).

4.7 Bhutan

According to a study, the most common bacterial causes of diarrheal sickness in Bhutan were *Salmonella spp.*, *Shigella spp.*, and *Escherichia coli*, all of which had widespread multidrug resistance. Amoxicillin, ampicillin, and nalidixic acid showed the greatest resistance and gentamicin, ceftriaxone, and chloramphenicol were still largely effective against the majority of isolates (Gyem et al., 2025). A nationwide study reported that 10.6% of 2,290 samples that were isolated in Bhutan were multidrug-resistant tuberculosis (MDR-TB), with the districts of Thimphu, Samtse, and Sarpang having the highest burden. The need for improved monitoring and early detection of drug-resistant tuberculosis was highlighted by the identification of female sex, young adulthood, and prior TB treatment as significant risk factors (Dorji et al., 2024).

Table: 1 Bacterial pathogens and their antibiotic resistance in South Asia

Sr #	Bacterial pathogens	Antibiotics showing resistance	Country	Reference
1	<i>Escherichia coli</i>	Cephalosporin	Pakistan	(Noreen et al., 2025).
2	<i>Staphylococcus aureus</i>	Methicillin	Nepal	(Khanal et al., 2021).
3	<i>Escherichia coli</i>	Carbapenem	India	(Gheewalla et al., 2026).
4	<i>Escherichia coli</i>	Ciprofloxacin	Bangladesh	(Tanni et al., 2025)
5	<i>Escherichia coli</i>	Ampicillin, cephalixin, ciprofloxacin	Maldives	(Maharath & Ahmed, 2021)
6	<i>Staphylococcus aureus</i>	Methicillin	Sri Lanka	(Jayatileke, 2014).
7	<i>Escherichia coli</i>	Amoxicillin, ampicillin, nalidixic acid	Bhutan	(Gyem et al., 2025)

5. FACTORS FOR DEVELOPMENT OF ANTIBIOTIC RESISTANCE

The development of these panic scenarios in the form of bacteria adopting or obtaining resistance genes is caused by a number of circumstances, including poor organization, an unhygienic environment, un experts, overuse, as well as misuse of antibiotics (Boolchandani et al., 2019). The widespread use of antibiotics over the past six decades has led to the selection of resistant strains, raising the incidence of deadly infectious illnesses and burdening society financially. Although the extent of this issue is not well understood in many parts of the world, it is generally acknowledged as a global issue (Bilal et al., 2021).

6. RECOMMENDATIONS AND PREVENTIONS

The community needs to be made aware of the need for careful dosage administration. The community must forbid self-medication. Adopting suggested preventative measures, such as individual hand sanitation, training healthcare staff as well as interaction precautions can help reduce the ABR bacterial extent in healthcare services. Regularization of investigation practices, continuing national as well as regional surveillance, molecular investigations, and targeted initiatives are necessary to counteract the threat related with rise in antimicrobial resistance (Bilal et al., 2021).

The development and implementation of a hospital antimicrobial stewardship program, that includes a local antibiogram profile, to enhance physician prescribing practices (Frontières, 2016; Wayne, 2011). It should be mentioned that in this context, microbiological testing of urine for UTIs is not a standard clinical procedure. The necessity for wider access to microbiological analysis is shown by the resistance to empirical treatments (Bullens et al., 2022). Sex, clinical presentation, the incidence of resistance in the population, and the existence of anatomic or functional abnormalities should all be taken into account when selecting an antibiotic for the treatment of UTIs (Rosa et al., 2017).

7. FUTURE DIRECTIONS AND RESEARCH GAPS

In South Asia, integrated AMR surveillance is still insufficient despite growing awareness, especially in the veterinary and rural sectors. Targeted interventions are challenging due to the lack of molecular-level investigations and One Health-based research. Future initiatives must prioritize funding for innovative therapies, cross-sectoral collaboration, and national action plan evaluation.

8. CONCLUSION

Antibiotic resistance has become a significant issue in South Asia, affecting both human and animal health. The analyzed data shows that multidrug-resistant species are emerging and

certain important bacterial diseases are growing more resistant. Inadequate surveillance, inadequate infection control practices, and improper antibiotic use are the primary causes of this problem. Resistance in aquaculture, livestock, agriculture, and environmental settings increases the risk of transmission of resistant bacteria. Antimicrobial stewardship, laboratory surveillance, and infection prevention must therefore be strengthened. A coordinated One Health approach that integrates the environmental, animal, and human sectors can prevent the spread of resistant bacteria. Ongoing research and regional collaboration are also necessary to maintain the effectiveness of current antibiotics.

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