Comparative Analysis of Commonly Prescribed Antibiotics for Infectious Diseases in Two Different Regions of Bangladesh: Prevalence Variation and Antibiotic Prescription Patterns

By

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Declaration

It is hereby declared that

1. The thesis submitted is our own original work while completing our undergraduate degree at BRAC University.

2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The thesis does not contain material that has been accepted or submitted, for any other degree or diploma at a university or other institution.

4. We have acknowledged all main sources of help.

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Approval

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Abstract

Comparing the trends of infectious diseases and antibiotic prescription in following two geographically distinct regions in Bangladesh: rural in Netrakona & urban in Dhaka. Data were collected from 200 patients; one hundred patients from each region. The objective of this study is to determine the prevalence of the most common infectious diagnoses and most commonly prescribed antibiotics in these different settings and to ascertain any discrepancies between genders in terms of infection rates. Fever is found the highest number of diseases with a percentage of 8.6% of the total cases in Netrakona and 8.3% of the total case in Dhaka of patients. Significantly different antibiotic prescription patterns also were observed in the two regions, the study reported. Azithromycin was the most prescribed antibiotic in Netrakona, prescribed in 12.6% of the prescriptions, and amoxicillin prescriptions accounted for 15% in Dhaka. Variation in infection burden, by sex, was also documented in the table. This study contributes to a better understanding of the factors influencing antibiotic use in urban and rural settings, which is crucial for developing effective public health strategies to combat antibiotic resistance in Bangladesh.

Keywords: *Antibiotics; Prescription Patterns; Infectious Diseases; Bangladesh; Urban-Rural Comparison; Healthcare Practices.*

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Chapter 1

Introduction

1.1 Background Review

Antibiotic resistance is a major global health threat and is particularly concerning in developing countries-where healthcare infrastructure and regulatory control are weak. Overconsumption of antibiotics in Bangladesh has caused antibiotic-resistant infection rates to skyrocket, and threaten public health far and wide. The problem is so serious that the World Health Organization (WHO) has stressed the pressing importance of an improvement in the use of antibiotics in order to curb this.

The increasing problem of antibiotic resistance has turned into a major concern worldwide, mostly in areas with inadequate healthcare facilities and rampant antibiotic abuse. With a huge population and compromised healthcare services, Bangladesh constitutes a major chunk of the problem. The Primary Objective The main objective of this thesis is to study the prevalence comparison of the most common prescribed antibiotics for infectious syndromes in two different areas of Bangladesh and also to evaluate the patterns of antibiotic prescription (from 2014 to 2024)[1].

Bangladesh, with its wide range of socio-economic conditions will present unique challenges for the combat against antibiotic resistance. Many infectious diseases are diagnosed and treated through the facilities provided by the healthcare infrastructure, and this infrastructure differs greatly between the urban and rural areas. Cities like Dhaka have greater healthcare facilities, cutting-edge medical technologies, and thus it has more accessibility and numbers of healthcare professionals. Contrarily, rural territories like Netrakona have obstacles of deficient healthcare infrastructure, fewer healthcare professionals, and lower public health literacy.

This discrepancy affects antibiotic prescribing and use practices. In urban areas treatment is likely to be based on anatomic site and severity of infection, broad-spectrum antibiotics without specific confirmation of the diagnosis may be prescribed by the physician due to constraints of time and patient demand. Absence of diagnostic facilities, absence of trained healthcare providers, along with over-the-counter use of antibiotics, without proper medical advice, are some of the routine issues in the rural areas. Oral rehydration therapy and other simple

treatments are cheap and effective, but few patients seek these options because of the misconception that their doctor should give out antibiotics, and so many doctors who economize and prescribe other treatments may lose business to those who prescribe useless antibiotics and inappropriate prescriptions.

The factors that have been attributed to inappropriate prescription and consumption of antibiotics further complicate the problem of antibiotic resistance.

Infectious diseases also differ between urban and rural localities. It is likely that incidence of infectious disease will differ between urban areas (higher population density and better sanitation, airborne infectious diseases), and rural areas (poor sanitation and limited access to clean water, leading to higher incidences of gastrointestinal and respiratory infections). Examination of whether there were differences in antibiotic prescription patterns and the burden of infectious diseases, in urban and rural localities is essential for guiding focused interventions. Interventions are required to avoid people's irrational use of antibiotics and thereby to decrease antibiotic-resistant infections and eventually public health situations in Bangladesh.

Earlier studies have focused on the general misuse and overuse of antibiotics in Bangladesh, which has resulted in the emergence of multi-drug-resistant bacterial species. For example, a study published in PLOS ONE in 2022 reported a resistance rate of 67% of broad-spectrum antibiotics including meropenem, quinolones and the piperacillin-tazobactam combination in patients. In 2019, a study published in ScienceDirect recorded a concerning rate of resistance to most of the first-line drugs along with a significant proportion of them being resistant to multiple antibiotics [2].

This study, thus, undertakes an investigation of the patterns of antibiotic prescription and use in two geographically dissimilar regions of Bangladesh with respect to general prevalence of antibiotic resistance and possible factors responsible for determining antibiotic use. This will involve a broad-based examination of published literature on antibiotic prescriptions from 2014 to 2024 to detect prevailing patterns for the most frequently prescribed antibiotics and the forces behind their prescription [3].

The results of this study may offer an idea to the antibiotic prescription behavior in Bangladesh, and this will help the policymakers to design and implement targeted interventions to reduce antibiotic misuse and to promote the rational use of antibiotics in this country. Differentiation of antibiotic prescription patterns between two regions will enable us to understand the regional variations in antibiotic use and will show the areas which need to make interventions [4].

Here, the purpose of the study was to compare the prevalence of infectious diseases and the pattern of antibiotic prescribing for these infections in an urban setting of Dhaka and the rural district of Netrakona. The study is conducted with the expectation of giving some information

that can help the policymakers and health care providers to minimize this challenge of antibiotic resistance in Bangladesh considering different variations and determinants.

Here are the details of the antibiotics, including their uses, formula, mechanisms, and potential side effects:

Amoxicillin, a β-lactam antibiotic from the Aminopenicillin class, treats bacterial infections such as pneumonia, bronchitis, and urinary tract infections. It operates by blocking bacterial cell wall formation, which causes cell death. Amoxicillin is available in oral form (capsules, tablets, and liquid) and is well absorbed, with a 95% bioavailability when taken orally. Amoxil and Trimox are two often used brand names. It is ineffective against viral diseases such as colds and the flu [5].

Ampicillin is a semisynthetic antibiotic from the Penicillin family that is effective against a variety of gram-positive and negative bacteria. It is often used to treat diseases such as meningitis, sinusitis, and urinary tract infections. Ampicillin works by blocking bacterial cell wall formation, resulting in cell lysis. Common side effects include diarrhea and dermatitis, while severe reactions may include anaphylaxis and C. difficile infections. It is usually given orally, with the dosage varying depending on the type of infection. It is ineffective against viral diseases, such as colds and flu [6] [7].

Cefdinir is a third-generation Cephalosporin antibiotic that treats a variety of bacterial diseases, including bronchitis, pneumonia, and skin infections. It operates by inhibiting bacterial cell wall formation, resulting in bacterial mortality. It comes in pill and liquid versions and is commonly given for 5 to 10 days. Common adverse effects include diarrhea, nausea, and skin rash, with major concerns including Clostridioides difficile infection and anaphylaxis. Cefdinir should not be used to treat viral illnesses such as colds and flu [8].

Cefixime is a third-generation Cephalosporin antibiotic that treats a variety of bacterial diseases, including bronchitis, gonorrhea, and infections of the ears, throat, and urinary tract. It works by suppressing bacterial growth and is available in several forms, including pills and solutions. Adults typically take it once a day, but youngsters may receive it twice daily. Cefixime is ineffective against viral infections and should be administered as indicated to avoid antibiotic resistance. Common adverse effects include diarrhea, nausea, and abdominal pain[9].

Ceftazidime is a broad-spectrum beta-lactam antibiotic that belongs to the third generation of Cephalosporins. It is often provided via injection and is effective against a variety of bacterial infections, including those caused by Pseudomonas aeruginosa. Ceftazidime works by blocking bacterial cell wall formation, which causes cell death. It is used to treat serious infections such

pneumonia, meningitis, and skin infections. The medication is delivered as a sterile, dry powder that must be reconstituted before use[10].

Ceftriaxone is a broad-spectrum Cephalosporin antibiotic that is administered via injection. It is primarily used to treat bacterial infections of the respiratory tract, skin, and urinary system. It acts by blocking bacterial cell formation; hence it is effective against both gram-positive and gram-negative bacteria. Ceftriaxone is commonly administered in hospitals and is known for its stability against specific beta-lactamases, which can confer resistance to other antibiotics. Rocephin and Cefmetazole Plus are common brand names [11].

Cefuroxime is a second-generation cephalosporin antibiotic that treats a variety of bacterial diseases, such as respiratory tract infections, urinary tract infections, gonorrhea, and Lyme disease. It acts by blocking bacterial cell wall formation; hence it is effective against both Gram-positive and Gram-negative bacteria. Cefuroxime is available in oral tablet and liquid suspension forms, which are usually given every twelve hours with food to improve absorption. Common adverse effects include gastrointestinal disturbances and allergic responses, and it is contraindicated in patients who have known allergies to Cephalosporins or Penicillin [12].

Cephalosporins are β-lactam antibiotics produced from the fungus Acremonium, formerly known as Cephalosporium. They are classified into generations based on their spectrum of activity, with each subsequent generation showing higher efficacy against gram-negative bacteria . Cephalosporins cure a wide range of bacterial diseases, including skin and soft tissue infections, pneumonia, meningitis, and urinary tract infections. They can be given orally or intravenously, with the latter reserved for more serious infections. Cephalosporins are predominantly eliminated through the kidneys, hence patients with renal impairment require dose adjustments[13] [14] .

Clarithromycin is a macrolide antibiotic that is prescribed to treat a wide range of bacterial infections, including pneumonia, bronchitis, and infections of the ears, sinuses, skin, and throat . It inhibits the growth of germs and is frequently used in conjunction with other drugs to treat stomach ulcers caused by Helicobacter pylori. Clarithromycin is available as a tablet, extended-release tablet, and suspension to be taken orally once every eight to twelve hours for seven to fourteen days. It is not recommended for patients who have a known hypersensitivity to clarithromycin or other macrolide antibiotics, and it should not be combined with some other drugs due to potential drug interactions [15].

Clopidogrel, sold under the brand name Plavix, is an antiplatelet medicine used to prevent blood clots in people who are at high risk of having a heart attack, a stroke, or serious vascular problems. It operates by irreversibly blocking platelets' P2Y12 receptor, preventing them from aggregating. Clopidogrel is commonly administered after cardiac surgery or in conjunction with aspirin. Common adverse effects include easy bruising and bleeding, with major concerns

including hemorrhage and thrombotic thrombocytopenic purpura. It is administered orally, usually at a dose of 75 mg once daily [16].

As a flexible antibiotic from the tetracycline class, Doxycycline is frequently used to treat a range of bacterial illnesses as well as some malaria diseases. It works well against sexually transmitted illnesses like syphilis and chlamydia as well as respiratory, skin, and urinary tract infections. Additionally, Doxycycline is used for the management of rosacea, the treatment of acne, and the prevention of malaria. The drug prevents bacterial growth and reproduction by blocking the synthesis of proteins in bacteria. Doxycycline is commonly used orally once or twice daily with a full glass of water. It comes in a variety of forms, including tablets, capsules, and liquid suspension. Common adverse effects, albeit usually well tolerated, can include nausea, vomiting, and heightened photosensitivity [17].

A broad-spectrum carbapenem antibiotic called Ertapenem is used to treat a number of dangerous bacterial infections [18] . It is easy for outpatient therapy because it is given intravenously or intramuscularly, usually once daily; Many gram-positive, gram-negative, and anaerobic bacteria, including those that produce extended-spectrum beta-lactamases (ESBLs), are susceptible to the effects of ertapenem [18] [19] . It functions by preventing the formation of bacterial cell walls, which results in cell death [18] . Complex urinary tract infections, skin and skin structure infections, community-acquired pneumonia, difficult intra-abdominal infections, and diabetic foot infections are among the conditions for which Ertapenem is frequently prescribed. Although generally well-tolerated, it might have unfavorable effects such as headaches, diarrhea, and nausea. In rare instances, it can even be neurotoxic, especially in those with kidney impairment.

An antibiotic of the Penicillin class called Flucloxacillin is used to treat bacterial infections. Penicillinase is an enzyme that can render some antibiotics inactive, and it functions by either eliminating or inhibiting the growth of bacteria, especially those that are resistant to it. Flucloxacillin is a medication that is frequently prescribed for infections of the skin and soft tissues. It can be taken orally as liquid or capsules, and in hospital settings, it can also be injected. In order to maximize absorption, adults typically take 500 mg four times a day on an empty stomach. Flucloxacillin, like all antibiotics, is ineffective against viral infections; therefore, it's critical to take the medication as directed by a doctor to avoid infection recurrence and the emergence of bacteria resistant to medicines [20] .

A synthetic broad-spectrum antibiotic, levofloxacin is a member of the Fluoroquinolone drug class. Numerous bacterial illnesses, such as skin infections, urinary tract infections, respiratory tract infections, and some forms of pneumonia, are treated with it. Levofloxacin functions by preventing the production of bacterial DNA, particularly by targeting the enzymes DNA gyrase

and topoisomerase IV, which are critical for bacterial replication. With a high bioavailability of 99% when taken orally, the medication is available in oral and intravenous formulations. Although Levofloxacin is usually well tolerated, there is a chance that it will have more serious side effects, such as tendon rupture or peripheral neuropathy, in addition to less common side effects including headache, nausea, and diarrhea [21].

Metronidazole is a member of the nitroimidazole class of antibiotics that is used frequently. It works well against a range of bacterial and protozoal illnesses, such as anaerobic bacterial infections, trichomoniasis, and amebiasis. The medication causes cell death by infiltrating microorganisms' cells and causing DNA disruption. Depending on the particular ailment being treated, Metronidazole can be taken orally two to four times a day for up to ten days or more. It comes in a variety of forms, including tablets, capsules, and oral suspension. Although it is usually well taken, adverse effects including headaches, nausea, and a metallic aftertaste may occur. It's crucial that patients abstain from alcohol for at least three days following treatment completion and while taking Metronidazole in order to prevent a possibly serious [22] .

A Fluoroquinolone antibiotic called MO Vancomycin is used to treat a variety of bacterial infections, such as those that impact the stomach, sinuses, skin, and lungs. It functions by obstructing the synthesis of bacterial DNA, which stops bacterial growth and reproduction. The usual dosage of Moxifloxacin is one 400 mg oral tablet per day; the length of therapy varies according to the kind and severity of the infection. Although it works well against a variety of bacterial strains, it should be used with caution because it may cause major adverse effects such as peripheral neuropathy, effects on the central nervous system, and a worsening of myasthenia gravis . Similar to other Fluoroquinolones , Moxifloxacin ought to be administered solely in situations when less risky medications are deemed unsuitable or ineffective in managing the infection [23] .

Ofloxacin is a member of the Fluoroquinolone drug class and is a broad-spectrum antibiotic. It is used to treat a variety of bacterial infections, such as those that impact the skin, reproductive organs, urinary tract, and respiratory system. By selectively targeting two enzymes required for bacterial growth and reproduction, DNA gyrase and topoisomerase IV, Ofloxacin inhibits the replication of bacterial DNA. For the treatment of eye infections, the drug is offered in tablet, oral suspension, and ophthalmic solution forms. Ofloxacin is generally useful, but it can also have negative effects like headaches, nausea, and diarrhea. Additionally, it may not be appropriate for some groups, such as pregnant women and children under the age of 18 [24] .

Strong antibiotic Trimethoprim is mostly used to treat middle ear infections, diarrhea in travelers, and urinary tract infections. It functions by preventing the metabolism of folate by bacteria, which stops them from making DNA and RNA and eventually causes their death. Trimethoprim is usually given orally, once or twice a day, with or without food . Despite being typically helpful, it can have negative side effects including rash, nausea, and taste changes. Rarely, it may result in blood problems or hypersensitivity to the sun. For greater antibiotic coverage, Trimethoprim and sulfamethoxazole are frequently combined. It should be used carefully, as with all antibiotics, to avoid the emergence of bacterial resistance [25].
Strong Glycopeptide antibiotics like Vancomycin are mostly used to treat methicillin-resistant Staphylococcus aureus (MRSA) infections and other dangerous infections caused by gram-positive bacteria. It kills bacteria by preventing the formation of their cell walls. Vancomycin is usually given intravenously to treat systemic infections; however, it can also be taken orally to treat diarrhea caused by Clostridium difficile. Vancomycin necessitates cautious dosage and blood level monitoring due to its limited therapeutic window and potential for toxicity, particularly nephrotoxicity and ototoxicity. Its significance in contemporary medicine is highlighted by the fact that it is frequently used as a last-resort antibiotic for resistant infections [25].

Amikacin is a powerful Aminoglycoside antibiotic used to treat severe bacterial infections caused by gram-negative bacteria such as *Pseudomonas aeruginosa* and *Escherichia coli*, as well as some gram-positive bacteria. It is given intravenously or intramuscularly and works by blocking bacterial protein synthesis, which prevents growth. Amikacin is frequently used in intensive care units to treat life-threatening infections, and it has been widely researched in critically sick patients, with population pharmacokinetic models indicating significant variability in clearance and volume of distribution. Low-dose amikacin regimens aiming for high peak concentration to minimal inhibitory concentration (C Maximum/minimal inhibitory concentration (max/MIC) ratios have been investigated for the treatment of multidrug-resistant tuberculosis, with the goal of optimizing bactericidal effectiveness while minimizing toxicity [26] .

An Aminoglycoside antibiotic called Gentamicin works well against a variety of aerobic gram-negative bacteria. Serious infections like pneumonia, meningitis, septicemia, and urinary tract infections are frequently treated with it. Gentamicin causes cell death by preventing the synthesis of proteins in bacteria. Despite its overall effectiveness, there is a risk of nephrotoxicity and ototoxicity, especially when administered at high doses or in people with pre-existing kidney problems [27]. Gentamicin is mostly administered by injection, and usage needs to be closely watched to avoid any potentially serious side effects .

Amoxicillin, a Penicillin-type antibiotic, and clavulanic acid, a beta-lactamase inhibitor, are combined in the prescription antibiotic drug Augmentin. Because of this combination, Augmentin can successfully treat a variety of bacterial illnesses, such as skin infections, sinusitis, pneumonia, ear infections, bronchitis, and urinary tract infections. It functions by inhibiting the growth of bacteria, and the clavulanic acid component helps keep some bacteria from developing an amoxicillin resistance. Tablets, extended-release tablets, and liquid suspensions are among the forms of augmenting that are available. It is usually taken every 8 to 12 hours with food. As is the case with other antibiotics, it is crucial to finish the entire course of Augmentin as directed in order to avoid infection recurrence and the emergence of bacteria resistant to antibiotics [28].

Azithromycin is a widely used macrolide antibiotic. It is used to treat a variety of bacterial illnesses, including respiratory tract infections, skin infections, ear infections, and several sexually transmitted diseases. The medication acts by blocking bacterial protein synthesis, which effectively stops bacterial growth and multiplication. Azithromycin is available in a variety of forms, including tablets, capsules, oral suspension, and injectable solutions, and is normally administered once a day for a brief period of 1-5 days, depending on the specific infection being treated. While generally well-tolerated, possible side effects include gastrointestinal disturbances, headaches, and, in rare circumstances, more serious consequences such liver problems or irregular cardiac rhythms [29].

Doxofylline, a methylxanthine derivative, is a bronchodilator used to treat chronic respiratory illnesses such asthma and chronic obstructive pulmonary disease (COPD) It works by relaxing the smooth muscles in the airways, which facilitates breathing. Unlike other Xanthine, such as Theophylline, Doxofylline has a lower affinity for adenosine receptors, which likely contributes to its improved safety profile and fewer adverse effects. It is usually given orally in tablet form, with standard doses of 200 mg or 400 mg twice daily. While often well tolerated, possible adverse effects include nausea, headaches, and insomnia. Doxofylline is licensed in several countries to treat and manage asthma and COPD symptoms [30] .

Erythromycin is a Macrolide antibiotic that treats and prevents a wide range of bacterial infections. It acts by inhibiting bacterial growth and is effective against a wide range of illnesses, including respiratory tract, skin, and eye infections. Erythromycin comes in a variety of forms, including oral pills, ophthalmic ointments, and other formulations. When used as an eye medicine, it is very efficient at treating bacterial eye infections and avoiding certain eye infections in infants. Erythromycin, like other antibiotics, should be administered exactly as prescribed by a healthcare practitioner to ensure its efficacy and prevent the development of antibiotic resistance [31] .

Strong Aminoglycoside antibiotic Tobramycin works well against gram-negative bacteria, such as *Pseudomonas aeruginosa*. It binds to the 30S ribosomal subunit of bacteria irreversibly, preventing protein synthesis and causing cell death in the process, which is how it causes a bactericidal effect. This antibiotic is used in a number of ways, such as eye drops or ointments to treat bacterial eye infections and nebulized solutions for individuals with cystic fibrosis, where it helps manage persistent lung infections. For systemic infections, Tobramycin is usually administered intravenously or by injection because of its limited stomach absorption. Although generally successful, the emergence of bacterial resistance, especially in chronic infections, can limit its usage and need close monitoring and control of treatment plans. Nephrotoxicity and ototoxicity are possible side effects, particularly with extended use[32].

The synthetic antibiotic Trimethoprim (TMP) is mostly used to treat bacterial infections, such as middle ear infections and traveler's diarrhea, as well as urinary tract infections (UTIs). It causes bacterial cell death by blocking the action of bacterial dihydrofolate reductase, which interferes with the metabolism of folate required for DNA and RNA synthesis. Blood issues are an uncommon but potentially dangerous adverse effect, while nausea, rash, and taste changes are common side effects. Trimethoprim is on the WHO's List of Essential Medicines and is frequently coupled with sulfamethoxazole for increased efficacy against specific infections [33] .

1.2 Objectives

This paper with current work provides a comparative study of antibiotic utilization and infection burden between the rural district of Netrakona and the urban area of Dhaka in Bangladesh. In this study, we aimed to analyze regional differences in common infections and the content and quantity of prescribed antibiotics, using data from CICP. It will also determine if both regions have gender disparities in infection rates, and whether those trends vary between the two regions. The purpose of the study is to develop context-specific policy levers and interventions that target these prescribing practices to optimize antibiotic use and to interrogate their impacts on antibiotic resistance, within urban and rural complexity frameworks

1.3 Significance of the Study

This study is important because it was able to show a wider picture on the prevalence of infectious disease and antibiotic prescribing pattern comparing the two very separate geographical settings like Netrakona, a rural district and Dhaka, an urban city inside Bangladesh. The first compendium focused on inequalities across geographic regions and gender disparities in these infection rates, which could then inform public health policies and interventions for better stewardship of antibiotics with decreased misuse of antibiotics. These study results could

be effectively utilized for designing educational interventions and awareness campaigns to restrain the escalating menace of antibiotic resistance and for promoting judicious antibiotic use. Furthermore, this research adds to the international literature on antibiotic resistance and provides a model for similar efforts in other low-income settings, but also as a datapoint on global progress compendium.

Chapter 2: Literature Review

Antibiotic resistance has become a major health concern worldwide, and Bangladesh is no exception. A study by Majumder et al. (2022) on antibiotic resistance patterns in microorganisms causing urinary tract infections (UTIs) in a tertiary care hospital over ten years revealed worrying trends. The research found that *Escherichia coli* and *Klebsiella* species were the predominant uropathogens, with increasing resistance to commonly used antibiotics such as Cotrimoxazole, Ciprofloxacin, Cefuroxime, Cephradine, Amoxicillin, and Nalidixic acid. Resistance to Carbapenems and Aminoglycosides also significantly increased over the study period, highlighting the growing challenge of treating common infections with standard antibioticsdrugs [34] Haque, M. (2017). ANTIMICROBIAL USE, PRESCRIBING, AND RESISTANCE IN SELECTED TEN SELECTED DEVELOPING COUNTRIES: A BRIEF OVERVIEW Asian Journal of Pharmaceutical and Clinical Research, 10(8), 37. In the article "Pattern of Antibiotic Use among Hospitalized Patients according to WHO Access, Watch, Reserve (AWaRe) Classification," a detailed analysis was conducted on the types of antibiotics used in tertiary and secondary hospitals in Bangladesh. The study found an extensive use of third-generation Cephalosporins and Penicillin, which accounted for more than half of the antibiotics used. This over-reliance on Cephalosporins is concerning, given the rising resistance patterns observe threat [35] . The findings underscore the need for improved antibiotic stewardship to prevent further resistance development and preserve the efficacy of existing drugs.

The study "Prescription Antibiotics for Outpatients in Bangladesh: A Cross-Sectional Health Survey" further illustrated the prevalence of irrational prescribing practices. Conducted in three cities, the survey found that antibiotics were often prescribed without proper diagnostic testing, significantly contributing to the development of resistance. This practice not only jeopardizes patient health but also accelerates the emergence of multidrug-resistant bacteria. The study emphasized the necessity for improved antibiotic stewardship and adherence to treatment guidelines to mitigate this growing public health threat [36].

This study underlines the crucial issue of misuse of antibiotics in developing nations and emphasizes the significance of policy initiatives to ensure rational antibiotic usage, ultimately protecting public health (Biswas et al., 2014).

Lastly, the strategic directions outlined in "Infectious Diseases and Vaccine Sciences: Strategic Directions" emphasize the critical need for continuous surveillance of antibiotic resistance patterns and the implementation of comprehensive stewardship programs. The paper highlights that without robust strategies to promote the rational use of antibiotics and adherence to treatment guidelines, the health burden of antibiotic resistance will continue to escalate. This call to action underscores the importance of coordinated efforts among healthcare providers, policymakers, and the public to address the antibiotic resistance crisis effectively[37].

In summary, these studies collectively underscore the urgent need for comprehensive strategies to address antibiotic resistance in Bangladesh. The increasing resistance patterns, irrational prescribing practices, and lack of adherence to treatment guidelines highlight significant gaps in the current healthcare system. Addressing these issues through robust antibiotic stewardship programs, continuous surveillance, and public and professional education is crucial to mitigating the public health threat posed by antibiotic resistance.

Chapter 3. Methodology

3.1 Data Collection

Data were collected from hospitals and pharmacies in Dhaka, an urban area and Netrakona a rural area over a month period. The dataset includes patient demographics, types of infectious diseases diagnosed, and antibiotics prescribed Name, Age, Gender of the patients, Name of the disease/symptoms, Prescribed Antibiotics Name.

3.2 Data Analysis

The collected data were analyzed by visiting prescription points and various hospitals. The data were then extracted and prepared for further analysis. Subsequently, the data were categorized into various columns, including patient's name, area (Netrokona or Dhaka), age group, gender, disease, and prescribed medicine. The data were systematically organized and graphically represented using pie charts and bar charts. These diagrams illustrate the percentages and numbers of the various relevant results.

The data collected are attached here:
Insights from Dhaka survey
Insights from Netrokona survey

Chapter 4. Results

4.1 Prevalence of Infectious Diseases

The analysis revealed a higher prevalence of some different infections in the rural region compared to the urban region.

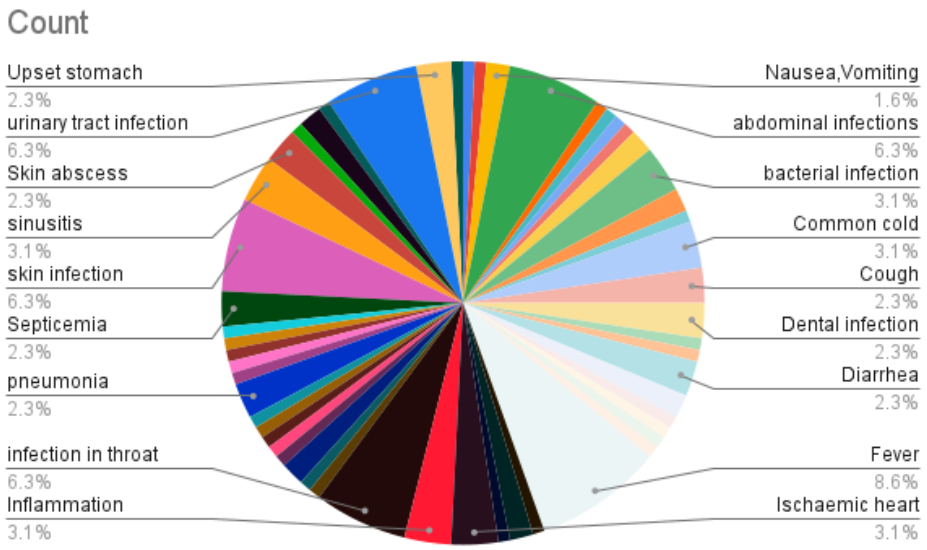


Figure 1: Prevalence rate of different diseases in Dhaka

This pie chart represents the distribution of various infectious diseases in Netrakona. Here is a detailed interpretation of the chart, mentioning specific percentages and identifying the most and least common diseases.

Here, Fever is the most prevalent disease, constituting 8.6% of the total cases and nausea vomiting is the least common symptom in patients consisting 1.6% of total cases.

Figure 2 : Prevalence rate of different diseases in Dhaka

The second pie chart represents the distribution of various infectious diseases in Dhaka. Here is a detailed interpretation of the chart, mentioning specific percentages and identifying the most and least common diseases:

Here also Fever is the most prevalent disease, accounting for 8.3% and abdominal cramp, bronchitis, and cellulitis each contribute 1.7% to the total cases which means these are least common diseases in Dhaka of the total cases.

4.2 Antibiotic Prescription Patterns

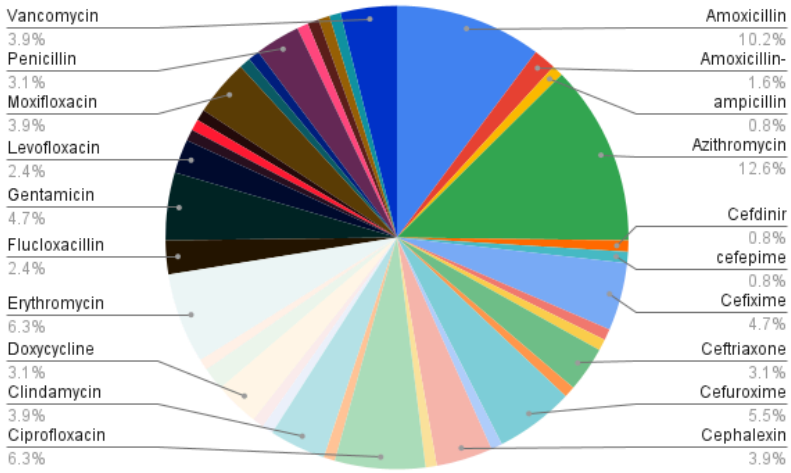


Figure 3: Percentage of different medicines in Netrakona

The pie chart illustrates the distribution of antibiotics prescribed in Netrakona. Here In Netrokona, Azithromycin is the most commonly prescribed antibiotic, accounting for 12.6% while Ampicillin, Cefdinir and Cefepime was the minimum use which is 0.8% of the prescriptions.

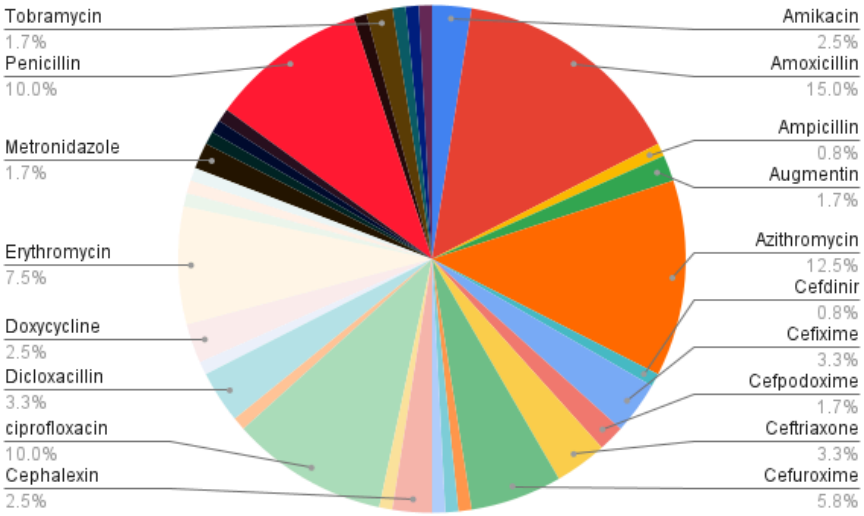


Figure 4 : Percentage of different medicines in Dhaka

The pie chart and the bar represents the distribution of antibiotics prescribed in Dhaka (fig 4).The most frequently used antibiotic is Amoxicillin, accounting for 15.0% and less frequently prescribed antibiotics include Cefpodoxime and Metronidazole, each at 1.7% followed by Cefdinir at 0.8%.

4.3 Comparative Analysis

The differences in prescription patterns can be attributed to factors such as healthcare accessibility, physician training, and patient socio-economic status. The urban region showed a higher rate of antibiotic resistance due to the overuse of broad-spectrum antibiotics.

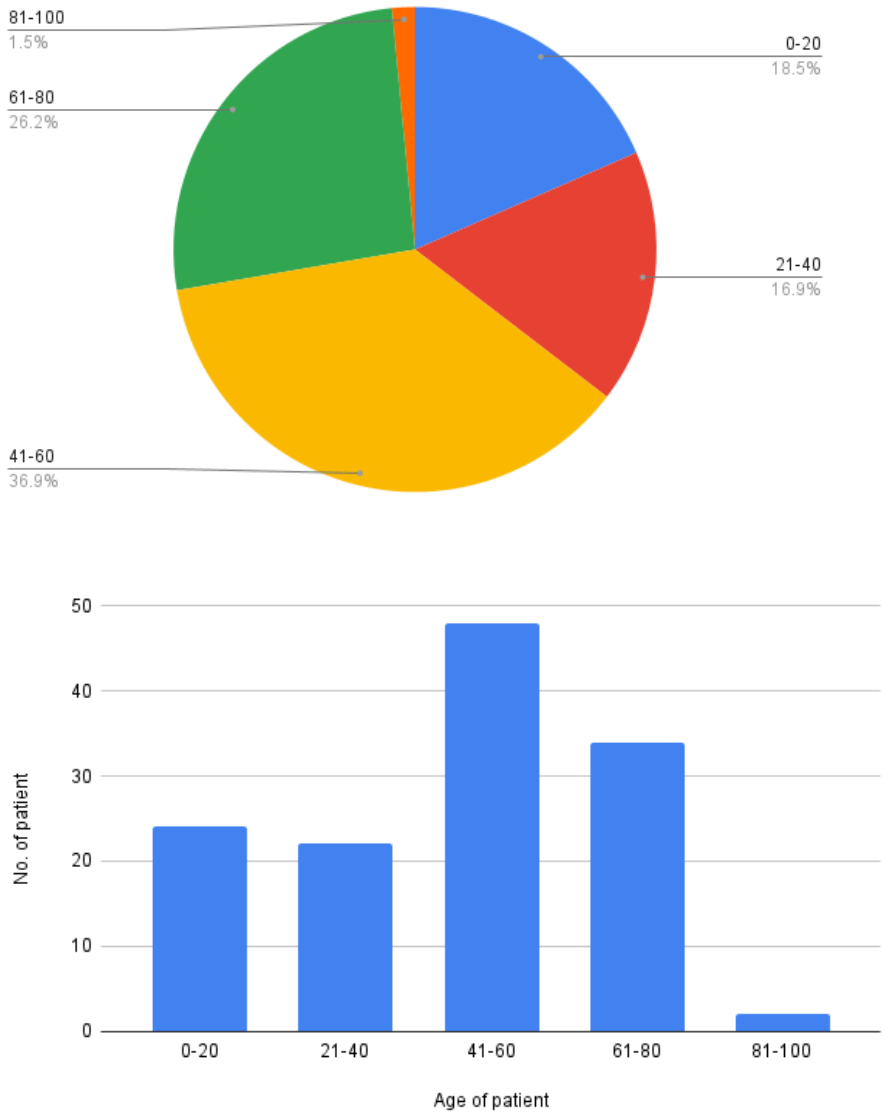


Figure 5: Percentage of patients of different ages in Netrakona

The bar presents the percentage distribution of patients across different age ranges of Netrakona and it's noticeable that most of the impacted people are between the ages of 41 and 60 and The smallest group is the 81-100 years range.

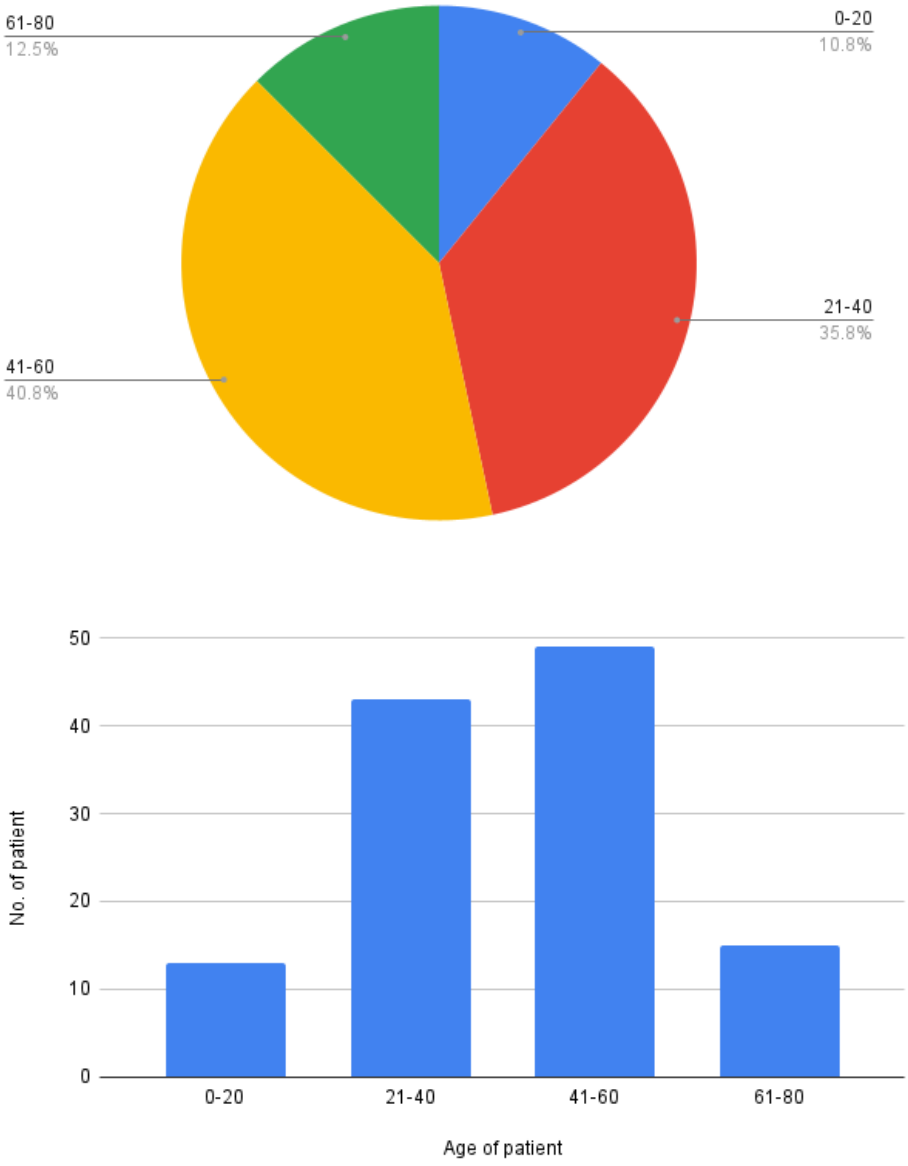
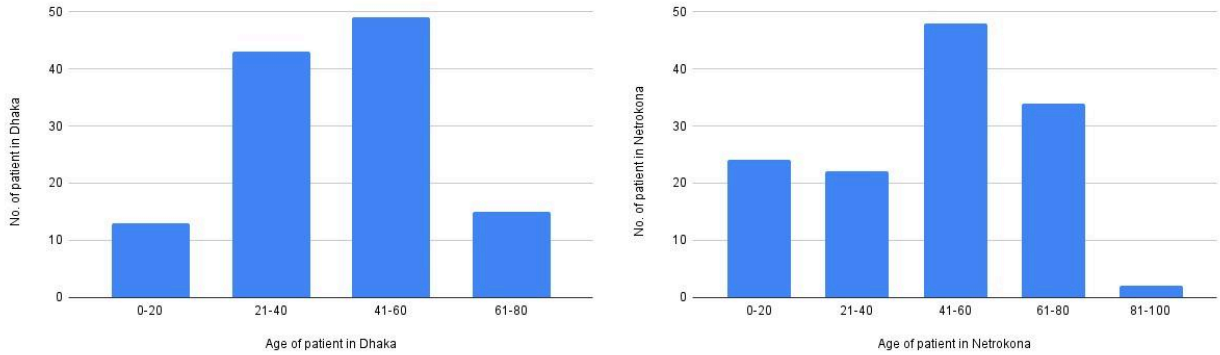


Figure 6: Percentage of patients of different ages in Dhaka

Here again the bar presents the percentage distribution of patients across different age ranges of Dhaka and it's noticeable too that most of the impacted people are between the ages of 41 and 60.



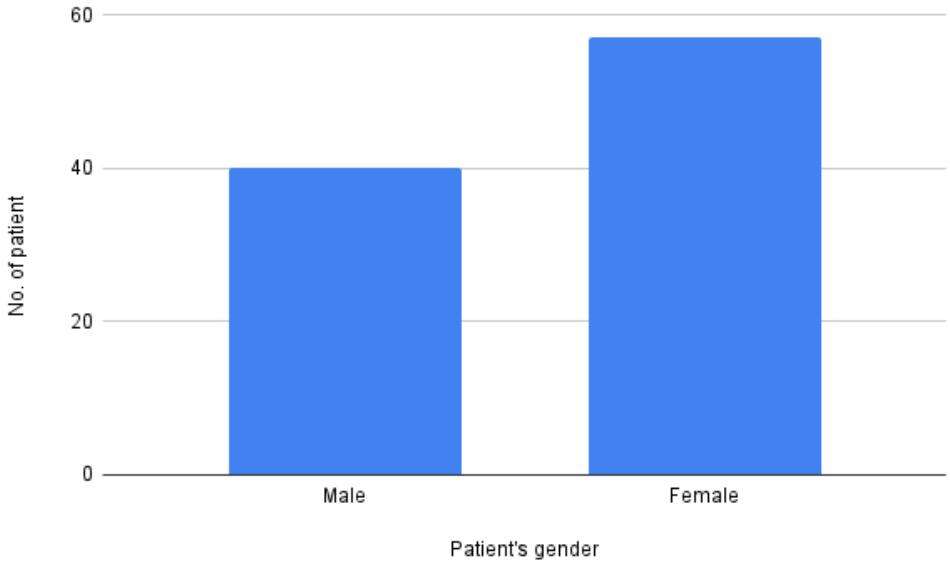


Figure 7: Percentage of patients differentiated by gender in Netrokona

The bar presents the percentage distribution of patients across different gender in Netrakona.

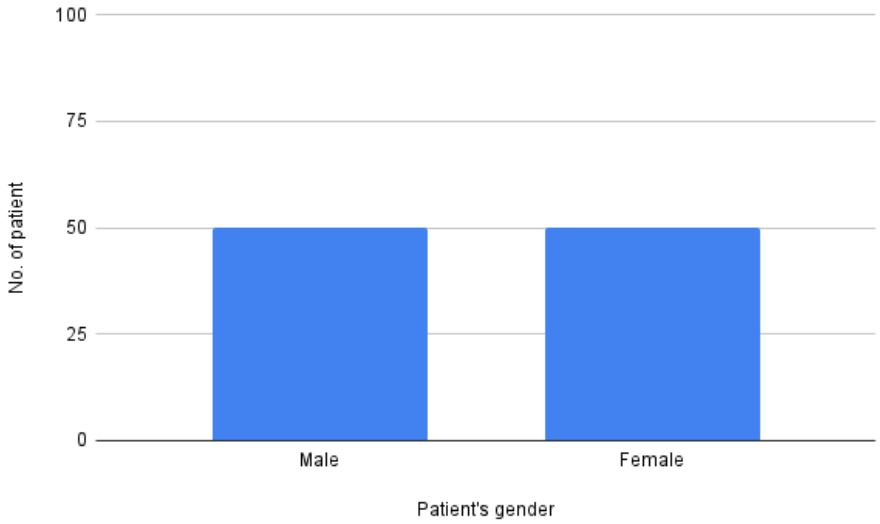
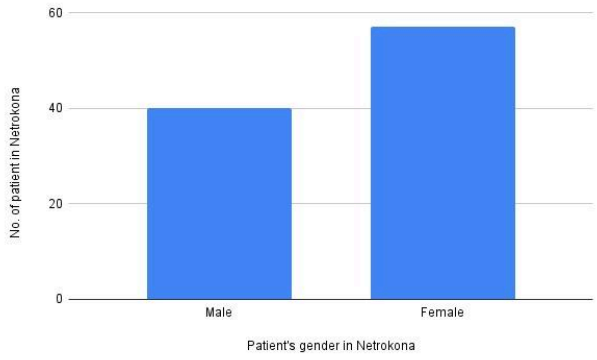
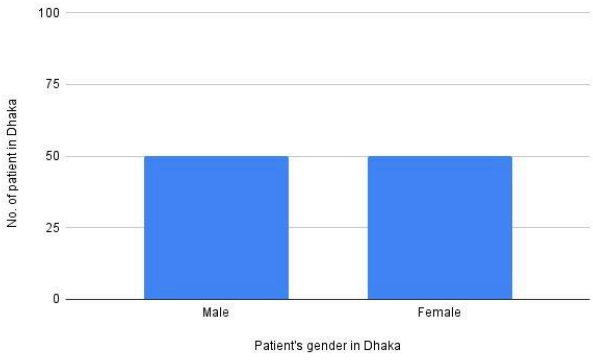


Figure 8: Percentage of patients differentiated by gender in Dhaka

The bar presents the percentage distribution of patients across different gender in Dhaka





Chapter 5. Discussion

As we found in fig 1, The names of the various diseases and their respective percentages in Netrakona are thus displayed in a pie chart. It provides a visual representation of the diseases' distribution in that region. We can tell which diseases are more common and which are less common by examining the chart. It can assist with comprehending Netrakona's health status and potentially figure out areas. This is an extensive review of the graph that highlights particular percentages and names the most and least prevalent diseases.

Here, Fever is the most prevalent disease, constituting 8.6% of the total cases. Then Urinary tract infection, skin abscess, abdominal infections, infection in throat, and septicemia each account for 6.3% of the total cases, indicating they are also relatively common. After that common cold, inflammation, sinusitis, and bacterial infection each makeup 3.1% of the cases and Upset stomach, skin infection, pneumonia, dental infection, diarrhea, cough, nausea/vomiting, and ischemic heart each contribute 2.3% to the total cases, making them less common compared to the above-mentioned diseases.

From this analysis, it is evident that fever is the most significant health concern in Netrokona, while diseases like upset stomach, skin infection, pneumonia, dental infection, diarrhea, cough, nausea/vomiting, and ischemic heart disease are less common.

Again, in Dhaka (fig 2) Fever is the most common disease, constituting 8.6% as well. But here ear infection is also highly prevalent, making up 7.5% of the cases. Sore throat contributes 6.7% to the total cases. Urinary tract infection and skin infection each represent 5.8% of the cases. Cough and pneumonia each account for 4.2%. Strep throat, dental infection, and common cold each makeup 3.3% of the cases. Whooping cough, respiratory infection, bacterial infection, and sinusitis each constitute 2.5% of the cases and typhoid fever, abdominal cramp, bronchitis, and cellulitis each contribute 1.7% to the total cases.

From this analysis, it is clear that fever and ear infections are the most significant health concerns in Dhaka, while diseases like typhoid fever, abdominal cramp, bronchitis, and cellulitis are less common. The comparison of infectious disease prevalence between Netrokona and Dhaka reveals that fever is the most common disease in both regions, slightly higher in Netrokona (8.6%) than in Dhaka (8.3%). Dhaka has a significant prevalence of ear infections (7.5%) and sore throats (6.7%), which are not prominent in Netrokona. Conversely, Netrokona shows higher rates of urinary tract infections, skin abscesses, abdominal infections, throat infections, and septicemia (each 6.3%), which are less notable in Dhaka. Common cold and bacterial infections have similar prevalence in both regions, with slight variations. These findings indicate distinct health challenges: Dhaka faces more ear infections and sore throats, while

Netrokona struggles more with various infections, emphasizing the need for region-specific healthcare strategies.

The study by Mondal et al. examined antibiotic prescribing practices for treating COVID-19 patients in Bangladesh. It found that physicians frequently prescribed antibiotics for COVID-19 patients, even in mild cases, which could further exacerbate the AMR problem [38].

Usually In urban areas, broad-spectrum antibiotics were more commonly prescribed, while in rural areas, there was a higher tendency to prescribe narrow-spectrum antibiotics. Here In (fig 3) Netrokona, Azithromycin is the most commonly prescribed antibiotic, accounting for 12.6% of prescriptions, followed by Amoxicillin at 10.2%. Ciprofloxacin and Erythromycin each constitute 6.3% of the usage, while Cefuroxime accounts for 5.5%. Cefixime and Gentamicin are each prescribed in 4.7% of cases, and Cephalexin, Clindamycin, Moxifloxacin, Vancomycin, and Ceftriaxone each makeup 3.9%. Penicillin and Doxycycline are each used in 3.1% of prescriptions, with Flucloxacillin and Levofloxacin at 2.4%. Amoxicillin-clavulanic acid is prescribed in 1.6% of cases, while Ampicillin, Cefdinir, Cefepime, and Cefixime each constitute 0.8% of the prescriptions. This distribution indicates a varied use of antibiotics tailored to the infections prevalent in the region, with a notable preference for Azithromycin and Amoxicillin.

In fig 4, The pie chart illustrates the distribution of antibiotics prescribed in Dhaka. The most frequently used antibiotic is Amoxicillin, accounting for 15.0% of prescriptions, followed by Azithromycin at 12.5%. Penicillin and Ciprofloxacin both make up 10.0% of the total usage. Cefuroxime is prescribed 5.8% of the time, while Erythromycin accounts for 5.0%. Antibiotics such as Ceftriaxone, Cefixime, and Dicloxacillin each represent 3.3% of prescriptions. Cephalexin and Doxycycline are each used in 2.5% of cases, similar to Amikacin. Less frequently prescribed antibiotics include Cefpodoxime and Metronidazole, each at 1.7%, and Cefdinir at 0.8%. This distribution highlights the varied antibiotic usage in treating infections in Dhaka, with a preference for a few broad-spectrum antibiotics.

The comparison of antibiotic prescription patterns between Netrokona and Dhaka highlights significant differences in rural and urban areas of Bangladesh. In Netrokona, a rural area, the most commonly prescribed antibiotics are Azithromycin and Amoxicillin, with a notable usage of Ciprofloxacin, Erythromycin, Cefuroxime, Cefixime, and Gentamicin. The distribution includes a variety of antibiotics, but there is a preference for narrower-spectrum options.

A study examining antibiotic use in various hospitals in Bangladesh found that third-generation Cephalosporins , Fluoroquinolones, and Penicillin were among the most commonly prescribed antibiotics. These are often used empirically, without confirmed bacterial infections, which can contribute to antibiotic resistance and In clinical settings, frequently prescribed antibiotics include Amoxicillin, Ciprofloxacin, and Azithromycin. These medications are often administered for the treatment of respiratory and urinary tract infections [39] [40].

The studies found a high prevalence of antibiotic resistance across Bangladesh, with many first-line antibiotics becoming largely ineffective. Here are some key findings:

Cephalosporins, Quinolones, Macrolides, and Penicillin were among the most commonly prescribed antibiotic classes, with Cephalosporins being the most frequently used [41]

Resistance was high to many commonly used antibiotics like Cephalosporins, Quinolones, and Penicillin. However, resistance to Carbapenems remained relatively low in most cases [42]

Antibiotic prescription practices varied between urban and rural areas, with drug shops playing a major role in providing antibiotics, even for serious illnesses, in rural areas. Cost was a major barrier to completing full antibiotic courses. Inappropriate antibiotic use was common, with incomplete dosing, multiple antibiotics prescribed, and antibiotics prescribed for non-bacterial infections. This was seen in both hospital and community settings [43].

From figure 5 we can observe that the largest proportion of affected individuals falls within the 41-60 years age range, making up 36.9% of the total. The second largest group is the 61-80 years range, comprising 26.2%. The 0-20 years and 21-40 years groups are relatively close in percentage, with 18.5% and 16.9%, respectively. The smallest group is the 81-100 years range, with only 1.5%. So it is clear that the age range 41-60 has the highest number of patients, with around 50. The 61-80 age group follows with about 35 patients. Both the 0-20 and 21-40 age groups have approximately the same number of patients, around 20 each. The age group 81-100 has the least number of patients, about 2. The data indicates that middle-aged adults (41-60 years) are the most significantly affected age group in Dhaka. This could be due to various factors including higher exposure, pre-existing conditions, or other demographic-specific reasons. The elderly (61-80 years) are also considerably affected, while the very young and very old are less impacted comparatively. This distribution can guide targeted healthcare measures and resource allocation.

In figure 6 the bar chart indicates that the age group most affected by infections requiring antibiotics in Dhaka is 41-60 years, making up 40.8% of the cases. This is followed by the 21-40 years age group at 35.8%. The 61-80 years age group accounts for 12.5%, while the 0-20 years age group is the least affected at 10.8%. This distribution highlights that middle-aged adults (41-60 years) are the most susceptible to infections, followed by younger adults (21-40 years), with elderly individuals (61-80 years) and children and adolescents (0-20 years) being less affected.

Figure 7 shows that in Netrokona females are more affected by the condition, comprising 58.8% of the total patients, while males account for 41.2%. This is shown in both the pie chart and bar chart, where approximately 60 patients are female and 40 are male. The higher prevalence among females suggests a need for targeted healthcare interventions to address this gender disparity, which could be due to higher susceptibility, exposure, or socio-economic factors.

On the contrary in Dhaka the percentage of genders of patients, with males and females being at a 50-50% split. That's quite interesting. It can be said that the male and female were equally affected according to the given data.

Chapter 6: Conclusion and Recommendations

This thesis offers important perspectives on the factors influencing antibiotic utilization and resistance in urban and rural areas of Bangladesh. The discoveries establish a foundation for crafting impactful public health measures to decrease antibiotic resistance and enhance healthcare results. The findings highlight the regional variations in infectious disease prevalence and antibiotic prescription practices, underscoring the need for targeted interventions to promote rational antibiotic use. Through the implementation of specific policies and educational campaigns, enhanced antibiotic stewardship can be attained, effectively addressing the increasing challenge of antibiotic resistance in Bangladesh.

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Appendix

Survey Questionnaire

Which disease occurs more in Netrakona?

Which disease occurs more in Dhaka?

What is the lowest prescribed antibiotic in Netrakona?

What is the lowest prescribed antibiotic in Dhaka?

What type of antibiotic is mostly prescribed in Netrakona?

What type of antibiotic is mostly prescribed in Dhaka?

What age of people are getting more affected in Netrakona?

Percentage of prescribed medicine Against a disease in Dhaka and Netrakona?

What is the Percentage of male patients in Dhaka and Netrakona?

#What is the percentage of female patients in Dhaka and Netrakona?

#Are there any differences in the prescription patterns of antibiotics between Netrakona and Dhaka?

What are the most commonly prescribed medications for children in Netrakona and Dhaka?

Are there any differences in the prescription patterns of medications for elderly patients between Netrakona and Dhaka?