

AFRICA UNIVERSITY
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ANTIMICROBIAL SUSCEPTIBILITY PROFILES OF *ESCHERICHIA COLI*
ISOLATED FROM URINE SAMPLES PROCESSED AT PATHOLOGY
LABORATORIES IN 2024

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE
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Abstract

Escherichia coli (*E.coli*) is a major etiological agent of Urinary tract infections (UTIs) worldwide. The increasing prevalence of multidrug-resistant (MDR) *E. coli* strains has compromised the effectiveness of commonly used antibiotics, posing a major challenge in clinical management. This study aimed to assess the antimicrobial susceptibility profiles of *E. coli* isolated from urine samples processed at Pathology Laboratories in 2024. A retrospective cross-sectional study was conducted using microbiology records from January to December 2024, analyzing a sample size of 190 *E. coli* isolates. Purposive sampling was first used to select urine samples positive for *E. coli*, followed by random sampling to ensure representativeness of the final sample. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method against 20 antibiotics. The results showed that *E. coli* infections were more prevalent in females (70.5%) than males (29.5%), with the highest infection rates observed in the 31–40 and 61+ age groups. High resistance rates were recorded for Levofloxacin (98.9%), Ampicillin (92.1%), Nitrofurantoin (76.3%), Nalidixic Acid (66.3%), and Cotrimoxazole (60%), while moderate resistance was observed for Tetracycline (52.6%) and Cefepime (41.1%). Cephalosporins (Ceftriaxone (93.7%), Cefuroxime (90.5%), and Ceftazidime (91.6%)) exhibited high effectiveness, and Carbapenems (Imipenem and Meropenem) and Chloramphenicol demonstrated complete susceptibility (100%). The study underscores the urgent need for enhanced antimicrobial stewardship programs, continuous surveillance of resistance trends, and strict Infection Prevention and control (IPC) measures. Clinicians should prioritize definitive therapy based on rapid and accurate antibiotic susceptibility testing rather than relying on empirical treatment, ensuring targeted and effective management of *E. coli*-associated UTIs while minimizing the risk of antimicrobial resistance. Public health interventions should focus on raising awareness about responsible antibiotic use. Strengthening laboratory-based surveillance and infection prevention strategies is critical to mitigating the spread of resistant *E. coli* strains and improving treatment outcomes.

Keywords: *Escherichia coli* (*e.coli*), antimicrobial, resistance, antibiotics, susceptibility, prevalence.

Declaration

I, Bliss Rumbidzai Dhaure, student number 210610 do hereby declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a Bachelor of Science degree.

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Dedication

I dedicate this dissertation to my mother Tabeth R Kabanda, whose unwavering support and encouragement have been my greatest source of motivation. Her belief in my abilities has fueled my passion for medical laboratory sciences and research. I also dedicate this work to my supervisor and mentor Mr. G. Malunga, who has played a crucial role in shaping my academic and professional journey. Lastly, I extend this dedication to all healthcare professionals working tirelessly to combat antimicrobial resistance and improve patient outcomes.

Acronyms and Abbreviations

<i>E. coli</i>	<i>Escherichia coli</i>
UTIs	Urinary tract infections
MDR	Multidrug-resistant
Pathlabs	Pathology Laboratories
UPEC	Uropathogenic <i>Escherichia coli</i>
uUTIs	Uncomplicated urinary tract infections
cUTIs	Complicated urinary tract infections
CLED	Cystine-Lactose-Electrolyte-Deficient
BA	Blood agar
ESBLs	Extended-spectrum beta-lactamases
AMR	Antimicrobial resistance
IPC	Infection Prevention and Control

Definition of key terms

***Escherichia coli* (*E. coli*)** is a Gram-negative, rod-shaped bacterium. While most *E. coli* strains are harmless, a few are pathogenic, causing a variety of infections.

Urinary Tract Infections (UTIs) - Infections of any part of the urinary system, such as the bladder, kidneys, ureters, or urethra.

Multidrug-resistant (MDR) - Bacteria resistant to multiple antibiotics, making treatment difficult.

Extended-Spectrum Beta-Lactamases (ESBLs) - They are enzymes produced by certain bacteria, including *E. coli*, that degrade and confer resistance to beta-lactam antibiotics like penicillins and cephalosporins.

Antimicrobial resistance (AMR) - It is the ability of microorganisms, such as bacteria, to withstand the effects of medications, rendering conventional treatments ineffective.

Uncomplicated Urinary Tract Infections (uUTIs) - UTIs that occur in healthy people who have no structural or functional abnormalities in the urinary tract.

Complicated Urinary Tract Infections (cUTIs) - UTIs that are accompanied by underlying conditions, such as obstructions or immunocompromised states, making treatment more difficult.

Uropathogenic Escherichia Coli (UPEC) - This is a strain of *E. coli* that causes urinary tract infections and is known for its virulence characteristics, which aid in infection.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

This chapter covers the background of the study, discussing how urinary tract infections (UTIs) are primarily caused by *Escherichia coli* (*E.Coli*), the rise of antibiotic resistance, and the clinical implications of these infections. The problem statement then outlines the challenges posed by *E. coli*-mediated UTIs, particularly in the context of increasing antibiotic resistance. The research objectives are then presented, focusing on the specific aims of the study. The chapter also addresses the research questions that guide the investigation. Justification of the study, study limitations and delimitations are also outlined in this chapter.

1.2 Study Background

Urinary tract infections (UTIs) are some of the most commonly encountered bacterial infectious diseases in clinical practice, leading to considerable morbidity and high medical costs. *E.coli* is the predominant pathogen responsible for 80-90% of community-acquired UTIs and 30-50% of hospital-acquired UTIs (Ejrnæs, 2010). Other bacteria can cause UTIs, but *E.coli* is the most common culprit, accounting for over 90% of cases globally (UCSF Health, 2023). In Africa, the prevalence of UTI was 32.12% with *E.coli* accounting for 86.4% of the isolates (Mwang'onde & Mchami, 2022). These infections are a major public health concern, particularly among women, the elderly, and those with underlying medical conditions (Foxman, 2014). *E. coli's* ability to cause UTIs is largely due to its various virulence factors, which allow it to colonise, invade, and persist in the urinary tract (Johnson & Russo, 2005). *E.coli* is found in the gastrointestinal tract, hence the close proximity of the anus and urinary system facilitates contamination (Mwang'onde & Mchami, 2022). One of the critical issues in managing *E. coli* UTIs is the increasing prevalence of antibiotic-resistant strains. Multidrug-resistant *E. coli* has become more common,

complicating treatment options and leading to higher rates of recurrence and complications (Kahlmeter, 2003). Examining the antimicrobial susceptibility profiles of *E.coli* isolates from urine samples is crucial for understanding the epidemiology of these infections, identifying resistance patterns, and informing the development of effective treatment strategies (Gupta et al., 2011).

1.3 Statement of the problem

Urinary tract infections (UTIs) are a significant global health issue, with *E. coli* being the leading cause of these infections. The situation is particularly alarming due to the rapid emergence and spread of multidrug-resistant (MDR) *E. coli* strains, which pose a serious challenge to public health worldwide. This growing resistance significantly undermines the effectiveness of standard antibiotic therapies, leading to more complicated and recurrent infections, prolonged illness, and higher healthcare costs. During the period at Pathology Laboratories in the microbiology department, *E.coli* was identified as the most commonly isolated pathogen in urinary tract infections (UTIs), prompting the decision to conduct research on the epidemiology and antimicrobial susceptibility patterns of this pathogen. *E.coli* strains were susceptible to very few drugs which were used. Ignoring this would allow resistant *E. coli* strains to spread unchecked, not only within communities but also across borders, posing a global threat. The lack of comprehensive data on the antimicrobial susceptibility profiles of *E. coli* strains hampers efforts to develop effective treatment guidelines. Without detailed knowledge of the specific resistance mechanisms present in local *E. coli* populations, healthcare providers are often left to rely on empirical treatments that may no longer be effective.

1.4 Research Objectives

1.4.1 Broad Objective

The main objective of this study was to assess the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples processed at Pathology Laboratories in 2024.

1.4.2 Specific Objectives

This study aimed to achieve the following objectives:

1. To identify socio-demographic factors of patients with *E.coli* infections attended at Pathology laboratories in 2024.
2. To assess the antimicrobial susceptibility profiles of *E. coli* isolated from urine samples processed at Pathology laboratories in 2024.
3. To determine the prevalence of antibiotic-resistant *E. coli* isolated from urine samples at Pathology Laboratories in 2024.

1.5 Research Questions

1. What are the socio-demographic factors of patients with *E.coli* infection who attended Pathology laboratories in 2024?
2. What are the antimicrobial susceptibility profiles of *E. coli* isolated from urine samples processed at Pathology laboratories in 2024?
3. What is the prevalence of antibiotic-resistant *E. coli* isolated from urine samples processed at Pathology Laboratories in 2024?

1.6 Study Justification

Existing research on the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples is often limited to a specific healthcare setting or country for example the one carried at Mulago Hospital, Kampala, Uganda in 2020. In Zimbabwe studies were also done by Takawira and Mbanga (2023) on the ‘Multidrug-resistant *Escherichia coli* and antibiotic resistance genes found in Harare, Zimbabwe's wastewater treatment plant and surrounding river water.’ Their research had nothing to do with UTIs. Another study examined ESBL-producing *E. coli* associated with urinary tract infections in nine different regions of Zimbabwe over a two-year period (2017-2019) (Takawira et al., 2017). This research study aimed to understand the molecular epidemiology of these antibiotic-resistant strains. Given the significant advances and shifts in antimicrobial resistance patterns since the last comprehensive study on ESBL-producing *E. coli* in Zimbabwe (2017–2019), this research on the antimicrobial susceptibility profiles of *E. coli* isolated from urine samples at Pathology Laboratories in 2024 is both timely and critical. The evolving nature of resistance mechanisms and the impact of socio-demographic changes necessitate an updated perspective. This study filled a significant gap by providing a current assessment of prevalence, antimicrobial susceptibility profiles, and associated socio-demographic variables. UTIs are one of the most common bacterial infections, affecting millions of people worldwide and posing a significant burden on public health and healthcare costs. Understanding the prevalence of the primary causative agent, *E.coli*, is crucial for effective diagnosis and treatment. In addition, there is growing global concern about *E. coli*'s resistance to commonly used antibiotics. This resistance can result in treatment failures, extended illness, and higher healthcare costs. Investigating the antimicrobial susceptibility profile of *E. coli* isolates was critical for determining the best antibiotic therapy. This study contributed to improved

patient outcomes, reducing the duration of illness and preventing complications associated with untreated or improperly treated infections.

1.7 Study delimitations

This study was conducted at Pathology Laboratories (Pathlabs) which is a private laboratory that was established in Harare, Zimbabwe with over 10 years of experience. It offers hospitals, healthcare professionals, patients and medical centres with the finest levels of expertise regarding laboratory operations. This remarkable coverage provided a reliable sample size for the study and the results presented a fair reflection of the UTI epidemiology. The study offered valuable insights into the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples processed Pathology Laboratories in 2024, focusing solely on *E.coli* and excluding mixed or contaminated samples.

1.8 Study limitations

This is retrospective cross-sectional study analyzed urine microbiology records at Pathology Laboratories. Some information of the clinical data of patients were lacking or missing. The research was restricted to Pathology Laboratories urine microbiology records. A prospective study could not be conducted due to lack of financial resources and also time constrains.

1.9 Chapter Summary

The study aimed to investigate the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples processed at Pathology Laboratories in 2024. By analysing urine samples from a diverse patient population, the study sought to determine the proportion of UTIs caused by *E.coli* and assess the resistance and susceptibility patterns of these isolates to commonly used antibiotics. This research was vital for guiding effective clinical treatment, informing public health strategies, and contributing to the understanding of antibiotic resistance trends. Data

collection was confined to Pathology Laboratories laboratory, focusing exclusively on *E. coli*, and excluded samples with mixed or contaminated cultures.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

In this chapter, the literature review concentrated on the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples, a topic of great importance in microbiology and clinical diagnostics. A literature review is a summary of previously published research on a given topic (Alex, 2024). It entailed a thorough examination of existing scholarly works relevant to the research topic, which served as context and background for the study while also highlighting gaps or inconsistencies in current knowledge.

2.2 Conceptual framework

The conceptual framework for this study was designed to outline and investigate the various factors that influence the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples. This framework incorporated a variety of variables that interact to influence the study's outcome, including strain characterisation, antibiotic susceptibility profiles, and *E.coli* infection clinical results.

Patient demographics, such as age, gender, underlying health conditions like diabetes, immunocompromised states, and a history of UTIs, all have an impact on *E.coli* susceptibility and strain characteristics. Furthermore, the type of urine sample collected (midstream or catheterised) and the clinical setting (outpatient versus inpatient) were important considerations because they could influence the types and concentrations of bacteria isolated as well as the infection characteristics observed.

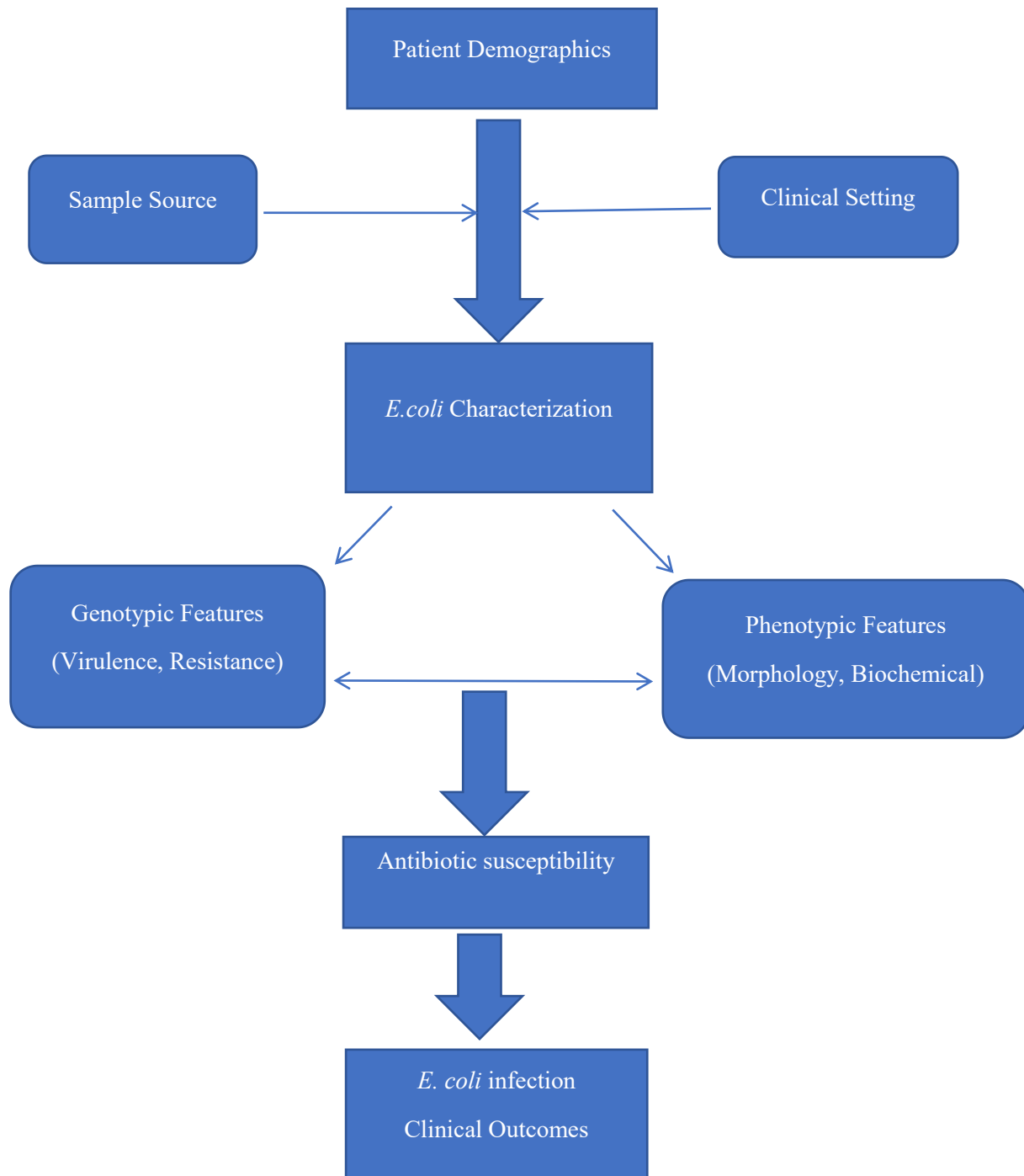


Figure 1: Conceptual framework of antimicrobial susceptibility profiles of *E. coli*

Figure 1 illustrates the conceptual framework guiding the study on antimicrobial susceptibility profiles of *E. coli*, highlighting the dependent variables such as *E.coli* strain characterization,

which included both genotypic (for example virulence and resistance genes) and phenotypic (for example colony morphology and biochemical reactions). Antibiotic susceptibility profiles, which describe susceptibility or resistance patterns, were critical for treatment and resistance research. Understanding the prevalence and distribution of resistant strains also helped in assessing their public health impact.

Mediating variables included antibiotic use and infection control strategies, both of which influenced resistance development and strain characteristics. Environmental factors, such as hospital sanitation and cross-infection with other infections, also impacted these outcomes.

Moderating variables encompassed *E. coli* strain genetic heterogeneity, which affected virulence and resistance, as well as prior antibiotic use, which influenced current resistance profiles.

2.3 Literature review in relation to study objectives.

2.3.1 Bacterial aetiology of UTIs.

According to Silva et al. (2022), urinary tract infections (UTIs) affect approximately 150 million people worldwide every year, and are among the most frequent bacterial diseases with *E.coli* as the most common cause of UTIs. Apart from *E. coli*, the most common bacteria found in UTIs are *Klebsiella pneumonia*, *Proteus mirabilis*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Staphylococcus saprophyticus*, *Staphylococcus aureus*, and *Streptococcus agalactiae* (Mancuso et al., 2023). However, uropathogenic *E.coli* (UPEC) is the predominant cause of both uncomplicated urinary tract infections (uUTIs) and complicated urinary tract infections (cUTIs) (Gupta et al., 2017). It is followed by other pathogens including *Klebsiella pneumoniae*, *Proteus mirabilis*, *Enterococcus faecalis*, and various *Staphylococcus* species as mentioned by the other authors. A study to investigate the prevalence of UTIs in stroke patients hospitalised to a teaching hospital in Zimbabwe was done in 2022 (Mukapa et al., 2022). This research was only

limited to stroke patients hence not giving us a information on a wider population range. A cohort study was also done between July 2019 and July 2020 and included patients from ten primary care clinics in Zimbabwe with the purpose to determine how antibiotic treatments improve clinical and bacterial outcomes in Harare patients with UTI symptoms (Chisenga et al., 2022). This study, titled ‘Antimicrobial Susceptibility Profiles of *E. coli* Isolated from Urine Samples,’ offered a more in-depth and pathogen-specific analysis of *E.coli*, providing valuable insights into its prevalence of antibiotic-resistant *E.coli*, socio-demographic factors, and antibiotic susceptibility profiles. Compared to the UTI cohort study, this study provided a more current and targeted understanding of *E.coli* infections, which was critical for defining effective treatment options and tackling current antibiotic resistance trends. Hence, this study did not give us biased information based on other people’s countries but our very own current and reliable data.

2.3.2 Isolation and Identification of *E coli* from urinary samples.

This section reviewed the methodologies and advancements in the isolation and identification of *E. coli* from urine samples. To avoid contamination, a clean-catch midstream urine sample is collected first when isolating *E. coli* from urine (Cleveland Clinic Laboratories, 2022) . The collected urine is then cultured on selective and differential media, which allow *E. coli* to grow while inhibiting or differentiating it from other bacteria.

In the microbiology laboratory, *E. coli* is isolated using a variety of culture media, including Cystine-Lactose-Electrolyte-Deficient (CLED) agar and Blood agar. Each medium has specific characteristics that make it appropriate for isolating and differentiating *E. coli*. CLED agar is a non-selective, differential medium that contains lactose, a fermentable carbohydrate, cystine, which promotes the growth of urinary pathogens, and bromothymol blue, a pH indicator (Smith,

2020). The absence of electrolytes in CLED agar prevents *Proteus* species from swarming and obscuring the growth of other pathogens.



Figure 2: The Growth of *E.coli* on CLED Agar

Figure 2 shows the characteristic growth of *E.coli* on CLED agar, presenting as yellow, smooth, circular colonies due to lactose fermentation. *E.coli* ferments lactose in the medium, releasing acid as a by-product. This acid lowers the pH, causing the bromothymol blue indicator to change colour and yield yellow colonies (Aryla, 2022). This distinct colour change makes it easier to identify *E. coli* colonies on CLED agar.

Blood Agar on the other hand is commonly used in conjunction with CLED agar to provide additional information about the organism, such as haemolytic activity, and to grow a wider range of bacteria.

E.coli is identified using a combination of biochemical tests and molecular techniques to confirm its presence and distinguish it from other Enterobacteriaceae. A gram stain can be done and if its

gram negative, rod shaped then it can be *E.coli*. To be sure, we move on to a motility test whereby *E. coli* is typically motile, characterised by a diffuse growth radiating away from the stab line, indicating movement through the medium (Brown, 2019). The indole test, which detects the ability to produce indole from tryptophan, is a critical test in which *E. coli* typically produces a positive result (Johnson & Lee, 2021). As for citrate test, *E. coli* is citrate negative, which means it doesn't use citrate, hence no colour change (White, 2018). Many other biochemical tests can also be performed.

2.3.3 The socio-demographic factors associated with *E.coli* infection among patients with UTIs.

Sociodemographic factors are population-specific social and demographic characteristics that influence individual health outcomes (Lund & Andersen, 2022). These factors usually include age, gender, income level, education, marital status, and occupation. It is hypothesized that sociodemographic factors may influence the incidence, prevalence, and severity of infections caused by *E. coli*. Understanding the sociodemographic determinants of *E. coli* UTIs is critical for developing targeted prevention and treatment strategies, particularly in relation to age and gender, which are two of the most important predictors of UTI risk.

A study by Ejrnaes (2011), stated how the incidence of UTI is influenced by gender and age, with UTI being most common among females in all age groups. Females are 30 times more likely to have UTIs than males, with *E.coli* accounting for 75-90% of the cases (Goecker, 2019). Women have a shorter urethra, which allows bacteria easier access to the bladder, making them more likely to develop UTIs (Nsiane, 2024). UTI affects more than half of all women and at least 12% of men in their lifetimes (Mlugu et al., 2023). All the above research agree on how UTIs commonly affect women when it comes to gender. Anyone can contract an *E. coli* infection,

but certain groups are more likely to become infected and develop serious illness, including sexually active women aged 20 to 40 years and postmenopausal women older than 60 years are the two populations at greatest risk for UTI (Ejrnaes, 2011). UTIs occur in all age groups, but some age-related patterns have been observed. According to Mlugu (2022) study, the prevalence of UTIs was 41% (141/344) and elders (≥ 60 years) had five times higher odds of having UTI than teenagers ($p < 0.001$). The most common bacteria was *E. coli* (47%; 66/141). According to another research, *E. coli* UTIs are more common in older adults due to functional impairments and the use of urinary catheters (Rowe & Juthani-Mehta, 2014). This proves how both patient age and gender are important factors in determining the aetiology of UTIs; they can improve accuracy in defining the causative uropathogen while also providing useful guidance for empiric treatment (Antonia et al., 2012). Hence, this study went into depth looking at the patient populations that goes to Pathology and see how age and gender determined the incidence, prevalence, and severity of infections caused by *E. coli*.

2.3.4 Antimicrobial susceptibility profiles of *E. coli* strains isolated from patients with UTIs.

Antimicrobial susceptibility is a micro-organism's ability to be inhibited or killed by a specific antimicrobial agent, such as *E. coli*'s respond to antibiotics (Benkova, Soukup & Marek, 2020). In the context of (UTIs), which are frequently caused by *E. coli*, understanding antimicrobial susceptibility is crucial for selecting appropriate treatment regimens.

A study by Naqid et al., 2020, reported that *E. coli* was highly susceptible to carbapenems (100%). The higher rate of sensitivity among UPEC isolates by other studies were towards amikacin (77.55%), imipenem (76.53%), nitrofurantoin (75.5%) and gentamicin (71.43%), with only a few isolates showing resistance (Hegazy et al., 2018). Furthermore, Nas et al. (2019)

reported that *E. coli* isolates exhibited high sensitivity to Gentamicin (82%), Ciprofloxacin (75%), and Chloramphenicol (65%).

One of the most concerning changes in *E. coli*'s antimicrobial resistance profile is the emergence of strains that produce extended-spectrum beta-lactamases (ESBLs). ESBL-producing *E. coli* strains have been linked to more serious infections, higher rates of treatment failure, and higher healthcare costs (Falagas & Karageorgopoulos, 2009). Enterobacteriaceae that produce ESBLs are commonly found in the community and in hospitals around the world. Reliable identification of ESBL-producing organisms in clinical laboratories can be difficult, so their prevalence is likely underestimated (David C Hooper, 2024).

The findings of Hegazy et al., (2018) showed how *E. coli* isolates demonstrated the highest resistance rates against Ampicillin and Cefazolin (100%), followed by Nalidixic Acid (91.84%). The increasing prevalence of antimicrobial resistance among *E. coli* is a growing global concern because it then makes infection treatment more difficult (Kibret & Abera, 2011). Detecting UTI-causing pathogens and analysing their resistance patterns to commonly prescribed antibiotics in clinical practice is essential and useful in improving the efficacy of empirical treatment (Peerapur et al., 2017). However, *E. coli* occurrence and susceptibility profiles vary significantly across regions, as well as between populations and environments (Kibret & Abera, 2011). Which is why this study was necessary since it focused on clinical samples processed at Pathology Laboratories (Pathlabs).

2.3.5 Prevalence Antibiotic-resistant *E. coli* infections

Prevalence is defined as the commonness of a condition (Cambridge Dictionary, 2024). Antimicrobial resistance continues to be a global health crisis with significant social and economic consequences. Multidrug-resistant bacteria, particularly Extended-Spectrum β -

Lactamase-producing Enterobacterales (ESBL-E), are considered high-priority pathogens that demand urgent research and the development of novel therapeutic solutions (Bayaba et al., 2024). In the study titled "Prevalence and Phenotypic Detection of Carbapenem and Multi Drug Resistant *E. coli* in Urinary Tract Infection Patients in District Swat," Uzma Noor et al. discovered that 80 (69.5%) of the total isolated bacterial species were identified as multidrug-resistant (MDR) *E. coli*. Another study by Bayaba et al., (2024), found 64.7% (44/68) of ESBL-producing Enterobacterales. Of these isolates, roughly 82% (36/44) were found to be multidrug resistant. The study also found substantial levels of antibiotic resistance, particularly to ceftazidime and amoxicillin + clavulanic acid. High degree of resistivity rates to ampicillin (85%), amoxicillin (85%), septrin (90%), erythromycin (75%) and tetracycline (75%) were detected in the study by Nas, (2019).

While these studies give useful information about the prevalence and antibiotic resistance of *E. coli* and other Enterobacterales, they are limited to specific regions other than Zimbabwe. There is still a huge study gap in knowing the antibiotic susceptibility profiles of *E. coli* in developing nations like Zimbabwe. Current data on *E. coli* prevalence and resistance patterns in Zimbabwe were scarce, particularly in private laboratories. This gap highlighted the need for further research to assess the regional disparities in antibiotic resistance, particularly in private healthcare settings such as Pathology Laboratories in Harare. The current study sought to address this gap by looking into the prevalence and antibiotic susceptibility characteristics of *E. coli* isolated from urine samples in Zimbabwe in 2024.

2.4 Chapter Summary

This literature review chapter on the characterisation of *E. coli* isolated from urine samples delved into several critical aspects, including the bacterial aetiology of urinary tract infections

(UTIs), methods for isolating and identifying *E. coli*, socio-demographic factors influencing *E. coli* infections, and antimicrobial susceptibility of these strains. The review emphasised the importance of understanding *E. coli* as the most common UTI pathogen, as well as the need for accurate identification techniques to guide effective treatment. However, significant gaps remained, particularly in developing countries such as Zimbabwe, where data on *E. coli* occurrence and antimicrobial susceptibility were scarce and frequently outdated. The review underscored that *E. coli* occurrence and resistance profiles could vary widely across regions, populations, and environments, highlighting the necessity of conducting research within specific contexts, such as Zimbabwe and specifically at Pathlabs. This regional focus was crucial for developing locally relevant treatment protocols and addressing the unique challenges posed by antimicrobial resistance in different settings.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter described the methodology used to examine the antimicrobial profiles of *E.coli* isolated from urine samples at Pathology Laboratories in 2024. It began with an overview of the research design and then moved on to describe the study site and population. The chapter outlined sampling methods, such as sample size determination and procedures for ensuring representative sampling. The data collection instruments and procedures were described, along with a discussion of the pilot study used to validate these methods. Data analysis and ethical considerations were also addressed, ensuring that the study was rigorous and adhered to ethical standards. The chapter ended with a summary of the key methodological aspects.

3.2 The Research Design

The research was a retrospective cross sectional study. A retrospective cross-sectional study is a type of observational study that examines data from a population at a certain point in time, but the data is collected from previous records (Hess., 2004). Data for this study was gathered from Electronic Medical Records (EMRs) or Laboratory Information Systems (LIS), Urine Culture Laboratory Reports and Antimicrobial Susceptibility Testing (AST) Reports.

Electronic Medical Records (EMRs) or Laboratory Information Systems (LIS) helped to extract clinical and microbiological data related to patient demographics, symptoms, medical history, and *E.coli* culture results. Patient ID, age, gender, clinical symptoms, diagnosis of UTI, test results for example urine culture, and antimicrobial susceptibility profiles (AST) were examples of data captured.

Urine Culture Laboratory Reports helped to gather specific details about the urine culture, including the identification of *E.coli*, colony counts, and sample types (midstream urine, catheter, etc.).

Antimicrobial Susceptibility Testing (AST) Reports helped to document the antimicrobial resistance patterns of *E.coli* isolates. Data on Sensitivity, Intermediate, or Resistance (S/I/R) results for antibiotics was captured and this was determined using the Kirby-Bauer disk diffusion method, following standard guidelines. Antibiotic-impregnated disks were placed on Mueller-Hinton agar plates inoculated with *E.coli* bacterial isolates, and after incubation (37°C) for 24hrs, the zones of inhibition (clear areas around the disks) were measured in millimeters.

Table 1: Antibiotic Susceptibility Breakpoints (CLSI Guidelines) for the 20 Drugs Tested

Drug	Quantity /µg	Zone of clearance diameter /mm			Drug	Quantity /µg	Zone of clearance diameter /mm		
		S	I	R			S	I	R
Levofloxacin	5	≥ 17	14-16	≤13	Meropenem	10	≥23	20-22	≤19
Ampicilin	10	≥ 17	14-16	≤13	Ceftazidime	30	≥21	18-20	≤17
Amikacin	30	≥17	15-16	≤14	Imipenem	10	≥23	20-22	≤19
Nitrofurantoin	300	≥17	15-16	≤14	Cefepime	30	≥25	19-24	≤18
Cefuroxime	30	≥23	15-22	≤14	Cephazolin	30	≥15		≤14
Augmentin	30	≥18	14-17	≤13	Cefuroxime	30	≥23	15-22	≤14
Co-amoxiclav	30	≥18	14-17	≤13	Ciprofloxacin	5	≥26	22-25	≤21
Chloramphenicol	30	≥18	13-17	≤12	Ceftriaxone	30	≥23	20-22	≤19
Kanamycin	30	≥18	14-17	≤13	Gentamicin	10	≥15	13-14	≤12
Tetracycline	30	≥19	15-18	≤14	Cotrimoxazole	25	≥16	11-15	≤10
Ceftazidime-Avibactam	30/20	≥21		≤20	Nalidixic Acid	30	≤13	14-18	≥19

Table 1 shows the zone diameter breakpoints used to interpret the antimicrobial susceptibility results of *E. coli* isolates in this study. The interpretation was based on predefined Clinical Laboratory Standards Institute (CLSI) guidelines, where isolates were classified as susceptible (S) if the zone of inhibition met or exceeded the susceptibility threshold, resistant (R) if the zone was

below the resistance cutoff, and intermediate (I) if the zone fell between these two values. These breakpoints varied depending on the antibiotic, with carbapenems (e.g., imipenem, meropenem) requiring inhibition zones of ≥ 22 –23 mm to be considered susceptible, while other classes such as beta-lactams, fluoroquinolones, aminoglycosides, and tetracyclines had their own specific thresholds.

3.3 Study Site

Pathology Laboratories (Pathlabs), a private laboratory founded in Harare, Zimbabwe, with over ten years of experience, was the study site for this research. The laboratory provided a comprehensive range of pathology services like STAT and Routine Testing, Haematology, Clinical Chemistry and Immunology, Microbiology and Virology, Molecular biology, Histology and Cytology.

3.4 Study Population

The study population consisted of patients of all age groups diagnosed with UTIs in 2024, from whom *E.coli* was isolated at Pathology Laboratories in 2024

3.5 Exclusion criteria

Records showing that the patient was receiving antibiotic medication prior to the sample collection were omitted. To eliminate unnecessary intervention, patient records with a positive urine antimicrobial test prior to culture were excluded.

3.6 Inclusion criteria

The study focused on urine microbiology records, with a specific emphasis on *E.coli*-related UTIs. There were no restrictions on age, gender, immunological status, or state of referring facility because records from a varied population will help fulfil the study's primary goals. To rule out antimicrobial interference, only samples from patients who had not received antibiotics

prior to culture were included, as urine was first cultured on Mueller-Hinton agar to detect the presence of antibiotic activity.

3.7 Sample size

The following formula was used to calculate the sample size :-

$$n = \frac{Z^2 \times p(1-p)}{D^2}$$

Where:-

n = the sample size

Z = the statistic corresponding to the level of confidence (1.96 = 95% confidence interval)

P = the expected prevalence of the disease in the population (14.2%)

d = the precision of the estimate, which is the maximum acceptable error (5%)

Hence:-

$$\begin{aligned} N &= \frac{1.96^2 \times 0.142(1-0.142)}{0.05^2} \\ &= 187.2 \end{aligned}$$

Therefore the study used a sample size of 190.

3.8 Sampling Procedure

A combination of purposive and random sampling techniques was used in this study to ensure that the sample is both relevant and representative. Purposive sampling was first utilized to identify urine samples from which *E.coli* has been isolated, focusing specifically on cases of urinary tract infections (UTIs) that align with the study objectives. This ensured that the selected samples are relevant for examining *E.coli* antibiotic-resistance, socio-demographic factors and antimicrobial susceptibility profiles.

After identifying these relevant cases through purposive sampling, random sampling was then then applied to select a required sample size from this subset. This step ensured that the final sample is statistically representative of the broader population of patients with *E.coli* related UTIs.

By combining these two sampling methods, the study balances targeted selection with randomization, enhancing the validity and generalizability of the findings.

3.9 Data Collection Instruments

Data collection instruments play an important role in gathering and organizing historical data from existing records since this study is retrospective. These instruments included records, laboratory information systems and microbiology worksheets. This study used microbiology records from Pathology laboratories in the year 2024, concentrating on patient demographics, urine culture results and antimicrobial susceptibility testing results. By using these instruments, the study collected exact data on prevalence of antibiotic-resistant *E.coli*, associated socio-demographic factors and antimicrobial susceptibility profile results.

3.10 Pilot Study

A small scale preliminary study of 20 samples was conducted at Interpath Medical Laboratories using data from 2023 to evaluate the feasibility, duration and the cost of the study and the data which was required to do the project was readily available.

3.11 Data Analysis and Organization of Data

In this study on the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples processed at Pathology Laboratories in 2024, data analysis and organization of data were important for converting raw data into valuable insights. After collecting the data, the following actions were followed to manage and analyse it:

3.11.1 Data Organization: The data was systematically organized in Microsoft Excel to provide clarity and accessibility. This included organizing the data into categories, such as:

Patient demographics (age and gender).

Culture results indicating the presence of *E. coli*.

Antimicrobial susceptibility profiles.

The structured data was coded and organized to guarantee consistency and prevent errors during analysis.

3.11.2 Data Cleaning: This step involved reviewing the data to identify and correct any inconsistencies, duplicates, or missing entries. Clean, accurate data was crucial for valid analysis.

3.11.3 Data Analysis: The study processed and analyzed the acquired data using Microsoft Excel, which was organized, cleaned, and structured for accuracy and consistency. A descriptive analysis was used to summarize major findings, such as the frequency of *E. coli* in urine samples, as well as the distribution of infections across age groups and genders. Tables were used to provide structured data and bar graphs to highlight demographic distributions and depict trends in antibiotic reactions. The findings were organized into clear visual representations to effectively communicate *E. coli* prevalence, infection patterns across age groups and gender, and antibiotic susceptibility trends, resulting in a thorough and structured presentation of the data.

3.12 Ethical Consideration

For the study on the antimicrobial susceptibility profiles of *E.coli* isolated from urine samples processed at Pathology Laboratories in 2024, the Pathology Laboratory Manager provided approval to access microbiology archives and patient records relating to UTI investigations. The microbiology laboratory registers from January 2024 to December 2024 were used as primary data sources. Ethical considerations were strictly adhered to during data collection, analysis, and

publication of results. Patient confidentiality was maintained, with records safeguarded against unauthorised access, ensuring that patient identities remain unknown. Thus, information like names and addresses was not extracted from the records. Anonymized codes were used instead of names. Only necessary data like age, gender and microbial isolates were used in analyses and publications ensuring that individual patients cannot be identified.

Patients' medical records and microbiological worksheets (such as their health history and demographic information) are sensitive. The privacy of these documents was protected, meaning that only authorized personnel should have access to this information.

Data from microbiology records was preserved in secure system, encrypted, and accessible only to authorized researchers. After the study was completed, was archived or disposed of in accordance with institutional policies. Research records were kept in password protected documents on the Researcher's laptop. Ethical approval was sought from Africa University Research Ethics Committee (AUREC).

CHAPTER 4 : DATA ANALYSIS AND PRESENTATION

4.1 Introduction

Data analysis is defined as a process of systematically collecting, cleaning, transforming, describing, modelling, and interpreting data, which is the focus of this chapter (Stephen Eldridge, 2025). This chapter provided an outline of the results obtained at Pathology Laboratories in 2024 from 190 unique and anonymous patients records, all of which tested positive for *E.coli*. Data analysis was done using Microsoft Excel. The results were presented using tables and graphs, highlighting the socio-demographic characteristics of patients with *E. coli* infections, as well as the age group most affected. Furthermore, the data showed the prevalence of antibiotic-resistant *E. coli* strains and their susceptibility profiles to various antibiotics.

4.2 Socio-demographic characteristics of study participants

Table 2: Socio-demographic characteristics of study participants

Characteristics	Frequency N(%)
Age [mean] / years	43.0
Gender	
Male	56 (29.5)
Female	134 (70.5)
Total	190 (100)

NB: Data is presented as N(%) unless specified.

Table 1 shows the socio-demographic characteristics of patients diagnosed with *E. coli* infections. The mean age of patients with *E. coli* infection is 43 years. This indicates that middle-aged individuals were commonly affected. A significantly higher proportion of cases were observed in females (70.5%), which suggested that *E. coli* infections, particularly UTIs, are more prevalent in women. This aligns with existing research by Trafimovich (2024), as anatomical and

physiological factors make females more susceptible to urinary tract infections. A smaller proportion of cases were reported in males (29.5%), which is expected, as men generally have a lower risk of UTIs compared to women due to their gonadal anatomy.

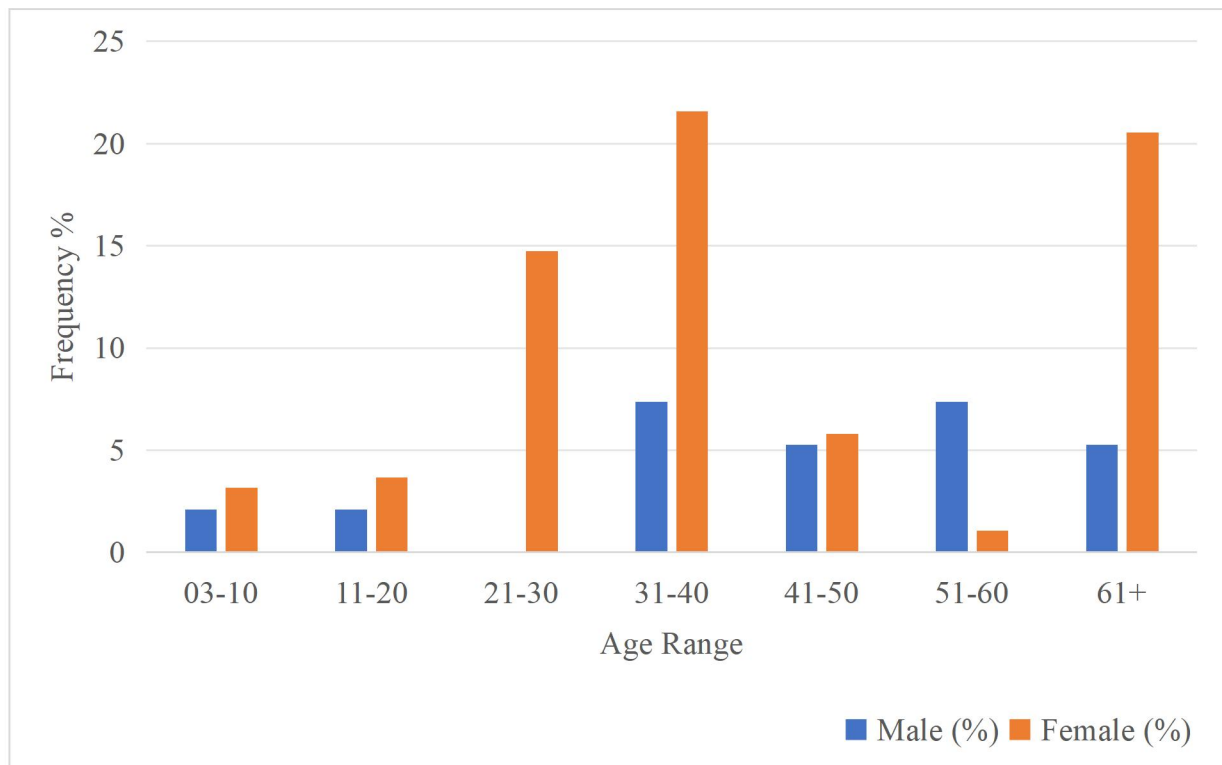


Figure 3: Age and gender distribution of study participants.

Figure 3 shows the age and gender distribution of study participants. The age and gender distribution of 190 patients with *E. coli* infection shows that females (70.5%) were more affected than males (29.5%) across all age groups. Generally, in most of the age groups females were more susceptible to *E. coli*. The highest number of infections was recorded in the 31–40 age group, with 21.6% of females and 7.4% males, followed by the 61+ age group, where infections were predominantly in females with 20.5% compared to males 5.3%. The 21–30 age group showed a significant gender gap, with 14.7% females and no male cases. In contrast, the 51–60 age group showed more males with 7.4% than females with 1.1%, suggesting a shift in susceptibility among older males. The younger age groups of 03–10 and 11–20 years had the

lowest number of infections, with slightly more cases in females than males. These findings show that *E. coli* infections are more prevalent in females, particularly in reproductive and older age groups, while males exhibit a more balanced distribution throughout ages, with a notable peak in the 51–60 age group.

4.3 Antimicrobial Susceptibility Profile of *E.coli* isolated from urine samples processed at Pathology Laboratory in 2024.

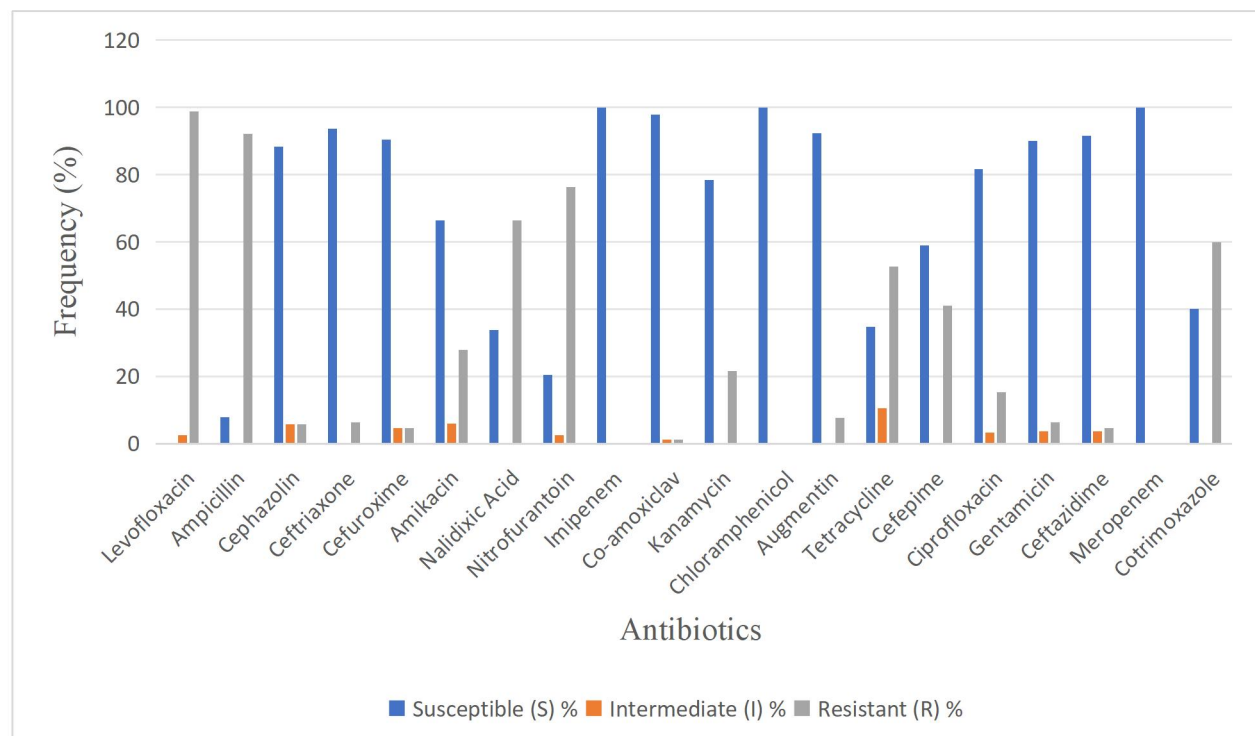


Figure 4: Antimicrobial Susceptibility Profile of *E.coli* isolates.

Figure 4 shows the antimicrobial susceptibility profile results for *E. coli* isolates to the 20 antibiotics used. The data was divided into three categories: susceptible (S), intermediate (I), and resistant (R), which indicated the efficacy of each drug.

Imipenem, Meropenem, and Chloramphenicol exhibited complete susceptibility (100%), with no intermediate or resistant isolates. Co-amoxiclav was 98% susceptible, had minimal resistance

(1%) and a low intermediate rate (1%). Most cephalosporins, including Cephazolin, Ceftriaxone, Cefuroxime, and Ceftazidime, displayed high susceptibility which was above 85%, with low intermediate rates ranging from 4% to 6% and minimal resistance. Aminoglycosides such as Gentamicin and Kanamycin also showed strong activity, though Amikacin had a moderate susceptibility rate of 66%, with 6% intermediate and 28% resistance. Ciprofloxacin was very effective in 82% of cases, with 3% intermediate and 15% resistant isolates. Augmentin had 97% susceptibility and showed minimal resistance of 3%. However, high resistance was noted for Levofloxacin with 99%, Ampicillin (92%), and Nitrofurantoin (76%), with Levofloxacin also having a small intermediate rate of 2%. Nalidixic Acid, Cotrimoxazole, and Tetracycline also showed resistance of 66%, 60%, and 53% respectively. Cefepime had mixed results, with 59% susceptibility, no intermediate cases, and 41% resistance. The findings indicated that carbapenems Imipenem and Meropenem remain the most effective treatment options, while Levofloxacin, Ampicillin, and Nitrofurantoin demonstrated significant resistance.

4.4 Prevalence of Antibiotic Resistant *E.coli* isolated from urine sample processed at Pathology Laboratory in 2024.

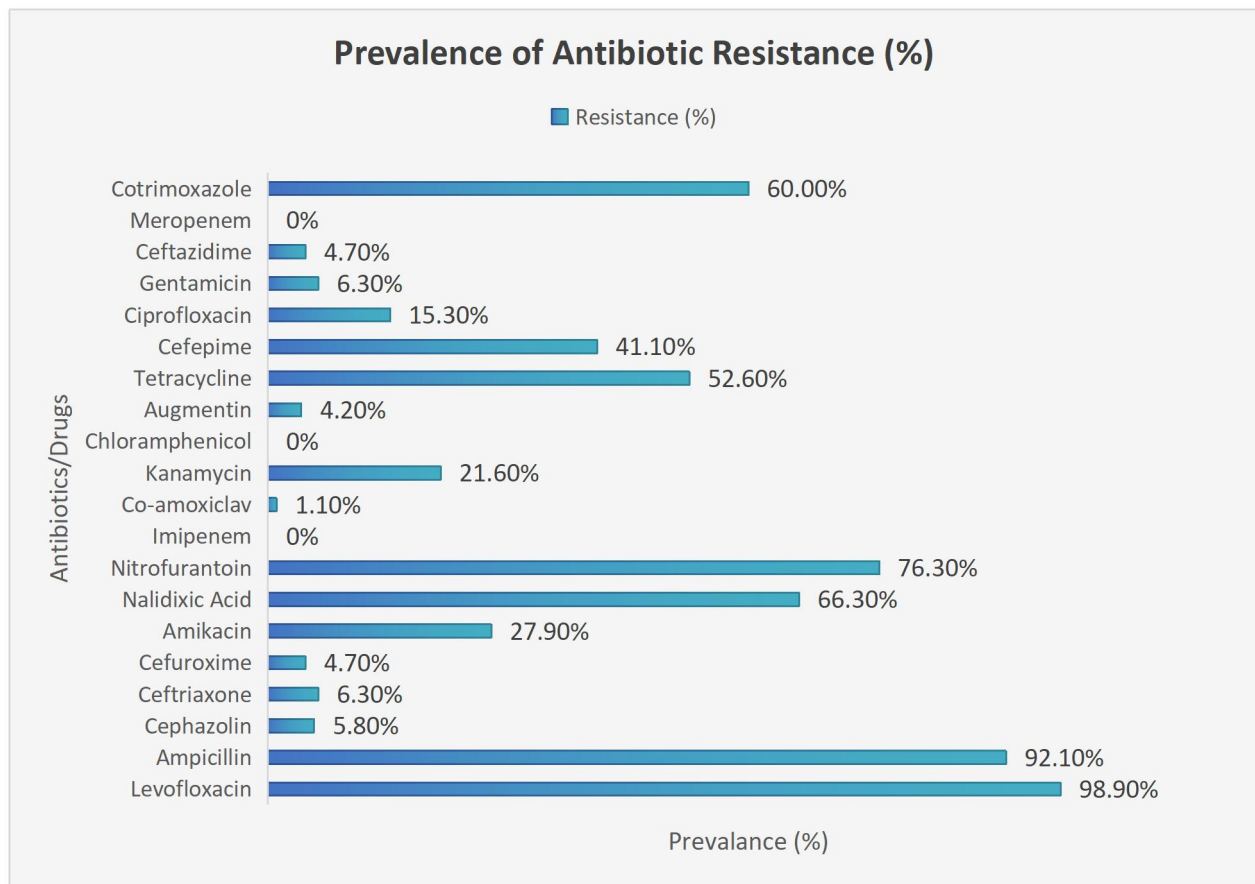


Figure 5: Prevalence of Antibiotic Resistant *E.coli* isolated at Pathology Laboratory in 2024.

Figure 5 shows the prevalence of antimicrobial resistance profile of *E. coli* isolates which varies significantly across different antibiotics. High resistance rates were observed for Levofloxacin (98.9%), Ampicillin (92.1%), Nitrofurantoin (76.3%), Nalidixic Acid (66.3%), and Cotrimoxazole (60.0%), indicating a reduced effectiveness of these antibiotics in treating *E. coli* infections. Tetracycline (52.6%) and Cefepime (41.1%) had moderate resistance, while Amikacin (27.9%) and Kanamycin (21.6%) exhibited lower but still concerning resistance levels. Ciprofloxacin exhibited a resistance rate of 15.3%, and other cephalosporins, such as Cephazolin (5.8%), Ceftriaxone (6.3%), Cefuroxime (4.7%), and Ceftazidime (4.7%), had minimal

resistance, indicating their continued effectiveness. Co-amoxiclav (1.1%) and Augmentin (4.2%) also showed low resistance levels. Imipenem, Meropenem, and Chloramphenicol exhibited 0% resistance, making them the most effective treatment options. Gentamicin also shown a relatively low resistance rate of 6.3%. The absence of resistance in certain antibiotics suggests their sustained efficacy, whereas the high resistance observed in Levofloxacin, Nitrofurantoin, and Ampicillin underscores the necessity for careful antibiotic selection guided by susceptibility testing.

4.4 Chapter Summary

The chapter presented the analysis of *E. coli* isolates from urine samples, focusing on socio-demographic characteristics, antimicrobial susceptibility profiles, and the prevalence of antibiotic resistance. The data, derived from 190 samples, highlighted variations in infection rates by age and gender. The susceptibility testing against 20 antibiotics revealed high resistance to drugs like levofloxacin, ampicillin, nalidixic acid, nitrofurantoin, tetracycline, cefepime, and cotrimoxazole, while imipenem, meropenem, and chloramphenicol showed 100% susceptibility. The results were illustrated using tables and graphs to emphasize the distribution of resistance and susceptibility patterns.

CHAPTER 5: DISCUSSION, CONCLUSION, AND RECOMMENDATION

5.1 Introduction

This chapter discusses the main findings of the study, comparing them with previous research to identify similarities, differences, and emerging trends. The discussion is structured to address the study objectives, highlighting significant findings, potential gaps, and any unexpected observations. Additionally, the implications of these findings on public health are explored, along with the study's limitations, conclusions, and recommendations for future research and policy changes.

5.2 Discussion

5.2.1 Socio demographic characteristics of patients with *E.coli* infections attended at Pathology Laboratory in 2024.

This study analyzed 190 *E. coli* isolates from urine samples and found a significantly higher prevalence of infection among female patients (70.5%) compared to males (29.5%). These findings are consistent with those of Naqid et al. (2020) done in Algeria, who examined 418 *E. coli* isolates and similarly reported a higher prevalence in females (73.9%) than in males (26.1%).

According to Odongo et al. (2020) from Uganda, this disparity between the two sexes can be attributed to anatomical factors, such as the close proximity of the anus to the warm urethral tube in females. Furthermore, the shorter length of the female urethra reduces the distance bacteria must move to reach the bladder, making women more susceptible to urinary UTIs (Nsiande, 2024). Similarly, Shanthi & Kayathri (2012) supported this explanation, stating that the anatomical structure of the female urogenital tract plays a key role in bacterial contamination from both internal and external flora. Additionally, factors such as poor hygiene, inadequate resources, and low socioeconomic status can exacerbate the risk of UTIs (Odongo et al., 2020).

Alterations in the vaginal micro-flora also play a crucial role in promoting the colonization of coliform bacteria (*E.coli*), which is strongly associated with UTIs.

In the present study, the highest prevalence of *E. coli* infections was observed in women aged 31–40 years, followed by those aged 61 years and older. This finding is somewhat in line with the study conducted by Tanzina et al. (2020) in Tunisia, which identified individuals aged 31–45 as the most vulnerable group for *E. coli*-induced UTIs. Similarly, a research by Nas et al. (2019) done in Nigeria highlighted that elderly patients between 41 and 70 years were the most affected age group, which aligns with the findings of the current study. *E. coli* infections maybe more common in older adults due to functional impairments and the use of urinary catheters (Rowe & Juthani-Mehta, 2014).

Moreover, Ejrnaes (2011) also reported that UTI incidence is influenced by both gender and age, with females across all age groups being more susceptible. The results of the present study, which found the highest prevalence of *E. coli* infections among women aged 31–40 years, followed by those aged 61 years and older, align with the findings of Ejrnaes (2011) which found out that sexually active women between 20 and 40 years, as well as postmenopausal women over 60, are at the greatest risk for UTIs.

5.2.2 Antimicrobial susceptibility profile of *E.coli* isolated from urine samples processed at Pathology Laboratory in 2024.

In this study, the antibiotic sensitivity pattern was analyzed using the Kirby-Bauer disc diffusion method. The findings revealed that all *E. coli* isolates from urine samples processed at Pathology Laboratory were highly susceptible to Imipenem, Meropenem, and Chloramphenicol (100%), aligning with the study by Naqid et al., (2020), which reported that *E. coli* was highly susceptible to carbapenems (100%). Similarly, Hassan et al., 2023, in Somalia, found that Imipenem was the

most effective antibiotic, with a susceptibility rate of 99.6%, further supporting the present study's results. The study by Wu et al., 2021, also observed that all isolates were susceptible to Meropenem (100%), reinforcing the consistency of carbapenems as highly effective antibiotics against *E. coli*. Daoud et al., 2020 in Tunisia concurred with these findings, stating that ESBL-producing isolates remain highly susceptible to carbapenems. A study by Akinyemi, (2020) also agreed with the present study on the most effective antibiotic for *E. coli* being Chloramphenicol.

The present study also found that Ceftriaxone (93.6%), Ceftazidime (91.5%), and Gentamicin (90%) exhibited moderate efficacy, with high susceptibility rates and low resistance levels.

These findings are somewhat consistent with the study by Munkhdelger et al., (2017) in Somalia that had sensitivity values of above 50% found to Gentamicin (57.4%), Ceftazidime (66.2%), Ceftriaxone (76.4%) and imipenem (98%). In comparison to the present study results, the study by Hegazy et al., (2018) in Egypt reported that Amikacin (77.55%), and Gentamicin (71.43%) were susceptible, but showing resistance in drugs like Cefotaxime, Ceftazidime and Ceftriaxone.

Furthermore, Nas et al. (2019) reported that *E. coli* isolates exhibited high sensitivity to Gentamicin (82%), Ciprofloxacin (75%), and Chloramphenicol (65%). However, in the present study, chloramphenicol demonstrated a 100% susceptibility rate, suggesting an even greater efficacy of this antibiotic in the study population. Additionally, co-amoxiclav showed minimal resistance, with only two isolates exhibiting resistance, indicating its continued reliability as a treatment option.

However, high resistance was observed against Levofloxacin and Ampicillin, with 98.9% and 92.1% resistant isolates, respectively. This trend is consistent with the findings of Hegazy et al., (2018) where *E. coli* isolates demonstrated the highest resistance rates against Ampicillin and

Cefazolin (100%), followed by Nalidixic Acid (91.84%). The present study identified multidrug resistance among *E. coli* isolates, with notable resistance observed against other antibiotics such as Nitrofurantoin, Tetracycline, Cefepime, Kanamycin, Amikacin, and Cotrimoxazole.

The present study's results indicated that carbapenems were the most effective antibiotics against *E. coli*, while ampicillin and levofloxacin exhibited the highest resistance rates. This finding can be attributed to several factors.

Carbapenems are regarded as the gold standard for treating infections caused by highly resistant bacteria, including *E. coli* (Aurilio et al., 2022). Their broad-spectrum activity and resistance to degradation by most β -lactamases, including ESBLs, make them highly effective. In this study, *E. coli* demonstrated 100% susceptibility to carbapenems, which suggests that resistance has not yet emerged in the studied population. However, the widespread use of carbapenems globally has contributed to the development of carbapenem resistance in some regions (Aurilio et al., 2022). To preserve their efficacy, it is crucial to use them judiciously, limiting their use to cases where no alternative treatments are available only.

On the other hand, the high resistance observed with Ampicillin and Levofloxacin is likely due to their frequent and often inappropriate use. Ampicillin, a β -lactam antibiotic, has been widely used for decades, leading to the selection of resistant *E. coli* strains through the production of β -lactamase enzymes (Akinyemi., 2020). Similarly, fluoroquinolones like levofloxacin are commonly prescribed for urinary tract infections, and excessive use has driven the development of fluoroquinolone-resistant *E. coli* strains.

These findings highlight the importance of antimicrobial stewardship to ensure that carbapenems remain effective while minimizing the overuse of antibiotics like Ampicillin and Levofloxacin, which contribute to increasing drug resistance.

5.2.3 Prevalence of Antibiotic-Resistant *E. coli* Isolated from Urine Samples Processed at Pathology Laboratory in 2024

The present study revealed a high prevalence of antibiotic resistance among *E. coli* isolates, with the highest resistance observed against Levofloxacin (98.9%) and Ampicillin (92.1%). These findings align with those of Naqid et al., (2020) who reported an Ampicillin resistance rate of 87.8%, as well as Hegazy et al., (2018) who found a complete (100%) resistance to ampicillin among *E. coli* isolates. The present study results were also consistent with the study conducted in Algeria by Tang et al. (2011), which also reported significantly high Levofloxacin resistance rates ranging from 26.51% to 43.20% over a five-year period. Both studies underscore an alarming trend in fluoroquinolone resistance.

Following Ampicillin and Levofloxacin, the present study also recorded notable resistance to Nitrofurantoin (76.3%) and Nalidixic acid (66.3%), findings that are partly consistent with Akter et al., (2015) who reported a higher resistance rate of 93.48% to Nalidixic Acid. Additionally, while the present study found a significant resistance rate to Nitrofurantoin (76.3%), Hegazy et al., (2018) reported a considerably lower resistance of 21.4%. In contrast, resistance to amikacin was comparable, with both the present study and Hegazy et al., (2018) reporting resistance rates of approximately 22.4% and 22.45%, respectively.

Resistance to Cefepime was also observed in the present study (41.1%), aligning with the findings of Hassan et al., (2023) who reported a slightly higher resistance rate of 51.8%. Similarly, Nas et al., (2019) reported high resistance rates to Ampicillin (85%) and Tetracycline

(75%), findings that partially correspond with the present study, where Tetracycline resistance was recorded at 52.6%.

While the present study found resistance rates of less than 20% for Ceftazidime, Augmentin, Co-amoxiclav, Ceftriaxone, Cefazolin, Gentamicin, and Ciprofloxacin, Wu et al., (2021) reported almost similar results whereby the resistance rates to Ceftazidime, Gentamicin, Ciprofloxacin, and Sulfonamides were 31, 20, 33, and 47%, respectively. Moreover, Nas et al., (2019) observed a high susceptibility of *E. coli* isolates to Ciprofloxacin (75%), which aligns with the findings of the present study, where *E. coli* isolates also demonstrated susceptibility to Ciprofloxacin. However, Daoud et al., (2020) reported that in Turkey, 50% of *E. coli* isolates were resistant to Ciprofloxacin. Their study emphasized the growing concern over fluoroquinolone resistance, a finding that partially aligns with the present study, where an exceptionally high resistance to Levofloxacin (98.9%) was observed which happens to be a fluoroquinolone antibiotic.

Antibiotic resistance among bacteria has become a critical global health issue, with particularly high resistance rates observed in developing countries. Daoud et al., (2020) highlighted concerns regarding the increasing resistance of *E. coli* as a consequence of frequent and inappropriate antibiotic use in empirical therapy. To treat UTIs, empirical antibiotic treatment is often initiated before susceptibility results are available typically requiring at least 48 hours. However, this practice has contributed to the emergence of resistance to several first-line antimicrobial agents. The unregulated sale and smuggling of antibiotics on the streets is a growing concern, as it promotes self-medication, improper dosing, and misuse which are factors that significantly contribute to the development and spread of antimicrobial resistance. Furthermore, the widespread resistance to Ampicillin and fluoroquinolones, along with the rise of multidrug-resistant strains and extended-spectrum beta-lactamase (ESBL)-producing *E. coli*, has become a

major concern worldwide (Daoud et al., 2020). That is why Ampicillin and fluoroquinolones are no longer recommended for the empirical treatment of urinary tract infections (UTIs).

5.3 Implication of findings to public health

This study shows the growing threat of AMR in *E. coli* infections, emphasizing the critical need for updated and current treatment guidelines and frequent antibiotic susceptibility testing. The high resistance rates to routinely used antibiotics, particularly Levofloxacin (98.9%) and Ampicillin (92.1%), highlighted the necessity of antibiotic stewardship programs in controlling the usage and prevention of resistance escalation.

The high rate of *E. coli* infections in females, particularly in the 31-40 and 61+ age groups, necessitates focused interventions such as hygiene promotion, awareness campaigns, and preventive measures. In order to minimize the spread of resistant *E. coli* strains, infection prevention and control (IPC) techniques must be strengthened, as well as resistance patterns to be monitored continuously.

To reduce the impact of AMR and enhance treatment outcomes, a comprehensive approach that incorporates laboratory surveillance, clinical best practices, and public health policy is required.

5.4 Limitations to the study

The study had certain limitations. As a retrospective cross-sectional study of urine microbiology records, it relied on existing data, some of which lacked comprehensive clinical details about the patients. Additionally, the research was limited to Pathology Laboratories records, limiting the generalizability of findings to other healthcare settings. Conducting a prospective study was not feasible due to financial constraints and time limitations considering the pressure which came by just being an undergrad student. Expanding future research to include multiple laboratories and a broader patient population would enhance the robustness and applicability of the findings.

5.5 Conclusion

This study highlighted the high prevalence of *E. coli* infections among female patients who attended Pathology Laboratories in 2024, particularly those aged 31 to 40 and 61 years and older. These findings align with existing literature, which identified gender and age as key risk factors for urinary tract infections (UTIs). Female anatomy, with a shorter urethra and is proximal to the anus, facilitates bacterial entry into the bladder, which is made worse by factors such as poor hygiene and socioeconomic status. The shift in vaginal microflora may also contribute to increased vulnerability by increasing the colonisation of coliforms that led to UTIs.

The study also highlighted concerning patterns of antimicrobial resistance among *E. coli* isolates. While Imipenem, Meropenem, and Chloramphenicol exhibited the highest susceptibility, with no observed resistance, moderate susceptibility was recorded for Ceftriaxone, Ceftazidime, and Gentamicin. *E. coli* isolates demonstrated extremely high resistance to Levofloxacin, Ampicillin, Nitrofurantoin, Nalidixic acid, Cefepime and Tetracycline, emphasizing the significant variation in resistance patterns. These findings underscore the persistent challenge of multidrug resistance (MDR) in *E. coli*, which remains a major public health concern due to its association with prolonged hospital stays, increased healthcare costs, and treatment failures.

The significant frequency of MDR *E. coli* necessitates prompt action to combat the growing threat of antibiotic resistance. Routine monitoring of resistance patterns is critical for guiding empirical therapy and building effective antimicrobial stewardship plans. To reduce the potential of resistance development, antibiotic use must be closely monitored and controlled. Laboratory facilities should implement rapid diagnostic techniques to aid in the early detection of bacterial infections and ensure timely and appropriate treatment, reducing reliance on empirical treatment.

Furthermore, a conservative approach to antibiotic use should be taken, with certain antibiotics reserved as last-line therapies to combat growing resistance.

To reduce the transmission of resistant *E. coli* strains, infection prevention and control (IPC) procedures must be reinforced in clinical settings. Improving hygiene education, especially among high-risk populations, is also critical for lowering UTI incidence. Furthermore, ongoing surveillance and periodic updates on resistance patterns will provide critical data for guiding regional antibiotic guidelines and policy changes.

These methods, if effectively adopted, will help to enhance patient outcomes while still preserving antibiotic efficacy in UTI care.

5.6 Recommendations

To combat antimicrobial resistance and improve treatment outcomes, a diversified strategy is essential. Scientists should prioritize rapid detection of bacteria and antibiotic susceptibility testing to ensure definitive therapy and reduce reliance on empirical therapies. Implementing strict antibiotic stewardship programs in healthcare facilities can help regulate antibiotic use and preserve their efficacy whereby the aim is on taking good care of our antibiotics. Continuous and updated surveillance of resistance patterns is crucial for informing treatment guidelines and public health policies. Strengthening infection prevention and control (IPC) measures, such as proper sanitation and hand hygiene, can help curb the spread of resistant *E. coli* strains, thus getting rid of the cause. Additionally, raising awareness among clinicians, laboratory scientists, pharmacists, nurses and the public about responsible antibiotic use, the risks of self-medication and self-prescriptions, and the importance of adherence to prescribed treatments is vital. Lastly, a conservative approach to antibiotic use should be adopted, whereby we reserve certain antibiotics for cases where resistance to first-line treatments is detected. Resolving these

challenges through laboratory-based surveillance, antibiotic stewardship, and public health interventions will improve patient outcomes and contribute to the global fight against antimicrobial resistance.

5.7 Dissemination of Results

The Pathology Laboratory Manager received a copy of the research findings to help guide laboratory practices and antimicrobial stewardship activities. Another copy was sent to Africa University's College of Health, Agriculture, and Natural Resources under the Department of Biomedical and Laboratory Science, for academic purposes and future reference. Furthermore, the data may be disseminated through scientific conferences, seminars, or publications to contribute to broader discourse on antimicrobial resistance and *E. coli* infections. By doing this, the findings of this study will actually help as compared to just being stored and kept safe somewhere.

5.8 Chapter Summary

The chapter discussed the findings of the present study aligning then to previous researches. A higher prevalence of *E. coli* infections was observed in females than in males, with the most affected age groups being 31–40 and 61+ years. This study found that carbapenems were the most the effective antibiotics against *E. coli*, with 100% susceptibility, likely due to their stability against β -lactamases. In contrast, Ampicillin and Levofloxacin showed high resistance, likely due to overuse and bacterial adaptation through β -lactamase production and fluoroquinolone target mutations. These findings highlight the need for antimicrobial stewardship to preserve carbapenem efficacy and curb rising resistance. Continuous surveillance and responsible prescribing are essential to maintaining effective treatment options for *E. coli* infections.

References

- Agricola, J., Roza, E. , Nsiande, L., Sued, Y., & Mtebe, M. (2024, May). Bacterial aetiology, antimicrobial susceptibility patterns, and factors associated with urinary tract infection among under-five children at primary health facility, North-Western Tanzania
<https://doi.org/10.1371/journal.pone.0303369>
- Akter T, Fatema K , Nahar S , Shazeed-Ul-Karim , Sultana H , Khan S , Alam S , Afrin A and Hossain M.J. (03, February, 2020). Spectrum of Antimicrobial Susceptibility of *Escherichia coli* Isolated from Urine Samples of a Tertiary Care Hospital of Tunisia.
- Andreia, S., Elisabeth, C., Américo, F., & Adelaide, A. (2022). Revisiting the Frequency and Antimicrobial Resistance Patterns of Bacteria Implicated in Community Urinary Tract Infections (mdpi.com)
- Antonia, I.L., Enrico, M., Vittorio, G., Loredana, D., Roberto, M., Paolo, R., & Clementina, E .C. Gender and age-dependent etiology of community-acquired urinary tract infections 10.1100/2012/349597
- Anupama, S., & Sagar, A. (2022, January). Citrate Utilization Test- Principle, Procedure, Results, Uses. Reviewed from <https://microbenotes.com/citrate-utilization-test-principle-procedure-and-result-interpretation/>

Aryal., & Sagar. (2022, January). CLED Agar- Composition, Principle, Preparation, Results, Uses. Reviewed from <https://microbenotes.com/cystine-lactose-electrolyte-deficient-cled-agar/>

Ait-Mimoune. N., Hassaine. H., & Boulanoir. M. (2022). Bacteriological profile of urinary tract infections and antibiotic susceptibility of *Escherichia coli* in Algeria.

Benkova.M., Soukup.O., & Marek.J. (2020) Antimicrobial susceptibility testing: currently used methods and devices and the near future in clinical practice. Reviewed from <https://onlinelibrary.wiley.com/doi/abs/10.1111/jam.14704>

CDC. (2024). Risk and *E. coli* Infection Reviewed from <https://www.cdc.gov/ecoli/risk-factors/index.html>

Daoud. N., Hamdoun. M., Hannachi.H., Gharsallah. C., Mallekh.W., & Bahri.O. (2020). Antimicrobial Susceptibility Patterns of *Escherichia coli* among Tunisia Outpatients with Community-Acquired Urinary Tract Infection (2012–2018)

Ejrnæs. K. (2010). Bacterial Characteristics of Importance for Recurrent Urinary Tract Infections Caused by *Escherichia coli*.

Eulambius, M., Juma, A.M., Raphael, Z. S., & Kennedy, D.M. (2023). Prevalence of urinary tract infection and antimicrobial resistance patterns of uropathogens with biofilm

forming capacity among outpatients in morogoro, Tanzania: a cross-sectional study.

Reviewed from <https://doi.org/10.1186/s12879-023-08641-x>

Flores-Mireles, A. L., Walker, J. N., Caparon, M., & Hultgren, S. J. (2015). Urinary tract infections: epidemiology, mechanisms of infection and treatment options. *Nature Reviews Microbiology*, 13(5), 269-284.

Foxman, B. (2014). Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. *Infectious Disease Clinics of North America*, 28(1), 1-13. <https://doi.org/10.1016/j.idc.2013.09.003>

Hassan. S. A., Ahmed. Y. M. A., and Hassan. G. D. (2023). Antimicrobial susceptibility of *Escherichia coli* isolated from diabetic patients in Mogadishu, Somalia. 10.3389/fmicb.2023.1204052.

Hegazy.E.E., Rasha Abd El-Hamid Alam El-Din., Amin.A.M., Mahgoub.F.M., & Samir Abd El-Hakeem El-Gamal. (2022). Microbiological Profile of Urinary Tract Infections with special Reference to Antibiotic Susceptibility Pattern of *Escherichia coli* Isolates. <https://doi.org/10.20546/ijcmas.2018.702.115>.

Gupta, K., Bhadelia, N., & Bonomo, R.A. (2017). The rising threat of multidrug-resistant Gram-negative infections in U.S. hospitals. *Annals of Internal Medicine*, 166(9), 648-656.

Kibret., & Abera. Antimicrobial susceptibility patterns of *E. coli* from clinical sources in northeast Ethiopia - PMC (nih.gov)

Mancuso, G., Midiri, A., Gerace, E., Marra, M., Zummo, S., & Biondo, C. (2023). Urinary Tract Infections: The Current Scenario and Future Prospects. *Pathogens* (Basel, Switzerland), 12(4), 623. <https://doi.org/10.3390/pathogens12040623>

Nas. F.S., Ali. M., Abdallah. S.M., & Zage. U.A. (May, 2019). Prevalence and Antibiotic Susceptibility Pattern of *Escherichia Coli* Isolated from Urine Samples of Urinary Tract Infection Patients.

Naqid. I. A., Balatay. A.A., Hussein. N. R., Saeed. K.A., Ahmed. H.A., and Yousif. S.H. (2020). Antibiotic Susceptibility Pattern of *Escherichia coli* Isolated from Various Clinical Samples in Blida City, Northern Region of Algeria.

Odongo. I., Ssemambo. R., & Kungu. J.M. (2020). Prevalence of *Escherichia Coli* and Its Antimicrobial Susceptibility Profiles among Patients with UTI at Mulago Hospital, Kampala, Uganda. <https://doi.org/10.1155/2020/8042540>.

Rowe, T. A., & Juthani-Mehta, M. (2014). Urinary tract infection in older adults. *Aging Health*, 9(5), 519-528. <https://doi.org/10.2217/ahe.13.38>

- Sudheendra, R.K., Basavaraj, V. P., & Kumar, S.S. (2017, Jul-Dec). Isolation and Antibiotic Susceptibility Pattern of *Escherichia coli* from Urinary Tract Infections in a Tertiary Care Hospital of North Eastern Karnataka - PMC (nih.gov)
- Simoni, A., Schwartz, L., Junquera, G.Y., Ching, C., & Spencer, J.D. (2024). Current and emerging strategies to curb antibiotic-resistant urinary tract infections. Reviewed from <https://www.nature.com/articles/s41585-024-00877-9>
- Trafimovich Y, (2024). Why Females Are More Susceptible To Urinary Tract Infections: Understanding The Gender Disparity. [Why Females Are More Susceptible To Urinary Tract Infections: Understanding The Gender Disparity | MedShun](#)
- Yang., Hui, C., Yue, Z., Sifeng, Q., Hao, W., & Fan, Y. (2022). Disease burden and long-term trends of urinary tract infections: A worldwide report Xiaorong. Reviewed from <https://www.frontiersin.org/journals/public-health/articles/10.3389/fpubh.2022.888205/full>
- Zeng, Z., Zhan, J., Zhang, K., Chen, H., & Cheng, S. (2022). Global, regional, and national burden of urinary tract infections from 1990 to 2019. Reviewed from

Appendices

Appendix 1: AUREC Approval Letter.



AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 Website: www.africau.edu

Ref: AU 3532/24

28 November 2024

BLISS RUMBIDZAI DHAURE

C/O Africa University

Box 1320

MUTARE

RE: **ANTIMICROBIAL SUSCEPTIBILITY PROFILES OF ESCHERICHIA COLI ISOLATED FROM URINE SAMPLES PROCESSED AT PATHOLOGY LABORATORIES IN 2024**

Thank you for the above-titled proposal you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal

- **APPROVAL NUMBER** AUREC 3532/24
This number should be used on all correspondences, consent forms, and appropriate document
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** November 28, 2024
- **EXPIRATION DATE** November 28, 2025
- **TYPE OF MEETING:** Expedited
After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.



Yours Faithfully

MARY CHINZOU

ASSISTANT RESEARCH OFFICER: FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE

Appendix 2: Study Site Approval Letter.



Appendix 3: Budget

ITEMS	UNIT COST \$	QUANTITY	TOTAL COST (US\$)
Transport	10	5	50
Stationery	0.50	6	3
Printing and Binding Services	0.1	50	5
Internet (Data)	13	2	26
Aurec Fees	15	1	15
Unforeseen Expenses	30	1	30
Total	68.6	65	129

Appendix 4: Gantt Chart

ACTIVITY	PERIOD				
	Aug 2024 – Nov 2024	Dec 2024 – Jan 2024	Feb 2025	Mar 2025	Apr 2025
Preparation and submission of proposal to AUREC					
Data collection					
Data processing and analysis					
Final project writing					
Project submission to Africa University					