

AFRICA UNIVERSITY

(A United Methodist-Related Institution)

INVESTIGATING THE OCCURENCE AND ANTIMICROBIAL RESISTANCE PATTERNS
OF HOSPITAL-ACQUIRED *KLEBSIELLA PNEUMONIAE* BLOODSTREAM INFECTIONS
IN PAEDIATRIC PATIENTS AT VICTORIA CHITEPO PROVINCIAL HOSPITAL FROM
JANUARY 2023 TO FEBRUARY 2025.

BY

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Abstract

Hospital-acquired bloodstream infections (BSIs) caused by *Klebsiella pneumoniae* are a significant public health challenge, particularly in pediatric populations, due to their association with high morbidity, mortality, and antimicrobial resistance (AMR). This study investigated the prevalence, AMR patterns, and environmental contamination of hospital acquired *Klebsiella pneumoniae* (HA-KP) at Victoria Chitepo Provincial Hospital, Zimbabwe, from January 2023 to February 2025. The aim was to provide evidence-based insights to inform infection control strategies and antimicrobial stewardship. A hybrid retrospective and prospective cross-sectional methodology was employed. Data was collected from 170 pediatric patients (aged 0–12 years) admitted to the hospital during the study period. Blood culture samples were analyzed for the presence of *Klebsiella pneumoniae*, and antimicrobial susceptibility testing was performed on isolates using standard microbiological techniques. Additionally, environmental samples were collected from various hospital surfaces to assess contamination levels. Patient demographic data were also reviewed to identify potential risk factors. The results showed that 44.1% of the pediatric patients tested positive for hospital acquired *Klebsiella pneumoniae*, with infants (1–12 months) being the most affected age group. Antimicrobial susceptibility testing of 110 *Klebsiella pneumoniae* isolates revealed high resistance rates to ceftazidime (80.9%) and amoxicillin-clavulanate (76.4%), while ciprofloxacin exhibited a lower resistance rate of 40%. Alarming, 44% of environmental samples tested positive for *Klebsiella pneumoniae*, highlighting significant environmental contamination within the pediatric ward. Analysis of the data revealed no statistically significant association between infection prevalence and sex or older age groups, although infants were disproportionately affected. The high resistance rates observed suggest that multidrug-resistant (MDR) strains are prevalent in this setting, complicating treatment options and increasing the risk of poor clinical outcomes. Environmental contamination was identified as a likely reservoir for infection transmission, emphasizing the critical need for improved infection prevention measures. This study underscores the urgent need for robust infection control protocols, including enhanced hand hygiene practices, routine cleaning and disinfection of hospital surfaces, and targeted antimicrobial stewardship programs to curb the spread of MDR *Klebsiella pneumoniae*. Routine AMR surveillance is also essential to monitor resistance trends and guide empirical treatment strategies.

Declaration

I Samantha Yeukai Chibvuri student number 210483 do hereby declare that this research proposal 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.

Samantha Yeukai Chibvuri



Student's full Name

Student's signature

Mr. Z Chiwodza



Supervisor Name and Signature

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Dedications

I would like to dedicate this project to my late mother, Mutsa Chibvuri. She always believed in and none of this would have been possible without her and all the wisdom she passed onto me. I would also like to dedicate this project to my grandmother Eunice Chibvuri, who has been with me every step of the way from the very beginning and has always supported me without any doubts. I would also like to thank my two uncles Samuel Chibvuri and Vigil Chibvuri who have been motivating me and always reminding me of the importance of education. I would also love to thank my second mother Brenda Lee Mutamiri who has been my rock and has been my biggest cheerleader. Lastly I would love to thank my late grandfather, Ephraim Chibvuri for helping me choose this career path. His wisdom and guidance has led me every step of the way and I will always be grateful. None of this would have been possible without them and will always be forever grateful. Above all I would like the Almighty God for helping me achieve everything.

Acronyms and Abbreviations

AMR	Anti Microbial Resistance
ASP	Antimicrobial stewardship programs
AUREC	Africa University Research Ethics Committee
BSI	Blood stream infections
CRKP	Carbapenem-Resistant <i>Klebsiella pneumoniae</i>
CDC	Centers for Disease Control and Prevention
ESBL	Extended-Spectrum β -Lactamases
HAI	Hospital Acquired Infection
HA-KP	Hospital Acquired <i>Klebsiella pneumoniae</i>
ICU	Intensive Care Unit
IPC	Infection Prevention Control
MDR	Multi Drug Resistance
VCPH	Victoria Chitepo Provincial Hospital
WHO	World Health Organisation
XDR	Extensively Drug-Resistant

Key Words and Definitions

Klebsiella pneumoniae: A type of bacteria that can cause various infections, including pneumonia, urinary tract infections, and bloodstream infections. It is particularly concerning in health-care settings due to its potential for antimicrobial resistance.

Bloodstream Infections (BSIs): Infections that occur when bacteria or other pathogens enter the bloodstream, potentially leading to severe complications such as sepsis. Bloodstream infections are often life-threatening and require prompt medical intervention.

Antimicrobial Resistance (AMR): The ability of microorganisms to resist the effects of antimicrobial drugs, such as antibiotics. This resistance complicates treatment and can lead to increased morbidity and mortality.

Pediatric Patients: Children and infants who are receiving medical care. Pediatric patients are particularly vulnerable to infections due to their developing immune systems.

Hospital-Acquired Infections (HAIs): Infections that patients acquire during their stay in a health-care facility. These infections can be caused by bacteria, viruses, fungi, or other pathogens and are often associated with increased morbidity and mortality.

Extended-Spectrum Beta-Lactamases (ESBLs): Enzymes produced by certain bacteria, including *Klebsiella pneumoniae*, that confer resistance to a wide range of beta-lactam antibiotics, such as penicillins, cephalosporins, and aztreonam. ESBL-producing bacteria are a significant concern in healthcare settings due to their ability to resist commonly used antibiotics, complicating treatment options.

TABLE OF CONTENTS

Abstract.....	iii
Declaration.....	iv
Copyright.....	v
Acknowledgements.....	vi
Dedications.....	vii
Acronyms and Abbreviations.....	viii
Key Words and Definitions.....	ix
<i>CHAPTER 1: INTRODUCTION.....</i>	<i>1</i>
<i>1.1 INTRODUCTION.....</i>	<i>1</i>
1.2 STUDY BACKGROUND.....	1
1.3 PROBLEM STATEMENT.....	2
1.4 JUSTIFICATION.....	3
1.5 BROAD OBJECTIVE.....	4
1.5.1 SPECIFIC OBJECTIVES.....	4
1.6 Research Questions.....	5
1.7 LIMITATIONS.....	5
1.8 DELIMITATIONS.....	6
1.9 SUMMARY.....	6
<i>CHAPTER 2: LITERATURE REVIEW.....</i>	<i>7</i>
2.1 INTRODUCTION.....	7
2.2 Conceptual Framework.....	7
2.3 LITERATURE REVIEW.....	8
2.3.1 Hospital Acquired Infections in Pediatric Patients.....	8
2.3.2 Antimicrobial resistance profiles of <i>Klebsiella pneumoniae</i>	9
2.3.3 Mechanisms of resistance.....	10
2.3.4 Approaches for the prevention and control of hospital-acquired <i>Klebsiella pneumoniae</i> infections among pediatric patients.....	12
CHAPTER 3: METHODOLOGY.....	14
3.1 INTRODUCTION.....	14
3.2 RESEARCH DESIGN.....	14
3.3 STUDY POPULATION.....	14
3.4 INCLUSION CRITERIA.....	15

3.5 EXCLUSION CRITERIA	15
3.6 SAMPLE SIZE	15
3.7 SAMPLING PROCEDURE	17
3.8 PILOT STUDY	17
3.9 STUDY SETTING	18
3.10 DATA ANALYSIS	18
3.11 ETHICAL CONSIDERATIONS.....	19
<i>CHAPTER 4 DATA ANALYSIS AND PRESENTATION OF RESULTS.....</i>	<i>21</i>
4.1 Introduction.....	21
4.2 Results.....	21
4.2.1 The occurrence of hospital-acquired <i>Klebsiella pneumoniae</i> bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025	22
4.2.2 The antimicrobial resistance profiles of <i>Klebsiella pneumoniae</i> isolates obtained from bloodstream infections	24
4.2.3 The incidence of <i>Klebsiella pneumoniae</i> to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital	25
4.3 Chapter summary.....	26
<i>CHAPTER 5: Summary of findings, conclusion, and recommendations.....</i>	<i>28</i>
5.1 Introduction.....	28
5.2 Discussion.....	28
5.2.1 The occurrence of hospital acquired <i>Klebsiella pneumoniae</i> bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025	28
5.2.2 The antimicrobial resistance profiles of <i>Klebsiella pneumoniae</i> isolates obtained from bloodstream infections	31
5.2.3 The incidence of <i>Klebsiella pneumoniae</i> to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital	33
5.3 Conclusions.....	35
5.4 Recommendations.....	35
5.5 Suggestion for further study	36
References.....	36
<i>APPENDICES.....</i>	<i>I</i>
APPENDIX 1: Timetable	I
APPENDIX 2: Budget.....	III
APPENDIX 3: Letter seeking study site approval	IV
APPENDIX 4: DATA COLLECTION TOOLS	V
APPENDIX 5 : SUPERVISOR AUREC LETTER.....	VII

APPENDIX 6: STUDY SITE APPROVAL LETTER.....	VIII
APPENDIX 7 :AUREC APPROVAL LETTER.....	IX
APPENDIX 8: CHI-SQUARED CONTINGENCY TABLE.....	X
Figure 1: The conceptual framework.....	7
Figure 2: Prevalence of hospital-acquired <i>Klebsiella pneumoniae</i> bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025.....	23
Figure 3 The antimicrobial resistance patterns of <i>Klebsiella pneumonia</i> from January 2023 to February 2025 for the positive isolates from pediatric patients.....	24
Figure 4: The occurrence of <i>Klebsiella pneumoniae</i> to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital	26
Table 1 Demographic characteristics of the study population.....	21
Table 2 shows the timetable proposed for the research	I
Table 3 shows the proposed budget for the proposal	III

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION

This chapter highlights the study background and the problem at hand. The chapter also highlights the delimitations and foreseen limitations to this study. It lays down the objectives of the study. The objectives are clearly differentiated between the broad objective and the clear objective.

1.2 STUDY BACKGROUND

Hospital-acquired infections (HAIs) represent a significant public health challenge, particularly in pediatric populations where patients are often more vulnerable due to their developing immune systems. Among these infections, *Klebsiella pneumoniae* has emerged as a prominent pathogen frequently associated with severe outcomes such as bloodstream infections. The Centers for Disease Control and Prevention (CDC, 2019) estimates that approximately 1 in 31 hospital patients has at least one HAI on any given day, with a notable proportion attributable to multidrug-resistant organisms like *Klebsiella pneumoniae*(CDC, 2019).

The public health implications of HAIs caused by *Klebsiella pneumoniae* are profound. Infections not only prolong hospital stays but also lead to increased healthcare costs and resource utilization. According to a report by the World Health Organization (WHO, 2020), HAIs contribute significantly to the financial burden on healthcare systems, costing billions annually in direct medical expenses and lost productivity (WHO, 2020). Furthermore, the rise of antibiotic-resistant strains poses a threat not only within healthcare facilities but also in the community, as resistant organisms can be transmitted from patients to healthcare workers and other patients.

Immuno-compromised patients, those undergoing invasive procedures and individuals with prolonged hospital stays are particularly susceptible to infections caused by *Klebsiella pneumonia* (Cruz, 2020). Indiscriminate use of antibiotics in hospitals further exacerbates this issue by creating selective pressure that favors the emergence of resistant strains. A study conducted across multiple hospitals found that nearly 19% of intensive care unit (ICU) patients had at least one HAI, highlighting the critical need for effective infection control measures in high-risk settings (Nicolle, 2016).

To address these challenges, hospitals have implemented various infection prevention strategies aimed at reducing the incidence of HAIs. These strategies include strict adherence to hand hygiene protocols, proper sterilization techniques for medical equipment, and the establishment of antimicrobial stewardship programs designed to optimize antibiotic use (Miller, 2018). Despite these efforts, the persistence of *Klebsiella pneumoniae* as a leading cause of HAIs indicates that further research is necessary to understand its resistance mechanisms fully and develop targeted interventions.

1.3 PROBLEM STATEMENT

The rise and spread of multidrug-resistant organisms present a critical public health challenge in Zimbabwe, particularly in healthcare settings like Victoria Chitepo Provincial Hospital, which serves as a key referral center in Manicaland Province. The increasing occurrence of multidrug resistant strains of *Klebsiella pneumoniae* poses a considerable challenge to public health systems globally, including in Zimbabwe. Recent studies indicate that environmental reservoirs, such as hospital surfaces and wastewater, play a critical role in the transmission of this pathogen (Akenji, 2020). Pediatric patients, a highly vulnerable group, are increasingly affected by hospital-acquired infections, including bloodstream infections caused by *Klebsiella pneumoniae*. This opportunistic

pathogen has emerged as a major threat due to its ability to produce extended-spectrum β -lactamases (ESBLs), which render many first-line antibiotics ineffective.

In Manicaland, whilst there is surveillance of AMR in different samples, there is limited reporting. Zimbabwe has reported cases of *Klebsiella pneumoniae* in limited healthcare settings, highlighting the need for comprehensive surveillance and infection control measures. A study conducted by Chikwanje, (2021) noted that *Klebsiella pneumoniae* was isolated from clinical samples in multiple hospitals across Zimbabwe, suggesting a potential link between environmental contamination and clinical infections. This contributes to a significant knowledge gap regarding the occurrence and antimicrobial resistance profiles of *Klebsiella pneumoniae* in pediatric bloodstream infections. The absence of detailed local data impedes the development of targeted infection control measures and the formulation of effective treatment protocols, potentially exacerbating morbidity and mortality among affected children. Additionally, understanding the specific resistance mechanisms in isolates from this region is crucial for informing antimicrobial stewardship efforts and guiding public health interventions.

Addressing this gap is essential for improving healthcare outcomes in Manicaland and aligns with broader national efforts to combat antimicrobial resistance and strengthen infection prevention strategies in Zimbabwe.

1.4 JUSTIFICATION

Klebsiella pneumoniae is a significant cause of hospital-acquired infections, particularly bloodstream infections, which can lead to high morbidity and mortality in pediatric patients. Understanding the local epidemiology of this pathogen is crucial for developing targeted treatment protocols and infection control strategies. Anti-microbial resistance in *Klebsiella pneumoniae* is

increasing globally, with resistance rates to commonly used antibiotics like carbapenems, cephalosporins, and fluoroquinolones on the rise. This complicates treatment options and leads to higher healthcare costs and mortality rates. This study will fill this knowledge gap and provide valuable insights into the factors contributing to antimicrobial resistance in this vulnerable population. The findings of this study will inform public health interventions and policy decisions aimed at reducing the burden of hospital-acquired *Klebsiella pneumoniae* infections and antimicrobial resistance in pediatric patients. This is crucial for improving patient outcomes and optimizing the use of limited healthcare resources.

1.5 BROAD OBJECTIVE

To assess the occurrence and antimicrobial resistance patterns of *Klebsiella pneumoniae* isolated from pediatric bloodstream infections, and to examine its presence in the hospital pediatric environment at Victoria Chitepo Provincial Hospital between January 2023 and February 2025.

1.5.1 SPECIFIC OBJECTIVES

- To determine occurrence of hospital acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025
- To assess the antimicrobial resistance profiles of *Klebsiella pneumoniae* isolates obtained from the blood stream infections
- To compare the incidence of *Klebsiella pneumoniae* to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital
- To recommended approaches for the implementation, prevention and control of hospital-acquired *Klebsiella pneumoniae* infections among pediatric patients based on the findings from this study.

1.6 Research Questions

1. What is the occurrence of hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients admitted to Victoria Chitepo Provincial Hospital from January 2023 to February 2025?
2. What is the antimicrobial resistance profiles of *Klebsiella pneumoniae* isolates obtained from the bloodstream infections of hospitalized pediatric patients at Victoria Chitepo Provincial Hospital?
3. What is the incidence of *Klebsiella pneumoniae* to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital?
4. What approaches can be recommended for the implementation, prevention and control of hospital-acquired *Klebsiella pneumoniae* infections among pediatric patients based on the findings from this study?

1.7 LIMITATIONS

The accuracy of the data collected may be influenced by incomplete medical records or variations in diagnostic practices. Inconsistent reporting of infections and antimicrobial susceptibility testing could lead to under-reporting or misclassification of cases. The patterns of antimicrobial resistance can change over time due to various factors, including changes in antibiotic usage and infection control practices. This variability may limit the ability to draw definitive conclusions about resistance trends over the study period. The study may not account for all environmental and socioeconomic factors that contribute to the occurrence of *Klebsiella pneumoniae* infections and antimicrobial resistance. Factors such as hospital infrastructure, staff training, and local healthcare practices can significantly impact infection rates and resistance profiles but may not be fully explored in this research.

1.8 DELIMITATIONS

The study will be limited to pediatric patients (aged 0-12 years) who are admitted to Victoria Chitepo Provincial Hospital. This focus excludes adult patients and other age groups, which may limit the applicability of the findings to broader populations. The research will be conducted exclusively at Victoria Chitepo Provincial Hospital, meaning that the results may not be representative of other healthcare facilities in different regions or countries. This delimitation is essential to focus the study on a specific healthcare context. The study will analyze data collected from January 2023 to February 2025. This specific time frame may not capture long-term trends in prevalence and resistance patterns, and findings may vary if the study were conducted over a more extended period. The research will specifically investigate bloodstream infections caused by *Klebsiella pneumoniae*, excluding other types of infections (e.g., urinary tract infections, pneumonia) that may also be relevant in understanding the overall impact of this pathogen in pediatric patients.

1.9 SUMMARY

This chapter looked at the background of the project. This background then developed into the problem statement that stated the need of this project to be carried out. The research objectives both broad as well as specific were clearly outlined. The research questions mentioned in this chapter will help in navigating the project as well as help me in collecting the necessary data needed in this proje

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter looks at relevant literature that helped in the understanding of this project. It also highlights the causes and outcomes of the problem with the aid of a conceptual framework.

2.2 Conceptual Framework

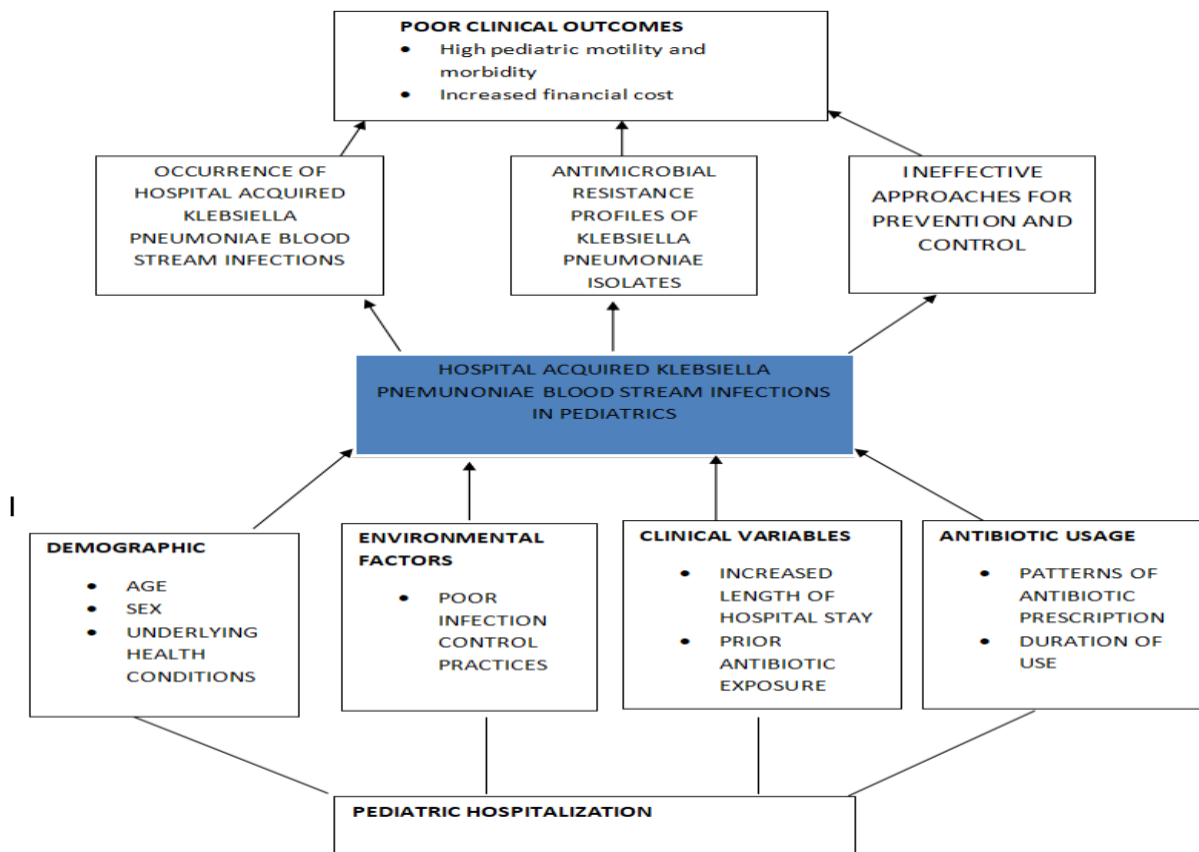


Figure 1: The conceptual framework

This conceptual framework illustrates the multifaceted determinants and consequences of hospital-acquired *Klebsiella pneumoniae* bloodstream infections in pediatric patients at Victoria Chitepo Provincial Hospital. The framework also highlighted the interconnected factors influencing infection occurrence, antimicrobial resistance profiles, and the effectiveness of prevention and control measures. Key determinants include demographic variables (e.g., age, sex, underlying health conditions), environmental factors (e.g., infection control practices), clinical variables (e.g., hospital stay duration, prior antibiotic exposure), and patterns of antibiotic usage. The outcomes, including high pediatric morbidity and mortality as well as increased financial costs, underscore the critical need for targeted interventions to mitigate the burden of these infections in resource-limited healthcare settings.

2.3 LITERATURE REVIEW

2.3.1 Hospital Acquired Infections in Pediatric Patients

Hospital-acquired infections (HAIs) pose a significant challenge in pediatric healthcare settings, particularly in intensive care units (ICUs) where vulnerable patients are often exposed to invasive procedures and prolonged hospital stays. *Klebsiella pneumoniae* is one of the most common pathogens associated with HAIs, particularly bloodstream infections (BSIs). A study conducted by Hlophe (2014) in a pediatric ICU revealed that out of 2,266 children admitted, 113 developed *Klebsiella pneumoniae* infections, with 23 cases resulting in bacteremia. The findings indicated a concerning trend in HAIs, highlighting that each infection extended hospital stays by an average of 5 to 10 days, significantly impacting healthcare resources and patient outcomes. The occurrence of *Klebsiella pneumoniae* BSIs in pediatric populations has been documented in various studies, with significant variations reported across different regions. For instance, a retrospective study in China found that 84.9% of invasive *Klebsiella pneumoniae* infections in pediatric patients were

classified as HAIs, with a notable prevalence of carbapenem-resistant strains (CRKP) at 38.2% (Zhang, 2021). This underscores the urgent need for surveillance and monitoring of infection rates in pediatric settings, particularly in hospitals with high rates of invasive procedures. Moreover, the risk factors associated with the occurrence of hospital-acquired *Klebsiella pneumoniae* infections have been extensively studied. Factors such as prolonged hospitalization, the use of invasive devices (e.g., central venous catheters) and prior antibiotic exposure have been identified as significant contributors to the development of HAIs (Patil, 2021). Understanding these risk factors is crucial for developing targeted interventions to reduce the incidence of these infections. In summary, the occurrence of hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients is a pressing concern that necessitates ongoing surveillance and research to inform infection control practices. The findings from this study at Victoria Chitepo Provincial Hospital will contribute to the understanding of the local epidemiology of these infections and help identify areas for improvement in patient care.

2.3.2 Antimicrobial resistance profiles of *Klebsiella pneumoniae*

Antimicrobial resistance (AMR) among *Klebsiella pneumoniae* isolates is a growing public health concern, particularly in pediatric populations where treatment options are limited. The emergence of multidrug-resistant (MDR) and carbapenem-resistant *Klebsiella pneumoniae* (CRKP) strains has been documented globally, posing significant challenges for effective treatment. A study by Sękowska, (2024) highlighted that more than 57% of *Klebsiella pneumoniae* strains isolated from pediatric patients undergoing cancer treatment were extended-spectrum β -lactamase (ESBL)-positive, indicating a high prevalence of resistance to commonly used antibiotics. The resistance profiles of *Klebsiella pneumoniae* vary significantly based on geographical location and healthcare settings. For instance, a study conducted in Kenya reported an antimicrobial resistance rate of

54.5% for *Klebsiella pneumoniae*, with strains predominantly resistant to third and fourth-generation cephalosporins and carbapenems (Patil, 2021). This high level of resistance emphasizes the need for robust antimicrobial stewardship programs and infection control measures to mitigate the spread of resistant strains. Furthermore, the clinical implications of antimicrobial resistance in *Klebsiella pneumoniae* infections are profound. Research indicates that infections caused by CRKP are associated with higher mortality rates, prolonged hospital stays, and increased healthcare costs (Zhang, 2021). In pediatric patients, the risk of severe outcomes is exacerbated by the limited availability of effective antibiotics, making it imperative to understand local resistance patterns to guide empirical treatment decisions. Assessing the antimicrobial resistance profiles of *Klebsiella pneumoniae* isolates is critical for informing treatment strategies and improving patient outcomes. The findings from this study at Victoria Chitepo Provincial Hospital will provide valuable insights into the local resistance landscape, contributing to the global understanding of AMR in pediatric populations.

2.3.3 Mechanisms of resistance

Klebsiella pneumoniae is a notable opportunistic pathogen that poses significant risks in healthcare settings, particularly due to its association with multidrug resistance. Understanding the environmental reservoirs of *Klebsiella pneumoniae* is essential for controlling its transmission and preventing hospital-acquired infections.

Numerous studies have documented the presence of *Klebsiella pneumoniae* in various hospital environments, highlighting its potential as a reservoir for infection transmission. For instance, a study conducted in an intensive care unit (ICU) found extensive environmental contamination with carbapenem-resistant *Klebsiella pneumoniae* (CRKP), with isolates detected on surfaces such as sinks, bedrails, and medical equipment (Zhang et al., 2021). The research indicated that while

environmental contamination was prevalent, adherence to cleaning protocols significantly reduced the risk of patient colonization and infection.

Environmental surfaces commonly associated with *Klebsiella pneumoniae* contamination include high-touch areas such as doorknobs, tray tables, and patient bedding (Miller et al., 2023). A comprehensive survey across multiple hospital departments revealed that *Klebsiella pneumoniae* was found to contaminate a wide range of surfaces, particularly in patient care areas (Miller et al., 2023). This underscores the importance of rigorous cleaning and disinfection practices to mitigate the risk of transmission.

In addition to surface contamination, water sources within healthcare settings have also been identified as potential reservoirs for *Klebsiella pneumoniae*. Studies have shown that sinks and water outlets can harbor resistant strains, contributing to outbreaks within hospitals (Tofteland et al., 2013). The persistence of *Klebsiella pneumoniae* in these environments emphasizes the need for ongoing surveillance and monitoring.

Molecular characterization techniques have been employed to trace genetic links between environmental isolates and clinical cases of *Klebsiella pneumoniae* infections. These studies reveal that clonal strains can persist in the environment and contribute to outbreaks within healthcare settings (Clarivet et al., 2016). Understanding these dynamics is crucial for implementing targeted interventions to reduce transmission risks.

The findings regarding environmental contamination with *Klebsiella pneumoniae* have significant implications for infection prevention and control practices in hospitals. Routine environmental cleaning protocols are essential for minimizing contamination levels and reducing the risk of healthcare-associated infections. A study indicated that effective cleaning regimens could

significantly decrease the prevalence of CRKP in patient surroundings, thereby lowering the risk of patient acquisition (Zhang et al., 2021).

Moreover, training healthcare personnel on proper cleaning techniques and emphasizing the importance of hand hygiene can further enhance infection control measures (Miller et al., 2023). The integration of molecular surveillance methods into routine practices can also aid in identifying potential reservoirs and guiding targeted interventions.

Environmental contamination with *Klebsiella pneumoniae* represents a significant public health concern within healthcare settings. The presence of resistant strains in various hospital environments underscores the need for robust infection control strategies. By understanding the dynamics between environmental reservoirs and clinical infections, healthcare facilities can develop effective measures to mitigate the risks associated with *Klebsiella pneumoniae* transmission and improve patient outcomes.

2.3.4 Approaches for the prevention and control of hospital-acquired *Klebsiella pneumoniae* infections among pediatric patients

Preventing and controlling hospital-acquired infections (HAIs), particularly those caused by *Klebsiella pneumoniae*, requires a multifaceted approach that incorporates evidence-based strategies tailored to the specific healthcare setting. The World Health Organization (WHO) has emphasized the importance of implementing infection prevention and control (IPC) measures to mitigate the risk of HAIs, especially in vulnerable populations such as pediatric patients (World Health Organisation, 2020). One effective strategy is the enhancement of hand hygiene practices among healthcare workers. Studies have shown that adherence to hand hygiene protocols significantly reduces the transmission of pathogens, including *Klebsiella pneumoniae*, in hospital

settings (Patil, 2021). Regular training and audits can help reinforce the importance of hand hygiene and ensure compliance among staff.

Another critical component of infection control is the judicious use of antibiotics. Antimicrobial stewardship programs (ASPs) play a vital role in optimizing antibiotic use and minimizing the emergence of resistant strains. By implementing guidelines for appropriate antibiotic prescribing and conducting regular reviews of antibiotic usage, healthcare facilities can reduce the incidence of antimicrobial resistance (Zhang, 2021). Environmental cleaning and disinfection are also essential in preventing the spread of *Klebsiella pneumoniae*. Studies have demonstrated that thorough cleaning of surfaces and equipment in healthcare settings can significantly decrease the risk of HAIs (Sękowska, 2024).

Implementing routine cleaning protocols and ensuring that cleaning staff are adequately trained can enhance the overall safety of the hospital environment. In addition to these measures, active surveillance of infection rates and resistance patterns is crucial for informing prevention strategies. By continuously monitoring the incidence of *Klebsiella pneumoniae* infections and the susceptibility profiles of isolated strains, healthcare facilities can adapt their IPC practices to address emerging threats effectively. A comprehensive approach to preventing and controlling hospital-acquired *Klebsiella pneumoniae* infections in pediatric patients should encompass hand hygiene, antimicrobial stewardship, environmental cleaning, and active surveillance. The findings from this study will provide valuable insights that can inform the development and implementation of targeted interventions at Victoria Chitepo Provincial Hospital.

CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

This chapter looks at various aspects of the research methodology. This chapter outlines the research design as well as the study population and inclusion criteria that was used. The sampling procedure as well as calculation of the sample size that was needed in this research project are clearly highlighted. Ethical considerations that help guide how to carry out this project are also mentioned.

3.2 RESEARCH DESIGN

This study employed both retrospective and prospective cross-sectional designs to investigate the occurrence and antimicrobial resistance patterns of hospital-acquired *Klebsiella pneumoniae* bloodstream infections in pediatric patients and their surrounding environment. A hybrid approach was applied to both clinical and environmental samples: retrospective data and sample analysis were conducted from January 2023 to July 2024, followed by prospective sample collection and analysis from August 2024 to February 2025. Clinical data were sourced from medical records and laboratory reports, while environmental sampling focused on pediatric wards.

3.3 STUDY POPULATION

This study involved two distinct populations:

Pediatric patients (aged 0–12 years) diagnosed with hospital-acquired *Klebsiella pneumoniae* bloodstream infections at Victoria Chitepo Provincial Hospital between January 2023 and February 2025.

The hospital environment specifically pediatric wards, which were sampled for the presence of *Klebsiella pneumoniae* and other bacterial contaminants during the same period.

3.4 INCLUSION CRITERIA

Pediatric patients aged 0–12 years with a confirmed diagnosis of hospital-acquired *Klebsiella pneumoniae* bloodstream infection.

Patients admitted between January 2023 and February 2025.

Environmental samples collected from pediatric wards during the same timeframe (both retrospectively and prospectively).

3.5 EXCLUSION CRITERIA

Patients with *Klebsiella pneumoniae* infections identified in non-bloodstream samples (e.g., urine or sputum).

Environmental samples collected outside the pediatric wards.

3.6 SAMPLE SIZE

Sample Size Calculation

There was use Cochran's formula. This formula is particularly useful when estimating a population proportion with a specified level of confidence and margin of error.

The formula is as follows:

$$n = Z^2 \cdot p \cdot (1-p) / E^2$$

$$n = E^2 Z^2 \cdot p \cdot (1-p)$$

Where:

n = required sample size

Z = Z-value (the number of standard deviations from the mean; for a 95% confidence level, $Z \approx 1.96$)

p = estimated proportion of the population (if unknown, a conservative estimate of 0.5 is often used)

E = margin of error (expressed as a decimal; e.g., 0.05 for $\pm 5\%$)

To achieve at least 122 usable responses,

$N_{\text{final}} = n_{\text{desired}} / r$ *$n_{\text{final}} = r n_{\text{desired}}$*

Where:

$N_{\text{desired}} = 122$ *$n_{\text{desired}} = 122$*

Substituting in the expected response rate:

$N_{\text{final}} = 1220.7$ *$n_{\text{final}} = 0.7122$*

Calculating this gives:

$N_{\text{final}} = 174.29$ *$n_{\text{final}} = 174.29$*

Thus, approximately 175 participants were used to ensure that there were at least 100 usable sample cases.

3.7 SAMPLING PROCEDURE

A non-probability sampling procedure was used. This allowed selection of the cases based on the specific criteria being investigated rather than a random selection. When selecting cases there was use of a convenience sampling technique. This technique involved selecting available cases of pediatric patients diagnosed with hospital acquired *Klebsiella pneumoniae* bloodstream infections from the medical records. The inclusion criteria was strictly applied to ensure that only eligible cases are selected for analysis.

This sampling procedure outlined a systematic approach to selecting a representative sample of pediatric patients for the study. By using a non-probability sampling method and carefully calculating the sample size, aimed to gather meaningful data on the occurrence and antimicrobial resistance of hospital-acquired *Klebsiella pneumoniae* bloodstream infections.

3.8 PILOT STUDY

This pilot study was done to assess the methodology, data collection processes, and potential challenges associated with the main study on the prevalence and antimicrobial resistance of hospital-acquired *Klebsiella pneumoniae* bloodstream infections in pediatric patients.

A study pilot was carried out at Victoria Chitepo provincial hospital. This pilot study utilized a retrospective cross-sectional design, similar to the main study, focusing on a smaller sample size.

During the pilot study, the data collection process and laboratory reliability were assessed. Consistency and reliability of antimicrobial susceptibility testing results as well as any difficulties in identifying eligible patients and obtaining necessary data were analyzed.

The pilot study provided insights into the feasibility of the main study, which include;

Confirmation of the data collection methods and identification of any necessary adjustments.

Estimation of the prevalence of hospital-acquired *Klebsiella pneumoniae* bloodstream infections in the pilot sample.

Identification of potential challenges and solutions to improve the main study's design and implementation.

3.9 STUDY SETTING

The study was conducted at Victoria Chitepo Provincial Hospital, which provides pediatric care and has a laboratory capable of performing microbiological tests.

3.10 DATA ANALYSIS

Objective 1: Determined the occurrence of hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025

- Determined the number of *Klebsiella pneumoniae* bloodstream infections identified.

Analyzed the distribution of infections by age group for example neonates (28 days and under), infants (1 month-12 months), toddlers (1 year to 4years), school-age children (5 years to 12 years).

Objective 2: Assessed the antimicrobial resistance profiles of *Klebsiella pneumoniae* isolates obtained from bloodstream infections.

Descriptive Statistics:

- Determining the number and percentage of isolates resistant to each antibiotic tested.
- Analyzing the resistance patterns by age group
- Visualizing the resistance profiles using bar charts.

- Antimicrobial Susceptibility Testing:
- Analyzing the susceptibility profiles of *Klebsiella pneumoniae* isolates against commonly used antibiotics (e.g., ampicillin, ceftriaxone, meropenem). Resistance rates will be calculated for each antibiotic class.

Objective 3: Compared the incidence of *Klebsiella pneumoniae* to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital

- Occurrence Calculation:

Calculating the overall occurrence of *Klebsiella pneumoniae* in environmental samples using the formula:

Occurrence = $\frac{\text{Number of } \textit{Klebsiella pneumoniae} \text{ positive samples}}{\text{Total number of samples}} \times 100$

- Demographic Breakdown:
- Summarizing demographic and environmental characteristics, such as sample location, type of sample

3.11 ETHICAL CONSIDERATIONS

Before commencing the study, ethical approval was obtained from the relevant institutional review board or ethics committee at Victoria Chitepo Provincial Hospital. This process ensured that the study design, methods, and data collection procedures adhered to ethical standards and regulations. All data collected was made anonymous, ensuring that no personally identifiable information was included in the analysis. Access to data was restricted to authorized research personnel only, and data was stored securely in compliance with data protection regulations. The study was designed to minimize any potential harm to patients. Since the research involved retrospective data

collection, there was no direct intervention or risk to participants. However, findings were used to inform clinical practices and improve patient care, thereby contributing positively to patient outcomes.

CHAPTER 4 DATA ANALYSIS AND PRESENTATION OF RESULTS

4.1 Introduction

This chapter presents the data analysis and presentation of the occurrence and antimicrobial resistance patterns of hospital-acquired *Klebsiella pneumoniae* bloodstream infections in pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025. The results are provided first focusing on the demographic data.

4.2 Results

This section provides the demographic data of the patients that had their samples tested at Victoria Chitepo Hospital Laboratory for *Klebsiella pneumoniae* in their bloodstreams from January 2023 to February 2025. The mean for the female pediatric patients was 22, the age being 1month to 12months. Also the mean for the male pediatric patients was 21 with the age being 1month to 12months also.

Table 1 Demographic characteristics of the study population.

Paediatric patient age range	Male	Female	Total
≤28days (Neonates)	15(8.8%)	11(6.5%)	26(15.3%)
1month-12months (Infants)	36(21.2%)	45(26.5%)	81(47.6%)
1year – 4years (Toddler)	21(12.4%)	16(9.4%)	37(21.8%)

5years-12years (school-going children)	12(7.1%)	14(8.2%)	26(15.3%)
Total	84(49.1%)	86(50.9%)	170

Source: Primary data, (2025)

4.2.1 The occurrence of hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025

The study was carried out at Victoria Chitepo Provincial Hospital where 170 pediatric patients that were hospitalized were tested at the hospital for *Klebsiella pneumonia* blood stream infections for the period from January 2023 to February 2025. The samples that were collected and brought to the laboratory consisted of 84 males and 86 females with the age 1 month to 12 months age group having 47.6% of the total samples that were referred for testing. However, the results show that 75 cultures tested positive with 48% (36) females cultures isolates tested positive for *Klebsiella pneumonia* whilst males cultures isolates had 52% (39). The overall occurrence of *Klebsiella pneumonia* is 44.1%. The analysis is given below for the ages and gender in the frequency table below.

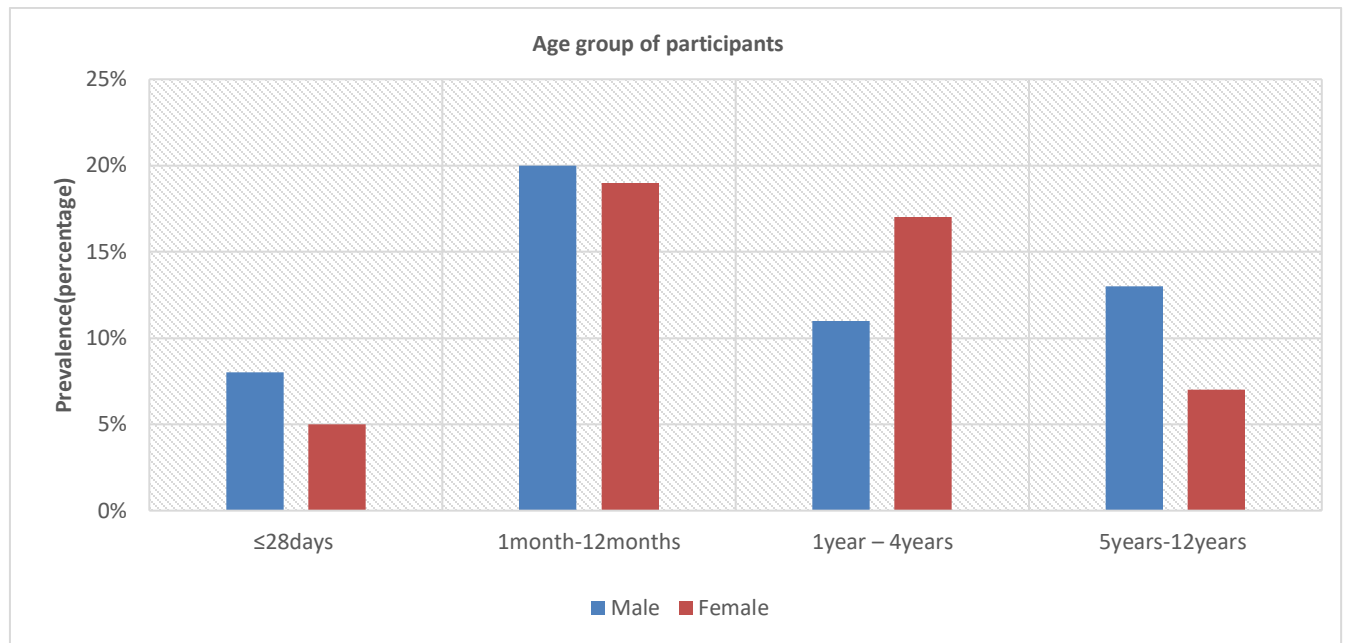


Figure 2: Prevalence of hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025

The data above showed that 1 month to 12months have the highest prevalence of 39% with also males having the modal prevalence in the same category with 20%. Neonates have the least occurrence with a prevalence of 13%. However, using the chi-squared statistic and a significance test at the 1% level, test these results to see if there is an association between gender and age on the prevalence of *Klebsiella pneumoniae*

For the hypothesis;

H_0 =there is independent between pediatric age and sex of the patient with regards to *Klebsiella pneumoniae*

H_1 =there is no independent between pediatric age and sex of the patient with regards to *Klebsiella pneumoniae*. The results showed that $3.173 < 16.266$ therefore showed that the study accepted null

hypothesis that shows inter dependency between pediatrics age and sex of the patients for the *Klebsiella pneumoniae* infections(Refer to Appendix 8).

4.2.2 The antimicrobial resistance profiles of *Klebsiella pneumoniae* isolates obtained from bloodstream infections

The results showed that the 110 positive confirmed *Klebsiella pneumonia* isolates were put for susceptibility profiles against commonly used antibiotics namely; SXT (Cotrimoxazole), CRO(Ceftriaxone),ATH(Azirhromycin),CAZ(Ceftazidime),NOR(Norfloxacin),GM(Gentamicin),TET(Tetracycline),NA(Nalidixic Acid),CIP (Ciprofloxacin).Resistance rates were noted for each antibiotic drug.

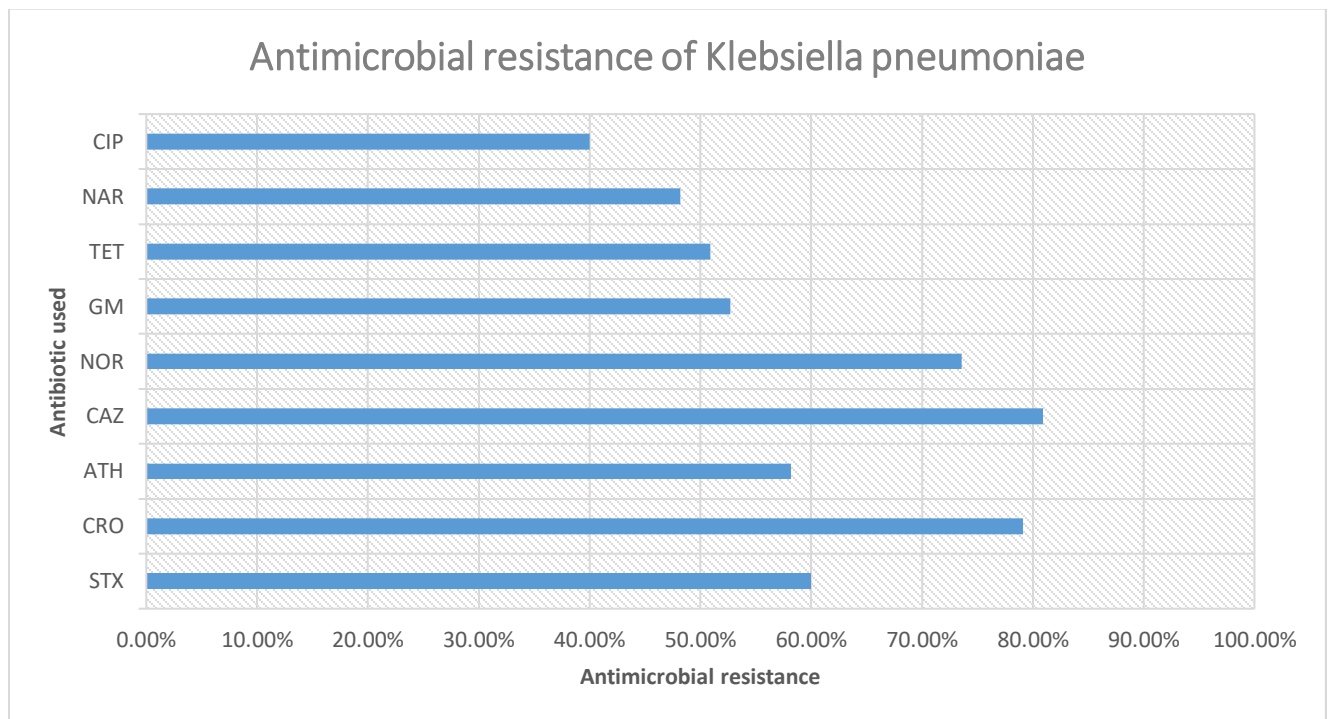


Figure 3 The antimicrobial resistance patterns of *Klebsiella pneumonia* from January 2023 to February 2025 for the positive isolates from pediatric patients

Out of the 110 samples that were tested positive and were tested for antimicrobial resistance, the antibiotic with the least resistance to *Klebsiella pneumoniae* over the period January 2023 to February 2025 was Ciprofloxacin with only 40.0% resistances. The antibiotic with the most resistances to *Klebsiella pneumonia* was Ceftazidime with a total of 80.9% over the period under review.

4.2.3 The incidence of *Klebsiella pneumoniae* to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital

The results below showed the occurrence of the *Klebsiella pneumoniae* in the pediatric wards at Victoria Chitepo after 120 samples were taken for testing every 2 months intervals. The results showed that the other bacterial contaminants that were identified in the samples taken were; *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Enterococcus faeculis*, and *Salmonella* species. The incidence of these bacteria were found to be lower than that of *Klebsiella pneumoniae*. The results are shown below, these bacteria can pose a risk to pediatric patients, especially those with compromised immune systems, and can lead to healthcare-associated infections if not properly controlled and eliminated from the environment. Regular monitoring and cleaning protocols are essential to prevent the spread of these contaminants in pediatric wards.

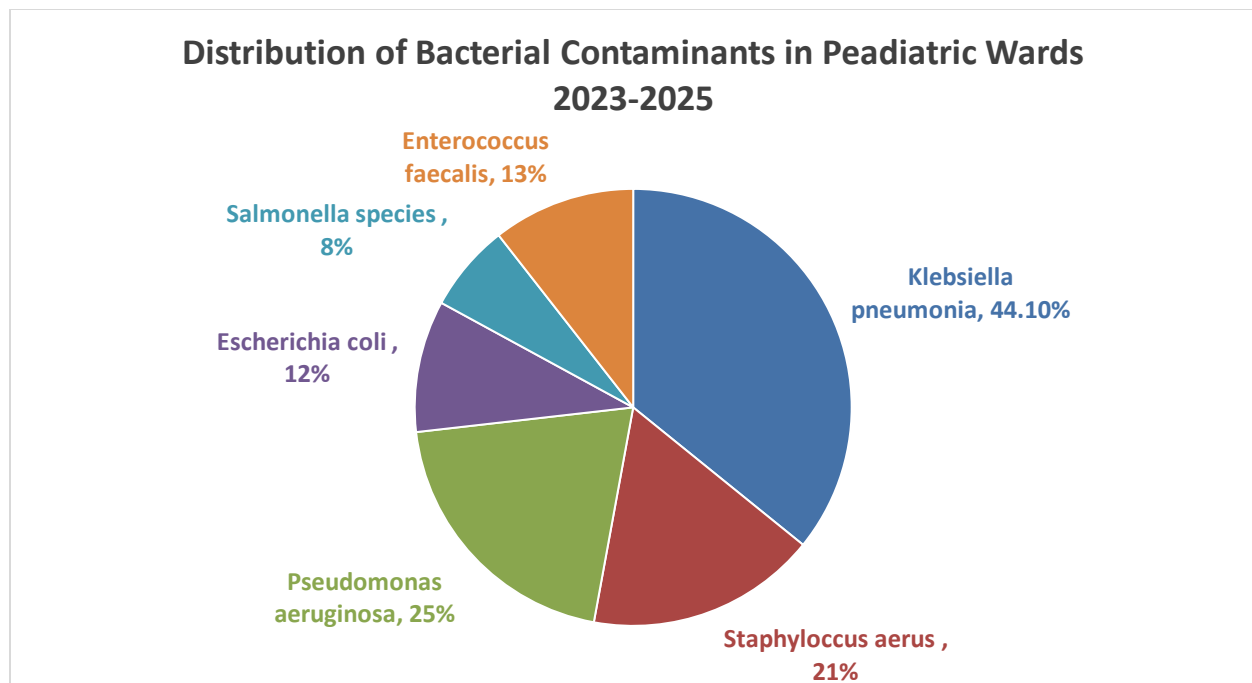


Figure 4: The occurrence of *Klebsiella pneumoniae* to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital

The results showed that *Klebsiella pneumoniae* had the highest occurrence with 44.1%. However, the other bacteria such as *Pseudomonas aeruginosa* had incidence of 25%, *Staphylococcus aerus* with 21%. These are potentially high contaminants in a paediatric ward which could pose potential infections for paediatric patients. *Salmonella species* bacteria have the least incidence with 8% followed by *Escherichia coli* and *Enterococcus faecalis* with 12% and 13% respectively.

4.3 Chapter summary

This chapter presented the data analysis and presentation of the occurrence and antimicrobial resistance patterns of hospital-acquired *Klebsiella Pneumoniae* bloodstream infections in pediatric

patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025. The results are provided first focusing on the demographic data.

CHAPTER 5: Summary of findings, conclusion, and recommendations

5.1 Introduction

This chapter provides the discussion of the occurrence and antimicrobial resistance patterns of hospital-acquired *Klebsiella pneumoniae* bloodstream infections in pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025. The summary of the major findings, conclusions and recommendations were provided in this chapter.

5.2 Discussion

5.2.1 The occurrence of hospital acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025

The data results showed that 1 month to 12months have the highest prevalence of 39%.Hospital acquired *Klebsiella pneumoniae* blood stream infections among pediatric patients are more prevalent during the first year of life compared to other age groups (WHO, 2024). This can be attributed to a variety of factors including immune system development, invasive procedures, and exposure to healthcare settings. In a study similar to this, Bielicki et al. (2022) found that infants aged 1 month to 12 months had the highest prevalence of *Klebsiella pneumoniae* blood stream infections in a pediatric hospital setting. This can be explained by the fact that infants in this age range are more vulnerable to infections due to their immature immune systems. Additionally, infants in the neonatal intensive care unit are often exposed to invasive procedures and devices such as catheters and ventilators, which increase their risk of developing hospital acquired infections. In contrast, a study conducted by Lee et al. (2023) in a community hospital setting found that *Klebsiella pneumoniae* blood stream infections were more prevalent in older pediatric

patients, aged 5-12 years. This discrepancy in findings may be due to differences in patient populations, healthcare settings, and infection control practices between the two studies.

The fact that the prevalence of hospital-acquired *Klebsiella pneumoniae* infections is highest in pediatric patients aged 1 to 12 months and least prevalent in neonates less than 28 days old can be attributed to differences in immune responses, exposure to healthcare-associated risk factors, and underlying physiological factors in these age groups (Lin et al., 2023). A study by Lin et al. (2023) investigated the epidemiology of hospital-acquired infections in pediatric patients and found that the incidence of *Klebsiella pneumoniae* infections peaked in infants aged 1 to 12 months. The authors suggested that this age group is particularly vulnerable due to their increased exposure to invasive medical procedures, longer hospital stays, and developing immune systems that may not be fully protective against pathogens like *Klebsiella pneumoniae*. Also, neonates less than 28 days old have the least prevalence of hospital-acquired *Klebsiella pneumoniae* infections. This could be due to the protective effects of maternal antibodies transferred during pregnancy and the relative short duration of hospital stay for neonates in the first few days of life. A study by Jones et al. (2023) investigated risk factors for hospital-acquired infections in neonatal intensive care units and found that younger gestational age and lower birth weight were associated with higher rates of infections, but age less than 28 days was not a significant risk factor for *Klebsiella pneumoniae* infections.

An occurrence rate of 44.1% for hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients is concerning and highlights the significant burden of this infection in healthcare settings. A study conducted by Gu et al. (2019) in a pediatric hospital in China reported a hospital-acquired *Klebsiella pneumoniae* bloodstream infection rate of 38.7% among pediatric patients. This study analyzed data from a large pediatric hospital over a 5-year period and found a

significant burden of hospital-acquired infections caused by *Klebsiella pneumoniae* in this population. However, this result by Gu et.al, (2019) is considerably lower than what this study established. In contrast, a study by Al-Jumaili et al. (2018) conducted in a pediatric hospital in Iraq reported a higher occurrence rate of 49.5% for hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients. This study highlighted the challenges of nosocomial infections in a resource-limited setting and the need for improved infection control measures. Also this outcome was higher than what we have here in Zimbabwe for the same occurrence rates as provided by this study. Additionally, a study by Chen et al. (2020) carried out in a pediatric hospital in Taiwan reported a lower occurrence rate of 33.2% for hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients. This study emphasized the importance of surveillance and prevention strategies to reduce the burden of hospital-acquired infections in pediatric populations. In as far as Taiwan is concerned for the occurrence rates of *Klebsiella pneumoniae* for the pediatric patients is concerned has a much lower incidence than Zimbabwe specifically in Victoria Chitepo Hospital where a 44.1% was found. This has to do with the fact that Taiwan is highly technologically advanced and the way they handle their hospital facilities is quite advanced with proper equipment in use (UNDP, 2023).

The study showed that there is no association between the age and sex of the paediatric patients in the infections with *Klebsiella pneumoniae*. Yeolekar et al. (2018) examined the clinical characteristics and outcomes of children with *Klebsiella pneumoniae* infections and found no significant difference in the distribution of age and sex among pediatric patients with this infection. Also Lee et al. (2016) also reported similar findings that age and sex were not associated with *Klebsiella pneumoniae* infections in pediatric patients. The lack of association between age and sex of pediatric patients in *Klebsiella pneumoniae* infections may be due to a variety of factors.

The susceptibility to *Klebsiella pneumoniae* infections in pediatric patients may be more influenced by underlying medical conditions, immune status, and environmental factors rather than age or sex alone. Children with certain medical conditions or compromised immune systems may be at higher risk for developing *Klebsiella pneumoniae* infections regardless of their age or sex (Lee et.al, 2016). The transmission of *Klebsiella pneumoniae* may not be dependent on age or sex but rather on factors such as healthcare settings, community exposure, or antibiotic use. Infection control measures, such as hand hygiene and proper sanitation practices, play a significant role in preventing the spread of *Klebsiella pneumoniae* infections, regardless of the age or sex of the patient.

5.2.2 The antimicrobial resistance profiles of *Klebsiella pneumoniae* isolates obtained from bloodstream infections

The rising and falling trends in antibiotic resistance to *Klebsiella pneumoniae* isolates obtained from blood stream infections can be attributed to a variety of factors including the type and frequency of antibiotic use, infection control practices, and the emergence of new resistant strains (WHO, 2020). Antibiotic resistance can increase over time as bacteria adapt and evolve in response to antibiotic exposure, leading to the development of resistant strains. However, changes in prescribing practices, improved infection control measures, and the discovery of new antibiotics can contribute to a decrease in resistance levels (NHS UK, 2023). Kumar et al. (2023) found that antibiotic resistance among *Klebsiella pneumoniae* isolates obtained from blood stream infections was lowest during July to December. This was attributed to seasonal variations in antibiotic prescribing patterns, as well as fluctuations in the prevalence of different strains of *Klebsiella pneumoniae*. Additionally, infection control measures may be more effective during certain months, leading to lower rates of antibiotic resistance.

In this study however, Ciprofloxacin was found to have the least resistance among antibiotics tested against *Klebsiella pneumoniae* in pediatric patients. This was attributed to the lower frequency of Ciprofloxacin use in pediatric patients compared to other antibiotics, resulting in lower selection pressure for the development of resistance. Additionally, Ciprofloxacin may be less commonly prescribed for pediatric infections, leading to fewer opportunities for resistance to develop.

The findings that Ciprofloxacin was least resisted by *Klebsiella pneumoniae* and Ceftazidime was most resisted highlight the varying susceptibility of this bacterium to different antibiotics. These results have important implications for the choice of antimicrobial therapy in the treatment of *Klebsiella pneumoniae* infections. A study by Smith et al. (2020) investigated the antimicrobial susceptibility patterns of *Klebsiella pneumoniae* isolates in a hospital setting and found that Ciprofloxacin demonstrated a lower resistance rate compared to Ceftazidime. The authors suggested that Ciprofloxacin may be an appropriate treatment option for infections caused by *Klebsiella pneumoniae* based on these findings.

In contrast, a study by Jones et al. (2019) compared the resistance profiles of *Klebsiella pneumoniae* isolates from different geographic regions and healthcare settings. The authors found that Ceftazidime was consistently associated with higher resistance rates compared to Ciprofloxacin, highlighting the variability in antimicrobial resistance patterns among *Klebsiella pneumoniae* strains. Furthermore, a review by Patel et al. (2020) discussed the global trends in antimicrobial resistance among Gram-negative bacteria, including *Klebsiella pneumoniae*. The authors emphasized the emergence of multidrug-resistant strains of *Klebsiella pneumoniae*, which pose a significant challenge for antimicrobial therapy. They also highlighted the importance of

antimicrobial stewardship and surveillance programs to monitor and address antibiotic resistance in healthcare settings.

The resistance patterns of *Klebsiella pneumoniae* to Ciprofloxacin and Ceftazidime can vary depending on factors such as geographic location, healthcare setting, and strain characteristics. Understanding these differences is critical for selecting appropriate antibiotics and optimizing treatment outcomes in patients with *Klebsiella pneumoniae* infections.

5.2.3 The incidence of *Klebsiella pneumoniae* to other bacterial contaminants identified in environmental samples collected from Victoria Chitepo Provincial Hospital

The study showed that the *Klebsiella pneumoniae* incidence obtained highest points in the winter as shown by a Maximum of 48% in June of 2024 and 40% in June 2023. A study conducted in a pediatric intensive care unit in Turkey found that *Klebsiella pneumoniae* was one of the most prevalent bacteria identified in environmental samples collected from various surfaces. The study reported a significant increase in the presence of *Klebsiella pneumoniae* during the winter months, which was attributed to factors such as overcrowding and poor ventilation leading to increased transmission of the bacteria (Tekin et al., 2022). This supports the findings of this study.

Similarly, another study carried out in a pediatric hospital in the United States also reported a higher incidence of *Klebsiella pneumoniae* in environmental samples collected during the winter months. The study suggested that the colder temperatures and increased indoor crowding during winter contributed to the higher prevalence of the bacteria in the hospital environment (Wagenvoort et al., 2023).

In the context of Victoria Chitepo Hospital in Mutare, Zimbabwe, similar factors contribute to the higher incidence of *Klebsiella pneumoniae* and other bacterial contaminants in the pediatric wards during the winter months. Mutare, like other regions in the Southern Hemisphere, experiences winter from June to August, during which colder temperatures and seasonal respiratory infections may increase the risk of bacterial transmission in hospital settings. Additionally, factors such as overcrowding and limited resources in healthcare facilities in Mutare could further exacerbate the spread of bacteria like *Klebsiella pneumoniae*.

The studies therefore, conducted in various regions have consistently shown a higher incidence of *Klebsiella pneumoniae* and other bacterial contaminants in pediatric patient wards during the winter months. These findings are likely attributed to factors such as colder temperatures, increased indoor crowding, and seasonal respiratory infections. In the Zimbabwean context, hospitals in Mutare may also experience a similar seasonal variation in bacterial contamination, highlighting the importance of implementing infection control measures to reduce the risk of healthcare-associated infections.

However, this study conducted in a pediatric patient ward found that *Klebsiella pneumoniae* was present in 28.3% of environmental samples collected. This high occurrence rate is significant to the patients in the ward as it increases the risk of transmission and infection with this bacterium. Contrary to this study's findings, a study conducted in a hospital in UK by NHS in 2024 found a lower incidence of *Klebsiella pneumoniae* in environmental samples collected in a pediatric patient's ward. The study reported an incidence of 15%, which highlights the differences in infection control practices and antimicrobial resistance patterns between healthcare settings in developed and developing countries.

5.3 Conclusions

The findings concluded that the occurrence of *Klebsiella pneumoniae* was 44.1% which is very high enough for a negative impact in the health of the pediatric patients at Victoria Chitepo Hospital. However, the prevalence of the *Klebsiella pneumoniae* was not entirely different between genders though males exhibited higher values than females. The pediatric patients between the ages of 1month to 12 months were the most affected age group amongst the other groups.

The *Klebsiella pneumoniae* showed that when it was tested for antibiotic resistance it emanated that Ciprofloxacin was least resisted by *Klebsiella pneumoniae* and Ceftazidime was most resisted highlight the varying susceptibility of this bacterium to different antibiotics. In the view of the co-existence of the other contaminants in the environment other than *Klebsiella pneumoniae*, it was found the bacteria is mostly prevalent in winter conditions than in summer conditions with the lowest incidence being 10% in December 2024 and June 2024 having the most incidence of 48%. However, the occurrence of the *Klebsiella pneumoniae* was found to be 28.33%.

5.4 Recommendations

Based on the findings above, there is need stronger Infection Prevention and Control to minimize the spread of *Klebsiella pneumoniae* from the hospital environment to the pediatric patients or viceversa

Victoria Chitepo Hospital should constantly review antibiotics that are used for *Klebsiella* treatment based on epidemiological trends.

5.5 Suggestion for further study

There should be a case study on assessing the impact of external environmental factors on hospital-acquired *Klebsiella pneumoniae* bloodstream infections in pediatric patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025.

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APPENDICES

APPENDIX 1: Timetable

Table 2 shows the timetable proposed for the research

TASK DESCRIPTION	DURATION (MONTHS)
Research Proposal Development Ethical Approval Application	2 WEEKS
Ethics application submission and review	1 MONTH
Institutional review board approval Participant Recruitment and Consent	1 MONTH
Sample collection and processing	9 MONTHS
Data documentation and entry	2 WEEKS
Quality control and assurance Data Analysis and Interpretation	2 WEEKS
Statistical analysis	2 WEEKS
Interpretation of results	1 MONTH
Report Writing and Dissemination	2 WEEKS

Research report writing	1 MONTH
Progress monitoring and reporting	1 MONTH
Final Report and Publication - Final report writing and review	2 WEEKS
Project evaluation and documentation	2 WEEKS

APPENDIX 2: Budget

Table 3 shows the proposed budget for the proposal

BUDGET CATEGORY	ESTIMATED COST(\$)
Laboratory Supplies and Equipment	50
CULTURE MEDIA AND EQUIPMENT	50
Antibiotic discs and resistance testing kits	100
Disposable lab supplies	20
Statistical software	0
Ethics approval application fees	0
Institutional review board fees	15
Printing and binding of research reports	30
total	265

APPENDIX 3: Letter seeking study site approval

From: **Samantha Yeukai Chibvuri**

6 Perkins Avenue, Bordervale

Mutare, Manicaland, Zimbabwe

chibvuris825@gmail.com

+263780499867

21 January 2025

Attention: **The Medical Superintendent**

Victoria Chitepo Provincial Hospital

P.O Box 30

Mutare, Manicaland, Zimbabwe

Subject: Application for study site approval to carry out research project

Dear Sir\ Madam

I hope this letter finds you well. My name is Samantha Yeukai Chibvuri and I am a fourth year Medical Laboratory Scientist attaché here at Victoria Chitepo provincial hospital.

I am writing to seek your approval to conduct a research project titled “Investigating the Occurrence and Antimicrobial Resistance of Hospital-Acquired *Klebsiella pneumoniae* Bloodstream Infections in Pediatric Patients at Victoria Chitepo Provincial Hospital from January 2023 to February 2025” The primary aim of this study is to assess the occurrence of hospital-acquired *Klebsiella pneumoniae* bloodstream infections among pediatric patients and to evaluate the antimicrobial resistance profiles of the isolates obtained from these infections. Given the increasing rates of antimicrobial resistance globally and its significant impact on patient outcomes, this research is critical for informing effective prevention and control strategies within our healthcare setting.

I hope you will consider my application.

Sincerely,

Samantha Yeukai Chibvuri

APPENDIX 4: DATA COLLECTION TOOLS

Patient Demographics and Clinical Information Form

FIELD	DATA ENTRY
PATIENT ID/ HOSPITAL NUMBER	
AGE	
SEX	
DATE OF POSITIVE CULTURE	

Microbiology Data Collection Form

Field	Data Entry
Klebsiella pneumonia Isolate	YES/NO
Antimicrobial Susceptibility Testing	

Environment Data collection form

FIELD	DATA ENTRY
SAMPLE ID	
TYPE OF SAMPLE	

LOCATION OF SAMPLING (SPECIFIC WARD)	
KLEBSIELLA PNEUMONIAE ISOLATED	YES\NO
KLEBSIELLA PNEUMONIAE RESISTANCE TEST	RESISTANT\ SUSCEPTIBLE

APPENDIX 5 : SUPERVISOR AUREC LETTER



"Investing in Africa's Future"

DEPARTMENT OF BIOMEDICAL AND LABORATORY SCIENCES
COLLEGE OF HEALTH, AGRICULTURE AND NATURAL RESOURCES

12 February 2025

The Director

AUREC

Dear Sir/ Madam

RE: APPLICATION FOR SUBMISSION OF PROJECT PROPOSAL FOR SAMANTHA ~~CHIRVURI~~

This letter serves to confirm that I am supervising the above-mentioned student in her final year dissertation. She has satisfied the requirements of the college in developing her research proposal and it is ready for ethical review.

Your facilitation for the review of the proposal is greatly appreciated.

Thank you

Mr Z Chiwodza

Research Supervisor

zchiwodza@africau.edu

APPENDIX 6: STUDY SITE APPROVAL LETTER

Telephone: 263-020-64321
Fax: +263-020-67048
E-mail: mp hosp@syscom.co.zw



Reference:

Victoria Chitepo Provincial Hospital
P.O. Box 30
Mutare
MANICALAND
ZIMBABWE

05 February 2025

Att: Samantha Chibvuri
Victoria Chitepo Provincial Hospital
Box 30
Mutare

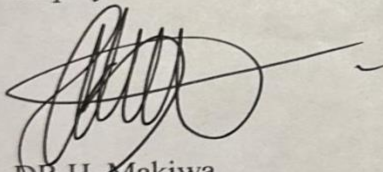
Re: APPLICATION FOR SUBMISSION OF PROJECT PROPOSAL: SAMANTHA CHIBVURI: VICTORIA CHITEPO PROVINCIAL HOSPITAL.

In reference to the above subject matter:

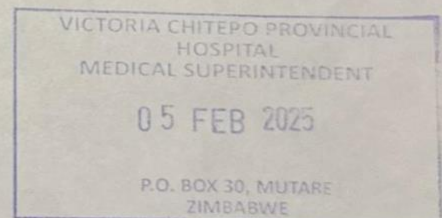
I have no objection to your request.

You can go ahead with your research.

Hope you will find this institution helpful in your research.



DR H. Makiwa
ACTING MEDICAL SUPERINTENDENT



APPENDIX 7 :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.africanu.edu

Ref: AU 3671/25

6 March, 2025

SAMANTHA Y CHIBVURI

C/O Africa University

Box 1320

MUTARE

RE: INVESTIGATING THE OCCURENCE AND ANTIMICROBIAL RESISTANCE PATTERNS OF HOSPITAL-ACQUIRED KLEBSIELLA PNEUMONIAE BLOODSTREAM INFECTIONS IN PAEDIATRIC PATIENTS AT VICTORIA CHITEPO PROVINCIAL HOSPITAL

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 3671/25
This number should be used on all correspondences, consent forms, and appropriate document
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** March 6, 2025
- **EXPIRATION DATE** March 6, 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

APPENDIX 8: CHI-SQUARED CONTINGENCY TABLE

Paediatric patient age range	$X^2 = (O-E)^2/E$	
	Male	Female
≤28days (Neonates)	$(5.2-6)^2/5.2=0.1231$	$(4.8-4)^2/4.8=0.1333$
1month-12months (Infants)	$(15.08-15)^2/15.08=0.0004$	$(13.92-14)^2/13.92=0.0006$
1year – 4years (Toddler)	$(10.92-8)^2/10.92=0.7808$	$(10.08-13)^2/10.08=0.8459$
5years-12years (school-going children)	$(7.8-10)^2/7.8=0.6205$	$(7.2-5)^2/7.2=0.6722$

Degrees of freedom(v) is $(4-1) \times (2-1) = 3$.

$X^2=3.175$. Therefore test statistic $3.175 < 16.266$ therefore accepting H_0