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ANTIBIOTIC RESISTANCE PATTERNS OF BACTERIAL ISOLATES IN
URINE SAMPLES OF PAEDIATRIC PATIENTS COLLECTED AT
DIAGNOSTIC LABORATORY SERVICES IN BULAWAYO 2019-2023: A
TREND ANALYSIS.

BY

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Abstract

Antibiotic resistance represents a significant global health challenge, particularly in managing urinary tract infections (UTIs) among children, where the emergence of resistant strains complicates treatment and increases the risk of adverse outcomes. This study investigates the antibiotic resistance patterns of bacterial isolates from urine samples of paediatric patients at Diagnostic Laboratory Services in Bulawayo, spanning the years 2019 to 2023. A retrospective analysis was conducted, utilizing data collected from urine cultures to evaluate temporal trends in antibiotic susceptibility and resistance. A total of 120 paediatric patients were included in the study, with an emphasis on demographic factors such as age and gender that may influence resistance patterns. Results indicated a high prevalence of UTIs, particularly in the 0 to 3 years age group, which accounted for 40% of total cases. The dominant pathogen identified was *E. coli*, isolated in approximately 29.2% of samples, followed by *Klebsiella spp.* at 25.8%. Notably, antibiotic resistance patterns revealed significant fluctuations over the study period. Imipenem consistently exhibited 0% resistance, while resistance to ciprofloxacin decreased markedly from 42.9% in 2019 to 10% in 2023. Similarly, nitrofurantoin resistance decreased from 26.3% to 0%, reflecting improved susceptibility rates. Conversely, cotrimoxazole and ceftriaxone showed concerning resistance trends, with ceftriaxone resistance peaking at 100% in 2022. The analysis highlighted the presence of multidrug-resistant organisms, indicating a growing challenge in effectively treating paediatric UTIs. Factors such as male uncircumcision and a history of previous UTIs were identified as significant risk factors. These findings underscore the necessity for continuous surveillance of antibiotic resistance trends to inform treatment decisions and guide clinical practice. In conclusion, this study provides critical insights into the changing landscape of antibiotic resistance in paediatric UTIs, emphasizing the need for robust antibiotic stewardship programs and targeted educational initiatives for healthcare providers. Future research should focus on understanding the underlying mechanisms driving antibiotic resistance and the development of effective prevention strategies.

Key words: AMR, paediatrics, prevalence

Declaration

I, Matthew Ndlovu, student number 210605 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.

Matthew Mpofana Ndlovu



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Student's Signature (02/04/2025)

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Acronyms and Abbreviations

UTI – Urinary Tract Infection

DLS – Diagnostic Laboratory Services

AMR – Anti Microbial Resistance

MDR – Multi Drug Resistant

ESBL - extended-spectrum beta-lactamase

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CHAPTER ONE : INTRODUCTION

1.0 Introduction

This study seeks to examine and analyse the antibiotic resistance pattern of bacterial isolates in urine of paediatric patients, specifically uropathogens, at Diagnostic Laboratory Services recorded during the January 2019 to December 2023 period. This chapter provides an overview of the study and its background as well as the clear definition of the problem statement. The purpose of the study and objectives will be stated, the research questions formulated and the significance of the study will be highlighted.

1.1 Background to the study

Antibiotics are medicines used to treat bacterial infections. Antibiotic resistance is whereby the bacteria change in response to said medicines. Antibiotic resistance has become a major public health concern where urinary tract infections (UTIs) are one of the most common bacterial infections. UTIs in children are typically caused by a variety of bacterial pathogens, including *Escherichia coli*, *Klebsiella pneumoniae*, and *Proteus* species, among others. This leads to one of the most common causes of antibiotic use in paediatric patients, which is a significant public health problem and burden (Esmat et al., 2025). However, the emergence of antibiotic-resistant bacterial strains has complicated the management of UTIs, leading to prolonged illness, increased healthcare costs, and a higher risk of complications.

In recent years, the prevalence of antibiotic-resistant bacteria in urine samples from paediatric patients has been increasing, raising significant concerns regarding the efficacy of standard empirical treatments. According to Golli et al. (2024); “AMR raises great concern in the case of the pediatric population due to limited treatment options for MDR pediatric infections,”

Resistance is to commonly used antibiotics such as carbapenems such as meropenem, third-generation cephalosporins, aminoglycosides such as gentamicin and amikacin, fluoroquinolones such as ciprofloxacin and co-trimoxazole as reported in WHO GLASS report for 2022 (WHO, 2022). This rise in resistance is attributed to multiple factors, including overuse and misuse of antibiotics, lack of appropriate diagnostic measures, and poor infection control practices (WHO, 2022). The patterns of antibiotic resistance in urinary tract pathogens in paediatric populations are dynamic and can vary geographically, making local surveillance and continuous monitoring crucial to developing effective treatment strategies.

This study aims to investigate the antibiotic resistance patterns of bacterial isolates from urine samples of paediatric patients, with a focus on identifying common resistant organisms and their susceptibility profiles. By examining these patterns, we can provide insights into the evolving landscape of bacterial resistance in paediatric UTIs, inform clinical practices, and contribute to better stewardship of antibiotics in this vulnerable population.

1.2 Statement of the Problem

The rising incidence of antibiotic resistance among clinical bacterial isolates, particularly in paediatric populations, is a major public health problem. There has little research in Bulawayo to address this rising concern. This study aims to help fill in this gap research. In healthcare settings, infections produced by multidrug-resistant bacteria can result in treatment failures, prolonged hospital stays, increased healthcare expenses, and worse patient outcomes. Irusen et al. (2021) identified increasing antibiotic resistance in paediatric urinary tract infections in Cape Town, particularly due to ESBL-producing *Klebsiella pneumoniae* and *Escherichia coli*. Irusen et al. (2021) further found that “21.3% of UTIs were hospital-acquired, and these were more likely to be caused by multi-drug-resistant (MDR) organisms. MDR infections can lead

to longer hospital stays and more aggressive antibiotic treatments.” The study by Irusen et al. (2021) was conducted at a hospital in Cape Town, South Africa, and so it may not fully represent antibiotic resistance trends in other regions in Southern Africa. This study aims to fill in the gaping hole of research in AMR in Bulawayo. Research on pediatric UTIs in Zimbabwe is limited. The available studies primarily focus on adult populations or do not provide age-specific data. For instance, a study conducted in Harare by Mhondoro et al. (2019) examined risk factors for community-acquired UTIs caused by ESBL producing bacteria but did not specify findings related to children. Understanding the antibiotic resistance patterns of bacterial isolates found in urine samples is critical for developing effective antimicrobial therapy and infection control methods.

1.3 Research Objectives

1.3.1 Broad Objective

To assess and analyse the evolving trends in antibiotic resistance patterns among bacterial isolates obtained from urine samples of paediatric patients collected at Diagnostic Laboratory Services over the five-year period from 2019 to 2023.

1.3.2 Specific Objectives

1. To determine temporal trends in antibiotic resistance patterns of bacterial isolates from urine samples of paediatric patients at Diagnostic Laboratory Services over the period 2019 to 2023, using retrospective data analysis to quantify annual resistance rates.
2. To evaluate key demographic and clinical factors (such as age, gender, history of prior UTIs, and comorbidities) associated with changes in antibiotic resistance among paediatric urinary isolates within the 2019–2023 period.

3. To assess the effectiveness of commonly prescribed antibiotics (e.g., ciprofloxacin, nitrofurantoin, imipenem, ceftriaxone) against the most frequently isolated urinary pathogens in paediatric patients at DLS, based on susceptibility profiles from 2019 to 2023.

1.4 Research Questions

- I. What are the prevailing antibiotic resistance patterns among bacterial isolates from urine samples and catheter tips collected at DLS from 2019 to 2023?
- II. Are there any notable shifts or trends in antibiotic resistance over this five-year period?
- III. How do patient-specific factors, including age, gender, and comorbidities, correlate with antibiotic resistance in urinary tract infections?
- IV. Are commonly prescribed antibiotics effective in inhibiting the growth of bacterial pathogens in UTIs of paediatric patients?

1.4.1 Hypothesis

From 2019 through 2023, the antibiotic resistance patterns of bacterial isolates in urine samples collected at DLS will show a considerable rising trend, showing an increase in resistance to routinely administered antibiotics.

1.5 Justification

Antibiotic resistance is a rapidly rising problem on a national and worldwide scale, and understanding the resistance patterns of bacterial isolates is critical for developing successful treatment options, especially in the vulnerable paediatric population. This study will give insight on future trends in antibiotic resistance, allowing Diagnostic Laboratory Services' healthcare personnel to effectively anticipate and handle growing resistance tendencies. The research will also reveal which medications are still effective in treating urinary tract infections, allowing clinicians to make informed treatment decisions for their patients in the coming years.

1.6 Delimitations of the study

The first constraint of the study is that it will only cover the years 2019 to 2023. It will not include data prior to 2019 or after 2023. This time span was chosen to examine patterns over a five-year period. The second constraint is that the study will be limited to Diagnostic Laboratory Services, with no data obtained from other healthcare facilities or places. This restriction ensures that the analysis is focused inside the bounds of a single laboratory. The third constraint of the study is that it will rely on data from Diagnostic Laboratory Services' records and databases. It will not include data from other healthcare institutions or external sources, limiting the analysis to the laboratory's internal data. The fourth constraint is that the research will use a trend analysis methodology, which may include statistical methodologies and historical data. Other research methods, such as experimental studies or qualitative research, will not be considered in this study.

1.7 Summary

The research topic "Antibiotic Resistance Patterns of Bacterial Isolates in Urine Samples of paediatric patients collected at Diagnostic Laboratory Services 2019-2023: A Trend Analysis" examines antibiotic resistance trends among bacterial isolates obtained from urine samples collected and analysed at Diagnostic Laboratory Services from 2019 to 2023. The purpose of this study is to look into the developing patterns of antibiotic resistance in bacteria often identified in urinary tract infections (UTIs). The study will analyse data acquired from clinical samples, such as urine cultures, to discover changes in bacterial resistance to routinely used antibiotics for treatment. The significance of this study stems from the growing concern about antibiotic resistance, which poses a serious threat to public health in paediatric patients. The study aims to provide insights into the effectiveness of present antibiotic treatments, the

emergence of new resistance patterns, and the potential need for changes in clinical practises and antibiotic prescribing procedures by examining resistance patterns across time.

CHAPTER TWO: LITERATURE REVIEW

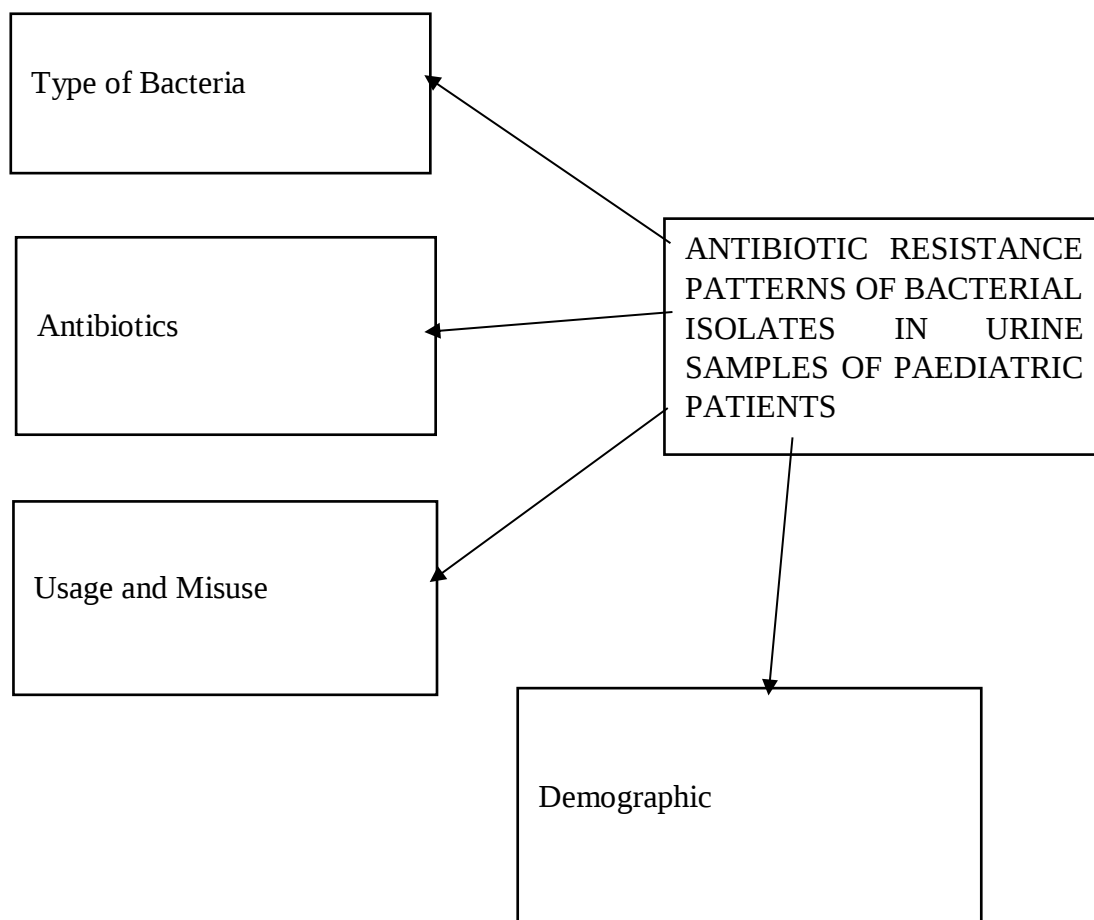
2.0 Introduction

Antibiotic resistance is a global health threat that occurs when bacteria change over time and no longer respond to antibiotics. This makes infections harder to treat and increases the risk of disease spread, severe illness, and death. Golli et al. (2024) state in a study in Romania; *“Around 200,000 of the deaths caused by multidrug-resistant bacteria occur in newborns,”*

As a result of drug resistance, antibiotics and other antimicrobial medicines become ineffective and infections become increasingly difficult or impossible to treat. Studying antibiotic resistance in urine samples of paediatric patients is significant for a number of reasons. The first is to guide empirical treatment of urinary tract infections (UTIs). UTIs are one of the most common infections treated with antibiotics, and antibiotic resistance is a major challenge in the management of these infections. By studying antibiotic resistance in urine samples, clinicians can better understand which antibiotics are most likely to be effective against the bacteria causing the infection. This information can be used to guide empirical treatment, which is the selection of an antibiotic before the results of culture and susceptibility testing are available to identify and track the spread of resistant bacteria. Urine samples are a source of information about the prevalence and distribution of resistant bacteria. This information can be used to track the spread of resistant bacteria over time and to identify areas where there is a high risk of infection with resistant bacteria. The second reason is there is little available data about the impact of AMR and the consequences of infection with multidrug-resistant pathogens on children, as most studies have targeted adults (Golli et al., 2024). If there is more research available on AMR in paediatrics it increases the awareness of medical staff and the population

regarding MDR infections especially among children. The third significance of the study is to develop new strategies for preventing and treating UTIs caused by resistant bacteria. By studying antibiotic resistance in urine samples, researchers can better understand the mechanisms by which bacteria develop resistance and how to develop new strategies for preventing and treating UTIs caused by resistant bacteria which in turn will lead to better patient outcome.

2.1 Conceptual Framework



2.1.1 Type of Bacteria

Studies have consistently reported *Escherichia coli* (*E. coli*) as the dominant uropathogen, exhibiting high resistance rates (>80%) to ampicillin, augmentin, and tetracycline (Fenta et al., 2020). Fluoroquinolones (ciprofloxacin) and cephalosporins (cefoxitin and ceftazidime) often show better susceptibility (Fenta et al., 2020), as well as carbapenems (imipenem and meropenem), (Golli et al., 2024). In a study by Duicu et al. (2021), it is indicated that the most common bacteria that was found in children in Central Romania was *E. coli* (72.2%) and *Klebsiella spp.* (8.15%). The frequency of infection by these pathogens, the researchers found, was similar to studies carried out in Nepal and Turkey. In another study by Esmat et al. (2025) in Afghanistan, the most common bacteria isolated were *E. coli* (65%) and *Klebsiella spp.* (12.5%) coinciding with the findings in Romania. These studies show the current epidemiological status and antibiotic resistance profiles of UTIs in Europe, Asia and Africa. The prevalence of UTIs is discussed, the most common uropathogens looked at and the resistance of these pathogens to commonly used antibiotics. All four studies point to *E. coli* as being the most common uropathogen affecting paediatrics. *Klebsiella spp.* is mentioned as being the second followed by occurrences of *Proteus spp.*, *S. aureus* and *Pseudomonas spp.* Focusing on the article by Duicu et al. (2021), the conceptual framework revolves around understanding the AMR patterns of uropathogens. The authors' aim is to identify the prevalence and resistance patterns of uropathogens causing UTIs in paediatrics and evaluate the association between urinary tract abnormalities and the occurrence of MDR uropathogens. Another aim is to assess the effectiveness of common antibiotics in treating the UTIs in paediatrics. The authors also aim to highlight the importance of ongoing monitoring of local antimicrobial sensitivities so as to maintain appropriate treatment strategies.

2.1.2 Antibiotics

Duicu et al. (2021) paper found the antibiotic resistance of bacteria causing urinary tract infections (UTIs) in Central Romania. It discusses the bacteria isolated from urine samples and their resistance to different antibiotics. The researchers found that *E. coli*, *Klebsiella*, *Pseudomonas spp* and *Proteus spp* were the most common bacteria causing UTIs. These bacteria were also the most resistant to antibiotics, with ampicillin (56.48% when used to treat *E. coli*), amoxicillin (33.05% when used to treat *E. coli*) and trimethoprim (24.68% when used to treat *E. coli*) being the least effective antibiotics. The most effective antibiotics used to treat UTIs were meropenem and ceftriaxone. Esmat et al. (2025) find in research, in Afghanistan, that *E. coli* (65%) and *Klebsiella spp* (12.5%) were the most common uropathogens causing UTIs. They were the most resistant to antibiotics, with cefazidime (98% when used to treat *E. coli*), ampicillin and amoxicillin (94% each when used to treat *E. coli* and *Klebsiella spp*) and ceftriaxone (82% when used to treat *E. coli*). In this study, *E. coli* was highly sensitive to nitrofurantoin, fosfomycin, piperacillin/tazobactam and imipenem. Fenta et al. (2020) paper in Ethiopia found that *E. coli* (63.6%) was the most frequently isolated bacteria followed by *Klebsiella spp* (15.9%). The researchers found that ampicillin (100%) followed by augmentin (88.6%) and tetracycline (81.8%) were the antibiotics with the most resistance. Zimbabwe mirrors global trends in *E. coli* resistance to ampicillin, amoxicillin, and tetracycline. Fluoroquinolone resistance is also rising, though potentially less pronounced than in some regions.

2.1.3 Usage and Misuse of antibiotics

The emergence and spread of antibiotic-resistant bacteria pose a significant threat to global health, particularly in the context of urinary tract infections (UTIs). Inappropriate antibiotic prescribing further exacerbate this challenge. This review delves into the link between antibiotic misuse and resistance patterns observed in bacterial isolates from urine samples highlighting relevant research and identifying gaps in knowledge. Several factors contribute to antibiotic misuse in UTIs such as overprescribing. Clinicians often prescribe antibiotics empirically due to diagnostic uncertainties, patient pressure, or fear of complications. Lagarde and Blaauw (2023) investigate the concerning issue of unnecessary antibiotic use in South Africa's primary care settings. The authors employed a standardized patient approach to compare prescribing practices across both public and private sectors. Their findings revealed alarmingly high rates of inappropriate antibiotic prescriptions in both sectors, with the private sector prescribing more antibiotics with a higher resistance risk. The study delves into the potential causes behind this overprescribing phenomenon. In the public sector, the authors attribute it partly to nurses' misconstrued beliefs regarding antibiotic efficacy. In contrast, private sector doctors might be influenced by decision fatigue or succumb to patient expectations, potentially leading to unwarranted antibiotic prescriptions. The authors of this study draw on previous research to frame their investigation of antibiotic overprescribing in South Africa. They note that antibiotic resistance is a growing problem worldwide, and that South Africa has some of the highest rates. They point out that most antibiotics are prescribed in primary care, often for viral infections for which they are ineffective. While past studies have identified factors such as patient demand and provider incentives as potential drivers of overprescribing, the authors note that these factors do not fully explain the phenomenon. They also argue that inadequate quality of care and provider beliefs about patient expectations may play a role. The research gaps identified in this study are; A lack of understanding of why antibiotic overprescribing is so common in South Africa, given that past explanations like

patient demand and provider incentives do not seem to fully account for it. A lack of research comparing antibiotic prescribing practices in the public and private sectors in South Africa.

2.1.4 Demographic Factors

Duicu et al. (2021) state; *“With respect to sex distribution, urine samples were processed from 147 boys and 184 girls (44.41/55.59%). The sex ratio was 1:1.25, high lighting that UTIs are a more frequent pathology in girls.”* More than a third of isolates (n=115, 34.74%) were from patients younger than 1 year. (Duicu et al., 2021). In the study it was also found that 42.29% of cases of UTIs were due to comorbidities such urinary tract abnormalities. UTIs are more frequent in females due to anatomical factors. Esmat et al. (2025) paper states that of the patients included 64% were female and most of the isolates were from patients younger than 1 year of age. This supports that UTIs are more common in females.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

The focus of the study was to determine the prevailing antibiotic resistance patterns among bacterial isolates from urine samples of paediatrics collected at DLS from 2019 to 2023 and to see if there were any notable shifts in the resistance patterns in the data to be collected. This methodology chapter looked at the research philosophy, type and strategy that was taken with reference to time horizon. Sampling strategy and data collection methods was also discussed.

3.1 Research Design

3.1.1 Research Philosophy

The research philosophy guiding this study on antibiotic resistance patterns of bacterial isolates was positivism. This philosophy aligned well with the aim of the research, which was to objectively and accurately quantify the antibiotic resistance patterns of bacteria found in these samples. The research involved identifying bacterial isolates and their resistance levels through already conducted laboratory tests. These tests generated quantifiable data, aligning with positivism's emphasis on empirical evidence. The research findings were used to create general conclusions about antibiotic resistance patterns in urinary tract infections, informing treatment protocols on a broader scale. This aligned with positivism's goal of establishing generalizable knowledge.

3.1.2 Research Type

The research type was deductive. Deductive research is a type of research that uses a general principle or theory to make specific predictions about the outcome of a study. In this case, the general principle was that antibiotic resistance is a common problem in healthcare settings, and

the specific prediction was that bacteria isolated from urine samples of paediatric patients were going to be resistant to a variety of antibiotics. Deductive reasoning helped to develop hypotheses about why certain bacteria were more resistant to antibiotics than others.

3.1.3 Research Strategy

A retrospective case study was an appropriate research strategy for this topic because it allowed the analysis of existing data to investigate patterns and trends in antibiotic resistance among bacterial isolates from urine samples of paediatric patients collected at DLS from 2019 to 2023. This type of study was particularly useful because it was impractical due to time constraints to conduct a prospective study, which would have required collecting new data from patients. There were also little ethical issues to be concerned with due to the fact that there is no interaction with any patient. DLS maintained records of urine samples collected from patients, including bacterial isolate identification and antibiotic susceptibility testing results. This existing data was to be used to assess antibiotic resistance patterns over time. A retrospective case study does not require any intervention or interaction with patients, making it a non-invasive and ethical research approach. The five-year timeframe (2019-2023) will allow the examination of potential shifts or trends in antibiotic resistance over time, providing valuable insights into the changing dynamics of antibiotic resistance in DLS.

3.1.4 Time Horizon

A cross-sectional study design was the most appropriate approach for investigating the antibiotic resistance patterns of bacterial isolates in urine samples collected at DLS from 2019 to 2023, and the research questions posed. The research questions primarily focused on understanding the prevailing antibiotic resistance patterns at a specific point in time (2019 to

2023) and identifying any changes in these patterns over the five-year period. A cross-sectional study effectively captured this snapshot of antibiotic resistance trends without the need for prolonged follow-up of individual participants. While a longitudinal study design could theoretically fulfil this aspect, it would require extended follow-up of individual participants over multiple years. A cross-sectional study can effectively address this temporal aspect by comparing data from different points in time (2019, 2020, 2021, 2022 and 2023), providing insights into trends in antibiotic resistance over the five-year period.

3.1.6 Sampling Strategy

A minimum sample size of 120 patients was required to provide sufficient statistical power to detect meaningful differences in antibiotic resistance patterns. The sample size can be calculated using a power analysis software or formula. Stratified random sampling was used to ensure that the sample is representative of the target population in terms of age, gender, and comorbidities. Patients were stratified by year (2019, 2020, 2021, 2022, and 2023), age (0-3, 4-7, 8-12), gender, and comorbidities, if there were any. Within each stratum, patients were randomly selected.

3.1.7 Data Collection Method

The data for this study was collected retrospectively from the records of patients at DLS who underwent urine cultures from 2019 to 2023. The following data was collected for each patient:

Patient demographics: Age, gender, race/ethnicity, comorbidities (e.g., diabetes, hypertension, immunosuppression)

Urine culture results: Date of culture, bacterial species isolated, antibiotic susceptibility patterns

3.1.8 Data Validation

Data validation involved multiple steps to ensure that laboratory records are accurate and errors are minimized. These steps included

1. Random sampling audits where a subset of the data was randomly selected and manually verified against the original records to ensure that the electronic database accurately reflected the source information.
2. Error logging and correction where any errors, if present, were documented and corrected and tracked to prevent future occurrences.

3.1.9 Data Analysis

The data analysis plan included descriptive analysis where the prevalence of different bacterial isolates from urine samples of paediatric patients was calculated. The resistance rates for various antibiotics among the identified bacterial isolates were determined. The distribution of resistance patterns across different years was then assessed.

Trend analysis was next where the changes in antibiotic resistance rates over time was analysed using descriptive statistics. Missing or incomplete data was managed using a two-part approach. First, records lacking critical information—such as bacterial identification or antibiotic susceptibility results—were excluded from the analysis as per the study's exclusion criteria. This deletion ensured that only complete, reliable records contributed to the findings.

Secondly, for non-critical variables (for example, missing demographic details like age or gender), imputation methods were employed. In such cases, simple imputation methods (e.g., replacing missing values with the mean or median for continuous data, or the mode for categorical data) were applied. If the extent of missing data is higher or if there was concern about bias, more sophisticated approaches like multiple imputation were considered. Additionally, the pattern of missing data was evaluated (i.e., assessing whether data are missing completely at random, at random, or not at random) to inform the appropriate imputation technique. Sensitivity analyses were then conducted to determine how these imputation choices impact the final results.

Expected Outcomes:

Characterization of the prevailing antibiotic resistance patterns among bacterial isolates from urine samples of paediatric patients at DLS

Identification of notable trends or shifts in antibiotic resistance over the five-year period

3.2 Inclusion Criteria

Bacterial isolates - from urine samples collected at DLS from 2019 to 2023

Patient population - Patients with urinary tract infections (UTI)

Age - Patients less than 12 years

Gender - Patients of both genders

3.3 Exclusion Criteria

Patient location	Patients not treated at DLS
Patient diagnosis	Patients without UTI
Age	Patients over 12 years of age
Incomplete records	Any record that lacked critical data necessary for analysis (e.g. laboratory results such as bacterial identification, antibiotic susceptibility profiles)

3.4 Ethical Considerations

Ethical clearance to conduct the study was sought from the Africa University Research Ethics Committee. Permission to review clinical records was received from the Laboratory management at DLS. Patient confidentiality was maintained when handling the data throughout the duration of the study. The study ensured confidentiality by removing direct identifiers from the laboratory records of patients. Instead of using names or other personal details, each record was assigned a unique study ID (the lab number) that cannot be traced back to an individual. In addition, only non-identifiable data—such as age, sex, and laboratory test results (organism type, susceptibility, and resistance patterns)—were used for analysis. All digital data was stored on password-protected, encrypted computer with access restricted solely to authorized research personnel (myself only). Finally, when reporting results, only aggregated data was presented to make sure that no individual patient can be identified. These measures aligned with the ethical guidelines outlined to maintain patient confidentiality throughout the study.

CHAPTER 4: RESULTS AND DATA ANALYSIS

4.0 Chapter Synopsis

This chapter contains the results of the study. The data is presented in the form of tables and is accompanied by brief descriptions of the particular set of information presented. The data is presented as absolute values and as percentages where appropriate.

4.1 Demographic Characteristics of Patients

A total of 120 patients were chosen who were affected by UTIs and sought treatment at DLS. Of these, 62 were male and 58 were female. The males in this study were at a slightly higher percentage with 51.7% whilst the females were 48.3% of the total participants chosen using a random sampling method. According to this data, more males (young boys) were affected by UTIs than females (young girls) treated at DLS.

4.2 Prevalence of UTI stratified by age

Looking at the cumulative prevalence of UTI over the five years, the age group from 0 to 3 years had a total of 48 positive cultures of patients from 2019-2023 which recorded a UTI of 40% of the total cases. The 4-7 years age group had a total of 45 positive cultures of patients from 2019-2023 which recorded UTI of 37.5% of the total cases. The final age group of 8-12 years had a total of 27 positive cultures of patients from 2019-2023 which recorded a UTI of 22.5% of the total cases. The stratified prevalence of UTI for each of the five years, in 2019 the age group from 0 to 3 years had 9 positive cultures which recorded a UTI of 30% of the cases that year. The 4-7 years age group had 12 positive cases which recorded a UTI of 40% for the year of 2019. The 8-12 years age group has 9 positive cases which recorded 30% of the UTI that year. In 2020, the age group from 0 to 3 years had 10 positive cultures which recorded

a UTI of 37% of the cases that year. The 4-7 years age group had 8 positive cases which recorded a UTI of 30% for the year of 2020. The 8-12 years age group has 9 positive cases which recorded 33% of the UTI that year. In 2021, the age group from 0 to 3 years had 9 positive cultures which recorded a UTI of 53% of the cases that year. The 4-7 years age group had 4 positive cases which recorded a UTI of 23.5% for the year of 2021. The 8-12 years age group has 4 positive cases which recorded 23.5% of the UTI that year. In 2022, the age group from 0 to 3 years had 9 positive cultures which recorded a UTI of 41% of the cases that year. The 4-7 years age group had 10 positive cases which recorded a UTI of 45% for the year of 2022. The 8-12 years age group has 3 positive cases which recorded 14% of the UTI that year. In 2023, the age group from 0 to 3 years had 11 positive cultures which recorded a UTI of 46% of the cases that year. The 4-7 years age group had 11 positive cases which recorded a UTI of 46% for the year of 2023. The 8-12 years age group has 2 positive cases which recorded 8% of the UTI that year. (Table 1)

Table 1 Prevalence of UTI stratified by age group (N=120)

Year	Age 0-3	Age 4-7	Age 8-12	Total
2019	9	12	9	30
2020	10	8	9	27
2021	9	4	4	17
2022	9	10	3	22
2023	11	11	2	24
Total	48	45	27	120

4.3 Isolated pathogens causing UTI

The following pathogens were isolated from urine samples at DLS over the five years from 2019-2023; *E.coli* was the most prevalent bacteria, isolated on 35 cases with a percentage of approximately 29.2%. The second most prevalent bacteria was *Klebsiella spp* isolated on 31 cases with a percentage of 25.8%. The third most prevalent bacteria was *S.epidermidis* isolated in 18 cases with a percentage of 15%.

Table 2 Isolated pathogens causing UTI (N=120)

Isolated Pathogen	Cases	Percentage
<i>E.coli</i>	35	29.2
<i>Klebsiella sp.</i>	31	25.8
<i>S.epidermidis</i>	18	15
<i>S.saprophyticus</i>	16	13.3
<i>Pseudomonas sp.</i>	5	4.2
Non-haemolytic <i>Streptococcus</i>	5	4.2
<i>S.aureus</i>	4	3.3
<i>Micrococcus sp.</i>	1	0.8
Lactose fermenting coliforms	1	0.8
Coagulase negative <i>Staphylococcus</i>	1	0.8
<i>Corynebacterium sp.</i>	1	0.8
<i>Proteus sp.</i>	1	0.8
<i>S.viridans</i>	1	0.8

4.4 Antimicrobial susceptibility and resistance of UTI from 2019-2023

Table 3 Antimicrobial susceptibility and resistance of UTI from 2019-2023 (N=120)

Year	Drug:	IMI	CIP	LEV	NI	T	NOR	CFX	COT	CRO	GM	CXM
2019	% Resistance	0	42.9	26.1	26.3	62	38.9	46.7	66.7	53.8	42.1	57.1
2019	%Susceptibility	100	57.1	73.9	73.7	38	61.1	53.3	33.3	46.2	57.9	42.9
2020	% Resistance	0	36.4	33.3	50	64.7	42.9	60	86.7	65	50	81
2020	%Susceptibility	100	63.6	66.7	50	35.3	57.1	40	13.3	35	50	19
2021	% Resistance	0	15.4	18.2	64.3	40	0	83.3	84.6	46.2	0	20
2021	%Susceptibility	100	84.6	81.8	35.7	60	100	16.7	15.4	53.8	100	80
2022	% Resistance	8.3	33.3	25	41.2	57.1	33.3	77.8	100	55.6	37.5	57.1
2022	%Susceptibility	91.7	66.7	75	58.8	42.9	66.7	22.2	0	44.4	62.5	42.9
2023	% Resistance	0	10	20	0	31.6	23.5	37.5	66.7	16.7	22.7	33.3
2023	%Susceptibility	100	90	80	100	68.4	76.5	62.5	33.3	83.3	77.3	66.7

Acronyms: CXM: Cefuroxime, GM: Gentamicin, CRO: Ceftriaxone, COT: Cotrimoxazole, CFX: Cefotaxime, NOR: Norfloxacin, T: Tetracycline, NI: Nitrofurantoin, LEV: Levofloxacin, CIP: Ciprofloxacin, IMI: Imipenem.

Imipenem (IMI) consistently showed 0% resistance. Ciprofloxacin (CIP) showed decreased resistance from 42.9% in 2019 to 10% in 2023, with an increase in susceptibility from 57.1% to 90%. With Levofloxacin (LEV), the resistance decreased from 26.1% in 2019 to 20% in 2023, while susceptibility increased from 73.9% to 80%. Nitrofurantoin (NI), the resistance decreased significantly from 26.3% in 2019 to 0% in 2023, with susceptibility rising from 73.7% to 100%. Tetracycline (T), the resistance decreased from 62% in 2019 to 31.6% in 2023, with susceptibility increasing from 38% to 68.4%. With Norfloxacin (NOR), the resistance decreased from 38.9% to 23.5%, while susceptibility improved from 61.1% to 76.5%. Cefuroxime (CFX) the resistance increased from 46.7% in 2019 to 37.5% in 2023, but susceptibility decreased slightly from 53.3% to 62.5%. Cotrimoxazole (COT) resistance increased significantly from 66.7% in 2019 to 100% in 2022, then showed some improvement

to 66.7% in 2023. Ceftriaxone (CRO) resistance increased sharply to 100% in 2022. Susceptibility dropped to 0% in 2022 and remained low at 33.3% in 2023. Gentamicin (GM) resistance fluctuated, starting at 53.8% in 2019, dropping to 16.7% in 2023, with susceptibility improving from 42.1% to 77.3%. Cefuroxime (CFX) resistance remained relatively high, starting at 57.1% in 2019 and varying between 37.5% and 66.7%. Susceptibility was fairly low.

4.5 Temporal trends in antibiotic resistance from 2019 to 2023

Table 4 Temporal trends in antibiotic resistance from 2019-2023

Year	Drug:	IMI	CIP	LEV	NI	T	NOR	CFX	COT	CRO	GM	CXM
2019	%Resistance	0	42.9	26.1	26.3	62	38.9	46.7	66.7	53.8	42.1	57.1
2020	%Resistance	0	36.4	33.3	50	64.7	42.9	60	86.7	65	50	81
2021	%Resistance	0	15.4	18.2	64.3	40	0	83.3	84.6	46.2	0	20
2022	%Resistance	8.3	33.3	25	41.2	57.1	33.3	77.8	100	55.6	37.5	57.1
2023	%Resistance	0	10	20	0	31.6	23.5	37.5	66.7	16.7	22.7	33.3

Imipenem (IMI) had consistent 0% resistance from 2019 to 2023. Ciprofloxacin (CIP) resistance decreased from 42.9% in 2019 to 10% in 2023. Levofloxacin (LEV) resistance decreased from 26.1% in 2019 to 20% in 2023. Nitrofurantoin (NI) resistance decreased from 26.3% in 2019 to 0% in 2023. Tetracycline (T) resistance decreased from 62% in 2019 to 31.6% in 2023. Norfloxacin (NOR) resistance decreased from 38.9% in 2019 to 23.5% in 2023. Ceftriaxone (CFX) resistance decreased from 46.7% in 2019 to 37.5% in 2023. Cotrimoxazole (COT) resistance increased sharply to 86.7% in 2020, then decreased to 66.7% in 2023. Ceftriaxone (CRO) resistance increased dramatically to 100% in 2022, then decreased to 66.7% in 2023. Gentamicin (GM) resistance fluctuated from 53.8% in 2019 to 16.7% in 2023. Cefuroxime (CXM) resistance remained high, starting at 57.1% in 2019 and varying between 37.5% and 57.1%.

CHAPTER 5: DISCUSSION AND CONCLUSION

5.0 Chapter Synopsis

This chapter discusses the results presented in Chapter 4, elaborating on the reasons for the outcomes noted.

5.1 Demographic Characteristics of Patients

The study indicates that among the patients affected by UTIs and treated at DLS, there is a slight predominance of males (young boys) over females (young girls). The percentages show that males account for 51.7% of the total participants, while females make up 48.3%. This data suggests that, in this specific study, young boys were affected by UTIs at a marginally higher rate than young girls. The research by Fenta et al. (2020) finds that boys are more susceptible to UTIs during the first year of life, especially in uncircumcised infants, who have a significantly higher risk. The findings of this study at DLS are backed as well by the findings of Irusen et al. (2021) which state that while the overall prevalence of UTIs tends to be higher in females, it notes that certain age groups, particularly younger males, exhibit higher rates of UTI, particularly in infancy.

5.2 Prevalence of UTI stratified by age

The data indicates that the age group of 0 to 3 years consistently shows a higher prevalence of UTIs compared to older age groups, particularly with a peak prevalence of 53% in 2021. The 4 to 7 years age group has also shown significant prevalence, but not as high as the youngest group. The 8 to 12 years age group has the lowest prevalence throughout the years, indicating that younger children, especially those under 3 years, are more affected by UTIs. This data is

backed by other studies, namely Esmat et al. (2025) state; “*The high percentage of UTIs in the female and younger age groups (<1 year) in our study is similar to the results of other studies, which also found a high percentage of UTIs among young children aged from 4 days to 2 years in the female patient group.*”

Although this study finds that the young female patient group suffers from UTIs more it does state that infants less than 1 year old are likely to be more affected by UTIs which is in line with this study conducted at DLS that finds infants in the 0 to 3 years age group to be more likely to suffer from UTIs. Irusen et al. (2021) also find that children less than 5 years were at a higher risk of suffering from a UTI.

5.3 Isolated pathogens causing UTI

E.coli was the most isolated pathogen from paediatric urine samples in the five years at DLS with a percentage of 29.2%. This finding is consistent with other studies that also found *E.coli* as the most isolated organism. The study by Irusen et al. (2021) reported that *E. coli* accounted for 50.7% of the cultured organisms. Esmat et al. (2025) identified *E.coli* as the most common pathogen with 65% of the isolates. Golli et al. (2024) found *E.coli* the most prevalent as well with 35.15% of all cases of pathogens isolated.

5.4 Antimicrobial susceptibility and resistance of UTI from 2019-2023

In this study Imipenem consistently showed 0% resistance. Ciprofloxacin resistance decreased from 42.9% in 2019 to 10% in 2023. Susceptibility increased from 57.1% to 90%. Levofloxacin resistance decreased from 26.1% in 2019 to 20% in 2023. Susceptibility increased from 73.9% to 80%. Nitrofurantoin resistance decreased significantly from 26.3% in 2019 to 0% in 2023.

Susceptibility rose from 73.7% to 100%. Tetracycline resistance decreased from 62% in 2019 to 31.6% in 2023. Susceptibility increased from 38% to 68.4%. Norfloxacin resistance decreased from 38.9% to 23.5%. Susceptibility improved from 61.1% to 76.5%. Cefuroxime resistance increased from 46.7% in 2019 to 37.5% in 2023. Susceptibility slightly decreased from 53.3% to 62.5%. Cotrimoxazole resistance increased significantly from 66.7% in 2019 to 100% in 2022, then improved to 66.7% in 2023. Ceftriaxone resistance sharply increased to 100% in 2022, with susceptibility dropping to 0% in 2022 and remaining low at 33.3% in 2023. Gentamicin resistance fluctuated, starting at 53.8% in 2019 and dropping to 16.7% in 2023. Susceptibility improved from 42.1% to 77.3%. Cefuroxime resistance remained relatively high, starting at 57.1% in 2019, varying between 37.5% and 66.7%, with fairly low susceptibility. This data indicates significant improvements in susceptibility for several antibiotics, particularly for ciprofloxacin, nitrofurantoin, and gentamicin, while highlighting concerning trends for cotrimoxazole and ceftriaxone. Esmat et al. (2025) find that in their study there are high resistance rates for ampicillin, amoxicillin, and trimethoprim/sulfamethoxazole. Golli et al. (2024) find that there is notable resistance to commonly used antibiotics; high susceptibility to nitrofurantoin and carbapenems matching up to the findings of this study. Irusen et al. (2021) find in their study that *E. coli* showed 90.8% resistance to amoxicillin/ampicillin and 71.8% resistance to trimethoprim/sulfamethoxazole.

5.5 Temporal trends in antibiotic resistance from 2019 to 2023

Imipenem (IMI) was consistently at 0% resistance from 2019 to 2023. Ciprofloxacin (CIP) resistance decreased from 42.9% in 2019 to 10% in 2023. Levofloxacin (LEV) resistance decreased from 26.1% in 2019 to 20% in 2023. Nitrofurantoin (NI) resistance decreased significantly from 26.3% in 2019 to 0% in 2023. Tetracycline (T) resistance decreased from

62% in 2019 to 31.6% in 2023. Norfloxacin (NOR) resistance decreased from 38.9% in 2019 to 23.5% in 2023. Ceftriaxone (CFX) resistance decreased from 46.7% in 2019 to 37.5% in 2023. Cotrimoxazole (COT) resistance increased sharply to 86.7% in 2020, then decreased to 66.7% in 2023. Ceftriaxone (CRO) resistance increased dramatically to 100% in 2022, then decreased to 66.7% in 2023. Gentamicin (GM) resistance fluctuated from 53.8% in 2019 to 16.7% in 2023. Cefuroxime (CXM) resistance remained high, starting at 57.1% in 2019 and varying between 37.5% and 57.1%. The data of this study found overall improvements in resistance for several antibiotics, particularly for ciprofloxacin, levofloxacin, and nitrofurantoin, while highlighting persistent issues with cotrimoxazole and ceftriaxone.

5.6 Conclusion

The study found a significant prevalence of urinary tract infections (UTIs) among pediatric patients, particularly in the 0-3 age group. Dominant pathogens were found with *E.coli* being the most frequently isolated pathogen, followed by *Klebsiella spp.* and *S.saprophyticus*. With antibiotic resistance trends, there was a notable variation in antibiotic resistance patterns over the study period (2019-2023), with some antibiotics showing improved susceptibility, such as nitrofurantoin and ciprofloxacin, while others, like cotrimoxazole and ceftriaxone, displayed alarming resistance rates. A significant proportion of bacterial isolates exhibited multidrug resistance, highlighting the growing challenge of treating UTIs effectively. The impact of demographic factors also played a part with factors such as male uncircumcision and a history of prior UTIs were identified as significant risk factors for developing UTIs.

5.7 Recommendations

Regular surveillance, and continuous monitoring of antibiotic resistance patterns in paediatric populations is essential to guide treatment decisions. There is a need for robust antibiotic stewardship programs for medical personnel to ensure rational use of antibiotics and to minimize the emergence of resistance. Education and awareness is important to increase awareness among healthcare professionals regarding the risks of antibiotic overuse and the importance of adhering to guidelines for prescribing. Further research must be conducted to explore the underlying causes of antibiotic resistance, including the impact of demographic factors and previous antibiotic use patterns. It is also important to educate parents and guardians about the importance of proper hygiene and the risks associated with untreated UTIs, particularly in young children.

REFERENCES

- Duicu, C., Cozea, I., Delean, D., Aldea, A., & Aldea, C. (2021). Antibiotic resistance patterns of urinary tract pathogens in children from Central Romania. *Experimental and Therapeutic Medicine*, 22(1). <https://doi.org/10.3892/etm.2021.10180>
- Esmat, E., Saadaat, R., Saedi, N., Hakimi, A., Baryali, A., Rasooli, A., Noor, S., Ahmad, M., & Haidary, A. M. (2025). Bacterial Isolates and Their Antimicrobial Susceptibility Patterns Among Pediatric Patients with Urinary Tract Infections: A Retrospective Cross-Sectional Study at Tertiary Level in Afghanistan. *Infection and Drug Resistance*, Volume 18, 51–60. <https://doi.org/10.2147/idr.s499017>
- Fenta, A., Dagne, M., Eshetie, S., & Belachew, T. (2020). Bacterial profile, antibiotic susceptibility pattern and associated risk factors of urinary tract infection among clinically suspected children attending at Felege-Hiwot comprehensive and specialized hospital, Northwest Ethiopia. A prospective study. *BMC Infectious Diseases*, 20(1). <https://doi.org/10.1186/s12879-020-05402-y>
- Golli, A., Popa, S. G., Cara, M. L., Stoica, G., Fortofoiu, D., & Stoica, M. (2024). Antibiotic Resistance Pattern of Pathogens Isolated from Pediatric Patients during and after the COVID-19 Pandemic. *Antibiotics*, 13(10), 966. <https://doi.org/10.3390/antibiotics13100966>

- Irusen, S., Rabie, H., & Du Buisson, C. (2021). The evolving antibiotic profile of paediatric urinary tract infections at a tertiary hospital in Cape Town. *Wits Journal of Clinical Medicine*, 3(1). <https://doi.org/10.18772/26180197.2021.v3n1a4>
- Lagarde, M., & Blaauw, D. (2023). Levels and determinants of overprescribing of antibiotics in the public and private primary care sectors in South Africa. *BMJ Global Health*, 8(7), e012374. <https://doi.org/10.1136/bmjgh-2023-012374>
- Mhondoro, M., Ndlovu, N., Bangure, D., Juru, T., Gombe, N. T., Shambira, G., Nsubuga, P., & Tshimanga, M. (2019). Trends in antimicrobial resistance of bacterial pathogens in Harare, Zimbabwe, 2012–2017: a secondary dataset analysis. *BMC Infectious Diseases*, 19(1). <https://doi.org/10.1186/s12879-019-4295-6>
- WHO (2022, December 9). *Global antimicrobial resistance and use surveillance system (GLASS) report: 2022*. <https://www.who.int/publications/i/item/9789240062702>

Appendices

Appendix 1: Timeline

- Months 1-2: Develop study protocol, obtain ethical approval
- Months 3-6: Data collection
- Months 7-9: Data analysis
- Months 10-15: Write and submit final project for publication

Appendix 2: Instruments

Patient records at Diagnostic Laboratory Services

Data Collection tool

Lab Number	Age	Sex	Infection (Organism)	Susceptibility	Resistance

History of Prior UTIs or Infections	Prior Antibiotic Use	Underlying Comorbidities	Residency (rural/ urban)

Appendix 3: DLS Approval Letter

A.Bhala (MSC-Med Microbiology, NUST), deputymanager@dls.co.zw

Diagnostics Laboratory Services

PO Box 9267, Hillside

Bulawayo

Africa University

CHANS

Faculty of Health Sciences

P.O Box 1320

Mutare

17/02/2025

To Whom it may concern

re: response to the study site approval letter

I write to inform you that, we formally accept your request to utilise DLS statistical data for your final year dissertation.

However, due to the Data protection act enacted by the Govt recently, we will not permit the use of patient demographic information, however any statistical information required will be availed to you.

Wishing you all the best in your future endeavours,

Regards.



Appendix 4: 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 3680/25

11 March, 2025

MATTHEW MPOFANA NDLOVU

C/O Africa University

Box 1320

MUTARE

RE: ANTIBIOTIC RESISTANCE PATTERNS OF BACTERIAL ISOLATES IN URINE SAMPLES OF PAEDIATRIC PATIENTS COLLECTED AT DIAGNOSTIC LABORATORY SERVICES IN BULAWAYO 2019-2023: A TREND ANALYSIS.

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 3680/25
This number should be used on all correspondences, consent forms, and appropriate document
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** March 11, 2025
- **EXPIRATION DATE** March 11, 2026
- **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

FOR CHAIRPERSON

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE