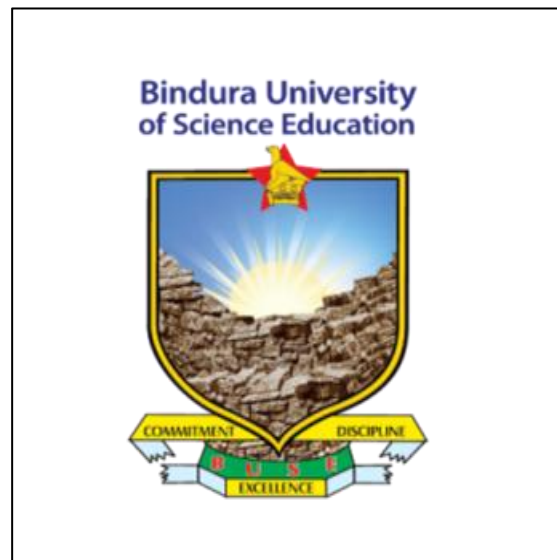




**A STUDY TO INVESTIGATE NEONATAL SEPSIS AT MPIOLO CENTRAL HOSPITAL**

**BY**

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**SUBMITTED TO BINDURA UNIVERSITY OF SCIENCE EDUCATION IN PARTIAL  
FULFILMENT OF THE REQUIREMENTS OF THE POST GRADUATE DIPLOMA IN  
INFECTION, PREVENTION AND CONTROL**

**SUPERVISOR: Ms A. Manwere**

## APPROVAL FORM

The undersigned certifies that they have supervised, read and recommended to Bindura University of Science Education for acceptance, a research project entitled:

A study to investigate Neonates admitted at Mpilo Central Hospital between January 1, 2024, and December 31, 2024, without a laboratory-confirmed diagnosis of sepsis submitted in partial fulfilment of the requirements of the Postgraduate Diploma in Infection Prevention and Control.

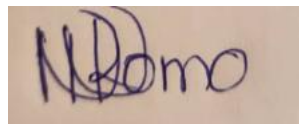
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18/07/2025

Signature of student



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I certify that I supervised Nokuthula Nkomo, registration number B231737B in carrying out the research entitled “A study to investigate Neonates admitted at Mpilo Central Hospital between January 1, 2024, and December 31, 2024, without a laboratory-confirmed diagnosis of sepsis”, in partial fulfilment of the requirements for the award of Post Graduate Diploma in Infection Prevention and Control (PGDIPC) and recommend that it proceeds for examination.

Supervisor:



25.09.2025

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### III. To be completed by Chairperson of the Department.

I certify to the best of my knowledge that the required procedures have been followed and the preparation criteria has been met for this dissertation.



25.09.2025

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## DECLARATION

I declare that a study entitled:

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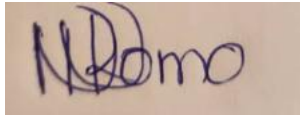
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Name of student:

Registration number: B231737B

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Signature:



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## **ABBREVIATIONS/ACCRONYMS**

**AOR** Adjusted Odds Ratio

**ANC** Antenatal Care

**ART** Antiretroviral Therapy

**CI** Confidence Interval

**COR** Crude Odds Ratio

**CS** Caesarean Section

**EMR** Electronic Medical Records

**HIV** Human Immunodeficiency Virus

**IPC** Infection Prevention and Control

**KMC** Kangaroo Mother Care

**NICU** Neonatal Intensive Care Unit

**PMTCT** Prevention of Mother-to-Child Transmission

**PROM** Premature Rupture of Membranes

**SDG** Sustainable Development Goal

**SVD** Spontaneous Vaginal Delivery

**STI** Sexually Transmitted Infection

**UTI** Urinary Tract Infection

## ABSTRACT

Neonatal sepsis is a major global public health concern and remains a leading cause of illness and death during the neonatal period (Mezgebu, T. et.al, 2023). Mpilo Central Hospital is not spared. It is also struggling with neonatal sepsis, contributing a large percentage to the high neonatal mortality rates in Zimbabwe. This study aimed to determine the factors associated with neonatal sepsis at Mpilo Central Hospital in Bulawayo, Zimbabwe.

A hospital-based case-control study was performed, comparing neonates with confirmed sepsis (cases) with matched controls with no sepsis at a ratio of 1:1. Using 12 months of already existing data (January 2024-December 2024), this study investigated maternal, obstetric, and hospital-risk factors through medical record review of 143 neonates without a lab confirmed diagnosis of neonatal sepsis (cases) and 143 neonates with no sepsis (controls). The study sample was selected using the matched case control sampling method. The study aimed to determine risk factors in a bid to guide targeted interventions and improve neonatal outcomes under this limited resource environment.

Controls were individually matched to cases based on chronological age at admission ( $\pm 3$  days) and gestational age at birth ( $\pm 1$  week). These variables were selected as matching criteria because they are important predictors of neonatal sepsis risk. Chronological age influences both the timing and nature of sepsis onset, as early-onset and late-onset sepsis often have different etiologies and risk factors. Gestational age, on the other hand, is a well-established determinant of neonatal vulnerability, with preterm infants being at significantly higher risk due to their underdeveloped immune systems and the likelihood of extended hospital stays. Matching on these variables helped control for potential confounding effects related to age and maturity, ensuring a more accurate assessment of other risk factors under investigation.

The results quantified significant associations among risk exposures and found out that maternal underlying infections such as HIV status (95% CI (1.52-3.89), low birth weight (95% CI: (2.14-5.81), poor access to antenatal care, delayed rupture of membranes, and having a caesarean section contributed to neonatal sepsis. The odds of developing neonatal sepsis being 3.53 times higher in low birth weight babies compared to the controls. These findings provide critical evidence for Mpilo Hospital's clinical practice guidelines and infection prevention policies, as



well as informing regional efforts to achieve Sustainable Development Goal targets for the reduction of preventable newborn mortality. In conclusion, this case-control study highlights maternal and neonatal factors and their association to neonatal sepsis in a low resource setting in Zimbabwe which calls for contextualized interventions to mitigate the incidence of sepsis in newborns.

## **Chapter Introduction**

### **1.1 Background**

Neonatal sepsis, a bloodstream infection occurring in infants under 28 days old, remains a significant contributor to neonatal morbidity and mortality worldwide. Characterized by a systemic inflammatory response to bacterial, viral, or fungal pathogens, this condition can rapidly progress to life-threatening complications, including septic shock and multi-organ dysfunction (Shane et al., 2017). While global efforts have led to some improvements, the burden of neonatal sepsis continues to be substantial, particularly in low- and middle-income countries (LMICs) (Seale et al., 2019). This research will explore the factors associated with neonatal sepsis, focusing specifically on the context of Mpilo Central Hospital, a major referral hospital in Bulawayo, Zimbabwe. Understanding these factors is crucial for developing targeted interventions to reduce the incidence and improve outcomes for affected newborns.

Globally, neonatal sepsis affects millions of newborns annually, resulting in hundreds of thousands of deaths (Global Burden of Disease Collaborative Network, 2018). In Zimbabwe, where neonatal mortality rates are a significant public health concern, the neonatal mortality rate is 24 deaths per 1,000 live births, with higher rates in rural areas at 32 deaths per 1,000 live births compared to 27 deaths per 1,000 live births in urban areas (UNICEF, 2022). Mpilo Central Hospital, a major referral centre in Bulawayo, recorded 280 child deaths in the first four months of this year, with neonatal deaths accounting for the majority at 122 (Mpilo Central Hospital Annual Report, 2022). The hospital's context, characterized by limited resources, high patient volume, and potentially suboptimal infection control practices, likely plays a role in the local epidemiology of neonatal sepsis.

Several factors are known to increase the risk of neonatal sepsis. Prematurity and low birth weight are major predisposing factors, as these infants have immature immune systems and are more vulnerable to infection (Weston et al., 2016). Obstetric factors, such as prolonged rupture of membranes, chorioamnionitis (infection of the amniotic fluid), and maternal infections, can also increase the risk of transmission to the newborn. Furthermore, factors related to the newborn's immediate environment, including unhygienic delivery practices, inadequate cord care,

and exposure to nosocomial infections in the hospital setting, can contribute to sepsis. At Mpilo Hospital, specific challenges related to these factors, such as the prevalence of home births with potentially less hygienic practices, the availability of resources for managing high-risk pregnancies, and the infection control protocols within the neonatal unit, would need to be investigated.

Beyond these established risk factors, socioeconomic conditions also play a significant role. Poverty, malnutrition, and limited access to quality healthcare contribute to a higher risk of infection in both mothers and newborns. In the context of Mpilo Hospital and its surrounding community, understanding the specific socioeconomic factors that contribute to neonatal sepsis is essential for developing targeted public health interventions. These might include programs addressing maternal nutrition, improving access to antenatal and intrapartum care, and promoting safe childbirth practices. According to the UNICEF DATA report on maternal and newborn health disparities in Zimbabwe, neonatal mortality rates are significantly higher in rural areas and among the poorest households, highlighting the critical need for targeted interventions in these communities (UNICEF, 2022).

A study conducted at Parirenyatwa Central Hospital in Zimbabwe found that hospital-acquired neonatal sepsis was significantly reduced through improved infection control practices and the suspension of mechanical ventilation (Mawadza, 2021). Addressing the challenge of neonatal sepsis at Mpilo Hospital requires a multi-faceted approach. Strengthening infection prevention and control practices within the hospital, including hand hygiene, aseptic techniques during deliveries and neonatal care, and appropriate management of invasive procedures, is crucial. Improving access to quality antenatal and intrapartum care, ensuring skilled birth attendance, and providing timely and appropriate management of maternal infections can also significantly reduce the risk of neonatal sepsis. Furthermore, community-based interventions aimed at improving hygiene practices, promoting safe cord care, and addressing malnutrition can contribute to long-term prevention efforts.

Research focusing on the specific factors associated with neonatal sepsis at Mpilo Hospital is essential for developing evidence-based interventions. Studies investigating the prevalence of

specific pathogens, the impact of existing infection control practices, and the role of socioeconomic factors can provide valuable insights for improving local protocols and resource allocation. Such research should also explore the challenges faced by healthcare workers in implementing best practices and identify potential barriers to effective prevention and management of neonatal sepsis within the hospital setting. Neonatal sepsis poses a significant threat to newborn survival, and the burden is likely substantial at Mpilo Central Hospital. A complex interplay of factors, including prematurity, obstetric complications, environmental exposures, and socioeconomic conditions, contributes to the risk of infection. Addressing this challenge requires a comprehensive approach that encompasses strengthening infection control practices, improving maternal and newborn health services, and addressing underlying socioeconomic factors. Targeted research focusing on the specific context of Mpilo Hospital is crucial for developing evidence-based interventions to reduce the incidence of neonatal sepsis and improve outcomes for newborns in Bulawayo.

## **1.2 Problem Statement**

Neonatal sepsis remains a major cause of morbidity and mortality, especially in LMICs. Mpilo Central Hospital faces significant challenges due to this condition. Despite its importance, there is limited understanding of the specific risk factors for neonatal sepsis in this setting, hindering effective interventions. This study aims to investigate these risk factors at Mpilo Central Hospital, seeking to identify key determinants and develop locally relevant strategies for prevention, early diagnosis, and improved management.

## **1.3 Objectives**

1. Identify maternal related risk factors associated with neonatal sepsis at Mpilo Hospital.
2. Identify neonatal related risk factors associated with neonatal sepsis at Mpilo Hospital
3. Assess health facility related factors on the incidence of neonatal sepsis.
4. To propose evidence-based interventions targeting the modifiable risks factors identified.

## **1.4 Research Questions**

1. What are the key maternal risk factors for neonatal sepsis at Mpilo Hospital?

2. What are the key neonatal risk factors for neonatal sepsis at Mpilo Hospital?
3. What are the health facility related factors that contribute to the incidence of neonatal sepsis?
4. What interventions can be implemented to reduce the risk of neonatal sepsis at Mpilo Hospital?

### **1.5 Justification of the study**

Neonatal sepsis remains a leading cause of neonatal morbidity and mortality globally, with the burden disproportionately affecting low- and middle-income countries like Zimbabwe. At Mpilo Central Hospital in Bulawayo, neonatal deaths account for a significant portion of child mortality, highlighting an urgent need for localized, evidence-based interventions. Despite anecdotal reports suggesting high prevalence, there is a critical lack of context-specific data on risk factors contributing to neonatal sepsis within this setting. This study seeks to address that gap by identifying key determinants, optimizing resource allocation, and informing the development of tailored, culturally sensitive interventions. By improving early diagnosis and management protocols, the research aims to reduce neonatal mortality rates, promote equitable healthcare, and build local capacity through collaboration and staff training, ultimately enhancing neonatal outcomes in Mpilo and similar resource-constrained environments. A case-control design was chosen as it is well-suited for investigating relatively uncommon but serious conditions like neonatal sepsis. It allows for the efficient assessment of multiple potential risk factors using existing records, making it a practical and cost-effective approach in low-resource settings.

### **1.6 Significance of the Study:**

The significance of this study lies in its potential to address critical gaps in knowledge and practice related to neonatal sepsis at Mpilo Central Hospital, ultimately contributing to a reduction in neonatal sepsis-related mortality in Bulawayo and improving resource allocation in this low-resource setting. The study's significance can be articulated through several key dimensions:

1. Improved Understanding of Risk Factors:

This study will provide valuable insights into the local epidemiology of neonatal sepsis at Mpilo, where anecdotal reports suggest a high prevalence of the condition. Understanding these risk factors is essential for developing targeted interventions tailored to the unique challenges of the hospital's patient population, which includes new-borns at high risk due to factors such as prematurity and low birth weight. This localized knowledge can also contribute to the broader body of research on neonatal sepsis in LMICs.

## 2. Enhanced Clinical Outcomes:

The study aims to identify and address the factors contributing to neonatal sepsis, ultimately improving clinical outcomes for new-borns. By developing evidence-based strategies for prevention, early diagnosis, and management, the study has the potential to reduce neonatal morbidity and mortality rates, particularly at Mpilo, where limited resources and high patient volumes often compromise the quality of care.

## 3. Resource Optimization:

By identifying the key determinants of neonatal sepsis, the study will enable more efficient allocation of resources at Mpilo. For example, determining the antibiotic resistance patterns of common sepsis-causing pathogens at Mpilo will inform the development of an antibiotic stewardship program, ensuring that the most effective antibiotics are used, reducing the development of resistance, and optimizing drug expenditure.

## 4. Policy and Practice Implications:

The study findings can inform healthcare policies and practices at local and national levels, contributing to national health priorities related to maternal and child health and the reduction of neonatal mortality. The evidence-based recommendations can guide policymakers, healthcare providers, and administrators in making informed decisions about neonatal care, including the development of standardized protocols for neonatal sepsis management.

## 5. Capacity Building and Training:

This study, conducted in collaboration with Mpilo Hospital staff, will foster local capacity in research and evidence-based practice. The training program for healthcare providers will be

integrated into existing hospital curricula to ensure sustainability and will be designed to be easily replicable at other facilities.

#### 6. Ethical and Culturally Sensitive Interventions:

The study will explore any cultural practices related to new-born care that might influence the uptake of recommended infection prevention measures. This will ensure that interventions are not only evidence-based but also culturally sensitive and ethically sound, promoting equitable healthcare and community trust.

#### 7. Addressing Potential Challenges:

While data collection in a busy hospital setting may present challenges, the research team will work closely with Mpilo Hospital staff to minimize disruption and ensure the study's feasibility. Ethical considerations related to data privacy and informed consent will be strictly adhered to. This study has the potential to make a substantial and lasting impact on neonatal care in Zimbabwe and other LMICs by providing a comprehensive understanding of neonatal sepsis risk factors, leading to effective interventions, optimizing resource use, informing policy, and building local capacity.

### **1.7 Scope of the study**

This study will investigate the factors associated with neonatal sepsis at Mpilo Central Hospital in Bulawayo, Zimbabwe, focusing on newborns within the first 28 days of life. It will include data collection from medical records, healthcare provider interviews, and observational studies within the neonatal unit. The study will be conducted over a period of five months.

### **1.8 Conceptual framework**

#### **A Multifaceted Conceptual Framework for Understanding Neonatal Sepsis**

Neonatal sepsis, a significant cause of morbidity and mortality in newborns, necessitates a comprehensive understanding of its complex interplay of contributing factors (Shane et al., 2017). While various conceptual frameworks exist, a synthesized approach, integrating elements from existing models, offers a more nuanced perspective. A multifaceted framework, drawing upon the PIRO (Predisposition, Infection, Response, Organ dysfunction) model (Dellinger et al., 2013),

hierarchical predictor models (McCall et al., 2016), and the established categories of maternal and neonatal risk factors, to provide a holistic understanding of neonatal sepsis is proposed.

The PIRO model provides a useful structure for understanding the pathogenesis of sepsis. "Predisposition" encompasses factors that render the neonate susceptible to infection. These can be further categorized using the hierarchical predictor model, which distinguishes between distal, intermediate, and proximal factors. Distal factors, such as socioeconomic status, maternal health, and access to prenatal care, influence the overall health and resilience of both mother and child, creating a foundational context for risk (Kumar et al., 2010). Intermediate factors, including conditions during pregnancy and labor like premature rupture of membranes (PROM) or chorioamnionitis, directly impact the immediate environment of the fetus and the likelihood of intrapartum infection (Gomez-Lopez et al., 2019). Proximal factors, observable at birth, such as low Apgar scores, meconium aspiration, or prematurity, reflect the newborn's immediate physiological state and vulnerability (Polin et al., 2017). These proximal factors, in conjunction with some intermediate factors (e.g., preterm labor leading to prematurity), often directly contribute to the "Predisposition" component of the PIRO framework.

The "Infection" component of PIRO involves the specific pathogen and its source. Here, intermediate factors such as PROM and chorioamnionitis play a crucial role in facilitating the introduction of pathogens (Khalakdina et al., 2015). Furthermore, maternal infections, a significant maternal risk factor, can directly lead to neonatal infection, highlighting the interconnectedness of maternal and neonatal health.

The "Response" of the neonate to the infection is crucial in determining the severity and progression of sepsis. This response is influenced by both proximal factors, such as the immaturity of the immune system in preterm infants, and distal factors, like maternal nutritional status which can impact the development of the fetal immune system (Bodeau-Livinec et al., 2014). Neonatal factors like low birth weight further compound the vulnerability of the newborn and influence their ability to mount an effective immune response.

Finally, "Organ Dysfunction," the ultimate consequence of severe sepsis, is a culmination of the preceding factors. The initial predisposition, the nature and source of the infection, and the



neonate's physiological response all contribute to the development of organ dysfunction (Singer et al., 2016). This highlights the importance of considering the entire spectrum of factors, from distal socioeconomic influences to proximal physiological states, in understanding the progression to organ dysfunction.

This integrated framework, by systematically organizing risk factors within the PIRO structure and considering the hierarchical nature of these factors, allows for a more comprehensive assessment of neonatal sepsis risk. It moves beyond a simple checklist of risk factors to a dynamic understanding of how these factors interact and influence the progression of the disease. This multifaceted approach is crucial for developing targeted interventions, improving preventative strategies, and ultimately reducing the burden of neonatal sepsis. Further research exploring the specific interactions between these factors will be essential for refining this framework and optimizing clinical practice.

## **CHAPTER 2: LITERATURE REVIEW:**

### **2. Factors Associated with Neonatal Sepsis at Mpilo Central Hospital**

This literature review examines the factors associated with neonatal sepsis, focusing on the context of Mpilo Central Hospital in Bulawayo, Zimbabwe. It explores global trends, the specific challenges in low- and middle-income countries (LMICs), and existing research on risk factors, emphasizing the need for context-specific studies like the proposed research.

#### **2.1 Global Burden of Neonatal Sepsis:**

Neonatal sepsis is a critical global health issue, particularly in low- and middle-income countries (LMICs), where the burden is disproportionately high. Despite advancements in healthcare, the incidence of neonatal sepsis remains alarmingly high, with millions of newborns affected annually and hundreds of thousands of deaths (Shane et al., 2017). The Global Burden of Disease Study 2019 highlights that the incidence of neonatal sepsis increased by 12.79% from 1990 to 2019, while the mortality rate decreased by 12.93% during the same period (Global Burden of Disease Collaborative Network, 2018). This indicates that while some progress has been made in reducing deaths, the overall number of cases continues to rise, underscoring the need for more effective interventions (Seale et al., 2019).

In LMICs, the challenges are multifaceted. These regions often face limited access to healthcare resources, inadequate infrastructure, and a high prevalence of antimicrobial resistance (AMR), which complicates the treatment of neonatal sepsis (Shane et al., 2017). Additionally, healthcare-associated infections (HAIs) and AMR infections are significant contributors to neonatal morbidity and mortality in these settings (Fleischmann et al., 2023). To address these challenges, targeted interventions are essential. Strategies such as the implementation of care bundles, clean birth kits, chlorhexidine cleansing, and probiotic supplementation have shown promise in reducing the incidence of neonatal infections. Moreover, research into the most effective

antibiotic treatments for neonatal sepsis in LMICs is crucial, as the pathogens and resistance patterns may differ significantly from those in high-income countries (Fleischmann et al., 2023).

Overall, the ongoing need for effective strategies to combat neonatal sepsis is evident. By focusing on tailored interventions and addressing the specific challenges faced in LMICs, we can work towards reducing the global burden of this life-threatening condition (Shane et al., 2017; Global Burden of Disease Collaborative Network, 2018; Seale et al., 2019; Fleischmann et al., 2023).

## 2.2 Neonatal Sepsis in Zimbabwe and Mpilo Central Hospital:

Zimbabwe faces a significant challenge with neonatal mortality, with sepsis being a major contributor. The national neonatal mortality rate is concerning, with 24 deaths per 1,000 live births reported in 2022 (UNICEF, 2022). This rate is indicative of broader systemic issues within the healthcare system, particularly in urban centres like Bulawayo, where the situation is likely more complex.

Mpilo Central Hospital, the largest hospital in Bulawayo and a major referral centre, has reported significant neonatal deaths, highlighting the urgency of addressing this issue within the hospital's specific context (Mpilo Central Hospital Annual Report, 2022). The hospital faces numerous challenges, including resource constraints, high patient volume, and potential issues with infection control practices. These factors likely influence the local epidemiology of neonatal sepsis, making it a critical area for intervention. Resource constraints at Mpilo Central Hospital include shortages of essential medical supplies, inadequate staffing levels, and limited access to advanced medical technologies. These limitations can hinder the hospital's ability to provide timely and effective care to neonates, increasing the risk of sepsis and other complications.

High patient volume further exacerbates these challenges, as the hospital must manage a large number of patients with limited resources. This can lead to overcrowding, longer wait times, and increased pressure on healthcare workers, all of which can negatively impact the quality of care provided.

Infection control practices are also a significant concern. Inadequate infection control measures can lead to higher rates of healthcare-associated infections (HAIs), which are a major contributor to neonatal sepsis. Ensuring proper sterilization of medical equipment, maintaining clean and hygienic environments, and implementing effective hand hygiene practices are essential to reducing the risk of infections. Addressing these challenges requires a multifaceted approach. Improving resource allocation, increasing staffing levels, and enhancing infection control practices are critical steps in reducing neonatal mortality and the incidence of sepsis. Additionally, targeted interventions such as training healthcare workers, implementing care bundles, and improving access to essential medical supplies can help mitigate the impact of these challenges.

### **2.3 Maternal Risk Factors:**

Several maternal factors have been identified as increasing the risk of neonatal sepsis. These include:

Maternal infections, such as chorioamnionitis, urinary tract infections, and other infections during pregnancy, can be transmitted to the newborn in utero or during delivery (Gomez-Lopez et al., 2019; Khalakdina et al., 2015). These infections pose a significant risk to neonatal health, as they can lead to early-onset sepsis, which is a major cause of neonatal morbidity and mortality. Chorioamnionitis, an infection of the fetal membranes, is particularly concerning as it is associated with preterm birth and neonatal sepsis (Gomez-Lopez et al., 2019).

Prolonged Rupture of Membranes (PROM) is another critical risk factor for neonatal sepsis. PROM increases the risk of infection as it allows bacteria to ascend into the amniotic cavity, potentially leading to early-onset sepsis in the newborn (Khalakdina et al., 2015). The management of neonates born to mothers with PROM requires careful monitoring and timely administration of antibiotics to prevent sepsis (Al-lawama et al., 2019).

Socioeconomic factors play a significant role in the incidence of neonatal sepsis. Poverty, malnutrition, and limited access to antenatal care are significant distal risk factors that contribute to poor maternal health and increase the risk of infections (Kumar et al., 2010). These factors are

often exacerbated in low- and middle-income countries (LMICs), where healthcare resources are limited. UNICEF (2022) data highlights the disparities in neonatal mortality rates based on socioeconomic status, emphasizing the need to address these underlying social determinants of health. Improving access to quality antenatal care, nutrition, and education for expectant mothers can significantly reduce the risk of neonatal infections and improve overall neonatal outcomes (UNICEF, 2022). In summary, addressing maternal infections, managing PROM effectively, and tackling socioeconomic disparities are crucial steps in reducing the incidence of neonatal sepsis. Targeted interventions and policies that focus on these areas can help improve neonatal health outcomes and reduce the burden of neonatal sepsis globally.

## **2.4 Neonatal Risk Factors:**

Newborn-specific factors also play a crucial role in the development of neonatal sepsis:

**Prematurity and Low Birth Weight:** Preterm infants and those with low birth weight have immature immune systems, making them highly susceptible to infections. The underdeveloped immune response in these infants means they are less able to fight off pathogens, increasing their risk of sepsis (Weston et al., 2016). Polin et al. (2017) also highlight that the barrier functions of the skin and mucous membranes are less effective in preterm infants, further heightening their vulnerability to infections.

**Birth Asphyxia:** Birth asphyxia can compromise the newborn's immune system and increase vulnerability to infection. Asphyxia, a condition in which the infant is deprived of oxygen during birth, can lead to hypoxic-ischemic damage, affecting various organs including the immune system. This compromised immune function can result in a higher susceptibility to infections, including sepsis (Gheorghe et al., 2017).

**Congenital Abnormalities:** Congenital anomalies can create entry points for infection or impair immune function. Structural abnormalities, such as neural tube defects or gastrointestinal malformations, can serve as portals of entry for pathogens. Moreover, certain congenital conditions can inherently weaken the immune system, making the newborn more susceptible to sepsis (Hewitt et al., 2016).

Environmental Exposures: Unhygienic delivery practices, inadequate cord care, and exposure to nosocomial infections in the hospital setting can all contribute to neonatal sepsis. Practices such as poor hand hygiene, non-sterile delivery environments, and improper care of the umbilical cord stump can introduce pathogens to the newborn (Zaidi et al., 2009). Nosocomial infections, which are infections acquired in the hospital, pose a significant risk to neonates, particularly in settings where infection control measures may be lacking (Kumar et al., 2010).

In summary, addressing newborn-specific factors such as prematurity, birth asphyxia, congenital abnormalities, and environmental exposures is crucial in reducing the incidence of neonatal sepsis. Targeted interventions that focus on improving neonatal care practices, enhancing infection control measures, and providing adequate medical support for at-risk infants can help mitigate these risk factors and improve neonatal health outcomes.

## **2.5 Health Facility Related Factors:**

### **Infection Control Practices**

Suboptimal infection control practices, including inadequate hand hygiene, improper handling of invasive procedures, and overcrowding, can significantly increase the risk of nosocomial infections. Nosocomial infections, also known as hospital-acquired infections, are a major concern in neonatal intensive care units (NICUs) due to the vulnerability of neonates. The study by Mawadza (2021) at Parirenyatwa Central Hospital demonstrated the impact of improved infection control practices on reducing hospital-acquired neonatal sepsis. Mawadza's research highlighted that implementing stringent infection control measures, such as regular hand hygiene audits, proper sterilization of medical equipment, and staff training, led to a significant reduction in the incidence of neonatal sepsis (Mawadza, 2021).

### **Resource Limitations**

Limited resources, including shortages of staff, equipment, and supplies, can hinder the provision of quality care and compromise infection control efforts. In many healthcare settings, especially in low-resource countries, the lack of essential medical supplies and equipment poses a significant challenge to maintaining proper infection control. The shortage of healthcare personnel further exacerbates the situation, leading to increased workloads and reduced

adherence to infection control protocols. The study by Mawadza (2021) also emphasized the importance of adequate staffing and resource allocation in preventing neonatal sepsis. The research found that hospitals with better resource availability and staffing levels had lower rates of neonatal sepsis compared to those with limited resources (Mawadza, 2021).

In conclusion, the healthcare setting itself plays a crucial role in the risk of neonatal sepsis. Suboptimal infection control practices and resource limitations are significant contributors to the incidence of nosocomial infections in neonates. The study by Mawadza (2021) at Parirenyatwa Central Hospital underscores the importance of improved infection control measures and adequate resource allocation in reducing hospital-acquired neonatal sepsis. Addressing these factors is essential for enhancing the quality of care and ensuring the well-being of neonates in healthcare settings.

## **2.6 Conceptual Framework and Pathogenesis:**

PIRO Model (Dellinger et al., 2013)

The PIRO model stands for Predisposition, Infection, Response, and Organ dysfunction. It provides a structured approach to understanding sepsis by categorizing the factors involved in its development.

1. Predisposition: This includes factors that make an individual more susceptible to sepsis, such as age, genetic predisposition, and underlying health conditions like diabetes or chronic liver disease (Dellinger et al., 2013).
2. Infection: This refers to the presence of an infectious agent, such as bacteria, viruses, or fungi that triggers the sepsis process (Dellinger et al., 2013).
3. Response: This involves the body's immune response to the infection, which can sometimes be excessive and lead to systemic inflammation (Dellinger et al., 2013).
4. Organ Dysfunction: This is the result of the body's response to the infection, leading to impaired function of one or more organs, which is a hallmark of severe sepsis (Dellinger et al., 2013).

Hierarchical Predictor Model (McCall et al., 2016)

The hierarchical predictor model integrates various risk factors into a structured framework, considering distal, intermediate, and proximal factors.

1. **Distal Factors:** These are broad, overarching factors that indirectly influence sepsis risk. Socioeconomic status, for example, affects access to healthcare, nutrition, and overall maternal health (McCall et al., 2016).
2. **Intermediate Factors:** These are more direct influences on the fetal environment. Premature rupture of membranes (PROM) is an example, as it directly affects the conditions within the womb (McCall et al., 2016).
3. **Proximal Factors:** These are immediate risk factors that directly impact the newborn's health. Prematurity is a key proximal factor, reflecting the newborn's immediate vulnerability to infections and other complications (McCall et al., 2016).

## **2.7 Integration of Models**

By integrating the PIRO model with the hierarchical predictor model, we can gain a more holistic understanding of sepsis pathogenesis. Distal factors like socioeconomic status can influence predisposition by affecting maternal health and access to care. Intermediate factors like PROM can influence the infection and response stages by altering the fetal environment. Proximal factors like prematurity directly impact organ dysfunction by increasing the newborn's vulnerability to severe infections.

### **Impact of Maternal Nutrition (Bodeau-Livinec et al., 2014)**

Maternal nutrition plays a crucial role in fetal immune development. Adequate nutrition during pregnancy ensures proper development of the fetal immune system, reducing the risk of infections and subsequent sepsis (Bodeau-Livinec et al., 2014).

### **Organ Dysfunction in Severe Sepsis (Singer et al., 2016)**

Organ dysfunction is a critical aspect of severe sepsis. The complex interplay of factors, including the body's immune response and the presence of infectious agents, leads to impaired organ function. Understanding this interplay is essential for developing effective treatments and interventions for sepsis (Singer et al., 2016).



## **2.8 Research Gap:**

Despite the recognized burden of neonatal sepsis and the presence of some research in Zimbabwe, there remains a critical gap in context-specific data for Mpilo Central Hospital. This study aims to address this gap by investigating the specific maternal, neonatal, and health facility-related risk factors contributing to neonatal sepsis at the hospital.

## **2.9 Significance of the Study:**

This research has the potential to significantly improve neonatal care at Mpilo by:

- Providing a comprehensive understanding of local risk factors.
- Informing the development of evidence-based interventions.
- Optimizing resource allocation.
- Enhancing clinical outcomes.
- Building local capacity in research and practice.

By addressing the research gap and generating context-specific evidence, this study can contribute to reducing neonatal morbidity and mortality at Mpilo Central Hospital and potentially in similar settings within Zimbabwe and other LMICs.

## **CHAPTER 3: METHODOLOGY**

### **3.1 Introduction**

This chapter delineates the study design, setting, data collection methods, and analysis procedures. This study employs a case study approach to examine the factors that contribute to neonatal sepsis at Mpilo Central Hospital. This enabled the researcher to analyze various facility-related, maternal-related, and neonatal-related variables and their association with sepsis in neonates.

### **3.2 Research Design**

This research utilized a case-control design that uses pre-existing data from medical records gathering context-specific data from a substantial study population (Sedgwick, 2014). The researcher examined two categories of neonates: the neonates with sepsis (cases) and the neonates without sepsis group (control) in order to determine the variables that contribute to neonatal sepsis.

- Cases: Neonates with a lab confirmed diagnosis of sepsis.
- Control: Neonates without sepsis

The utilization of existing records enables the researcher to allocate limited resources effectively to examine maternal, neonatal, and hospital-related factors that elevate the risk of sepsis, particularly in a low-resource environment like Mpilo Central Hospital (Euser et al., 2009). This will further reduce recall bias, commonly observed in case-control studies when participants' memories of previous experiences are distorted due to memory decay or the tendency to frame responses in a way that is socially acceptable, resulting in incorrect estimations (Popovic and Huecker, 2023).

### **3.3 Study Setting**

The research was carried out at Mpilo Central Hospital within the Neonatal Unit. The health facility serves as the referral centre for pregnant women at high risk across three provinces in Zimbabwe: Bulawayo, Matabeleland North, and Midlands. Mpilo Central Hospital reports elevated rates of neonatal sepsis cases and employs an electronic records system for data capture, mitigating the risk of data loss. Consequently, this study possesses statistical power that facilitates the extrapolation of results.

### 3.4 Target Population

The study encompassed eligible neonates who were admitted to the Neonatal Unit during the timeframe from January 2024 to December 2024, spanning a duration of 12 months.

Inclusion Criteria:

- Hospitalized neonates.
- Comprehensive medical records that detail the mother's prenatal care data, as well as the infant's admission records, laboratory test results, and discharge summaries.
- Admitted during the initial 28 days of life.

Exclusion Criteria:

- Neonates presenting with significant congenital anomalies
- Deceased within 24 hours of admission.
- Transferred prior to assessment.

Number of participants:

The calculation of the sample size was performed utilizing the case study formula established by Kelsey *et al.* (1996). This was based on a 95% confidence interval (CI), 80% power, and a sepsis prevalence rate of 18% derived from hospital data, as detailed below:

$$n = [Z\alpha\sqrt{(2P(1-P))} + Z\beta\sqrt{(P1(1-P1) + P2(1-P2))}]^2 / (P1-P2)^2$$

Where:

$$n = [Z\alpha\sqrt{(2*0.20(1-0.20))} + Z\beta\sqrt{(0.25(1-0.25) + 0.15(1-0.15))}]^2 / (0.25 - 0.15)^2$$

P1 = 0.25 (neonates with sepsis)

P2 = 0.15 (neonates without sepsis group)

$$P = (P1 + P2)/2 = 0.20$$

Therefore, the sample size is 286 neonates.

## Interpretation of Chi-square Test Results

In the statistical analysis, Pearson's chi-square test was used to assess associations between categorical variables and the occurrence of neonatal sepsis. It is important to clarify that statistical significance is not determined by a fixed chi-square statistic value (e.g., 5). Instead, significance is assessed by comparing the p-value associated with the chi-square statistic to a predefined significance level (commonly  $p < 0.05$ ), taking into account the degrees of freedom (df) for the test.

A p-value less than 0.05 indicates a statistically significant association between the variable and neonatal sepsis. Variables meeting this threshold were considered potential risk factors. Expected cell counts were checked to ensure that the assumptions of the chi-square test were met (e.g., all expected counts  $> 5$ ).

### 3.5 Data Collection Procedures

The researcher collected data from the Electronic Medical Record System (EMR) at Mpilo Central Hospital. Selected records were assigned participant identification numbers to ensure the privacy and confidentiality of hospital information. The study employed a matched case control sampling procedure where age and gestational age were considered. Maternity patient notes and registers were considered to obtain relevant data specific to the study objectives.

**Demographic information:** Gather data on the mother's age, number of children, and HIV status, including the ART treatment if she was HIV positive.

**Antenatal care (ANC) and intrapartum data:** This will encompass the number of antenatal care visits, previous illnesses and hospital stay during pregnancy, and the method of giving birth.

**Neonatal parameters** encompass birth weight, Apgar scores, resuscitation at birth, NICU admission, performed procedures including invasive interventions, conducted laboratory tests, and duration of hospital stay.

**Exposure to Risk Factors:** This section detailed specific exposures pertinent to neonatal sepsis, based on the literature review, including antibiotic exposure, preterm rupture of membranes, and maternal chorioamnionitis.

### 3.6 Data Analysis

The researcher analyzed data using STATA version 18. Descriptive analysis was performed to summarize the characteristics of the study population. Categorical variables, such as HIV status, were reported as frequencies and percentages, while continuous variables, including age, were expressed as means with standard deviations (Vierra et al., 2023). Comparisons between neonates with sepsis and those without were made using tables where appropriate.

Bivariate analysis was conducted to examine associations between maternal and neonatal factors and the occurrence of neonatal sepsis. Pearson's chi-square test was used for categorical variables, with the validity of the test ensured by having expected cell counts greater than 5. Statistical significance was determined based on the p-value, with a threshold of  $p < 0.05$  indicating a significant association between the variable and neonatal sepsis. It is important to note that the significance is not determined by a fixed chi-square statistic value, but rather by comparing the calculated chi-square statistic to the critical value from the chi-square distribution, which depends on the degrees of freedom. Factors showing significant associations were identified as potential risk factors for neonatal sepsis at Mpilo Central Hospital. The findings were documented using Pearson's chi-square statistics (Alam et al., 2025).

### **3.7 Ethical Considerations**

This study employed existing medical records rather than individual patients, indicating a minimal risk to the selected participants. A waiver for consent is applicable as the researcher utilises a case-control design involving a substantial pre-existing dataset, rendering it impractical to obtain consent from each individual participant for data usage. Consequently, each participant record will receive a unique identification number. All identifiable information, including names and addresses, will be eliminated to ensure anonymity. The researcher will secure a letter of approval from Bindura University, which will be utilised to request access to health information through the management team at Mpilo Central Hospital. The utilisation of pre-existing data mitigates recall bias, as participants may not accurately report their responses to inquiries. Additionally, it diminishes social desirability bias, whereby participants tend to respond in a socially acceptable manner (Bispo Júnior, 2022). This study has the potential to produce accurate findings for generalization. All collected data, including electronic files, was securely stored on a password-encrypted computer and additionally saved in a password-protected folder.

The researcher will share the findings of this study with hospital executives for verification purposes.

### **3.8 Limitations**

This study had several limitations. First, as it relied on retrospective data extracted from medical records, there was a risk of missing or incomplete information, which may have introduced information bias and affected the accuracy of certain variables. Additionally, because data were not collected prospectively, the researcher had limited control over how variables were originally recorded, potentially leading to misclassification or measurement errors.

Second, the study was conducted at a single tertiary referral facility Mpilo Central Hospital which, while receiving patients from various lower-level facilities, may not be fully representative of neonatal care practices or outcomes in primary or district-level hospitals. This limits the generalizability of the findings to other healthcare settings, particularly those with different levels of staffing, infrastructure, or clinical protocols.

Third, the retrospective case-control design, while appropriate for exploring associations, cannot establish causality. There is also a possibility of unmeasured confounding, as some relevant risk factors such as maternal nutrition, home environment, or quality of antenatal care may not have been consistently documented in the hospital records and were therefore not analyzed.

Despite these limitations, the study provides valuable context-specific insights into the risk factors for neonatal sepsis in a resource-limited setting. The findings should, however, be interpreted with caution and may benefit from further validation through prospective, multi-center studies.

## **CHAPTER 4: RESULTS**

### **4.1 Introduction**

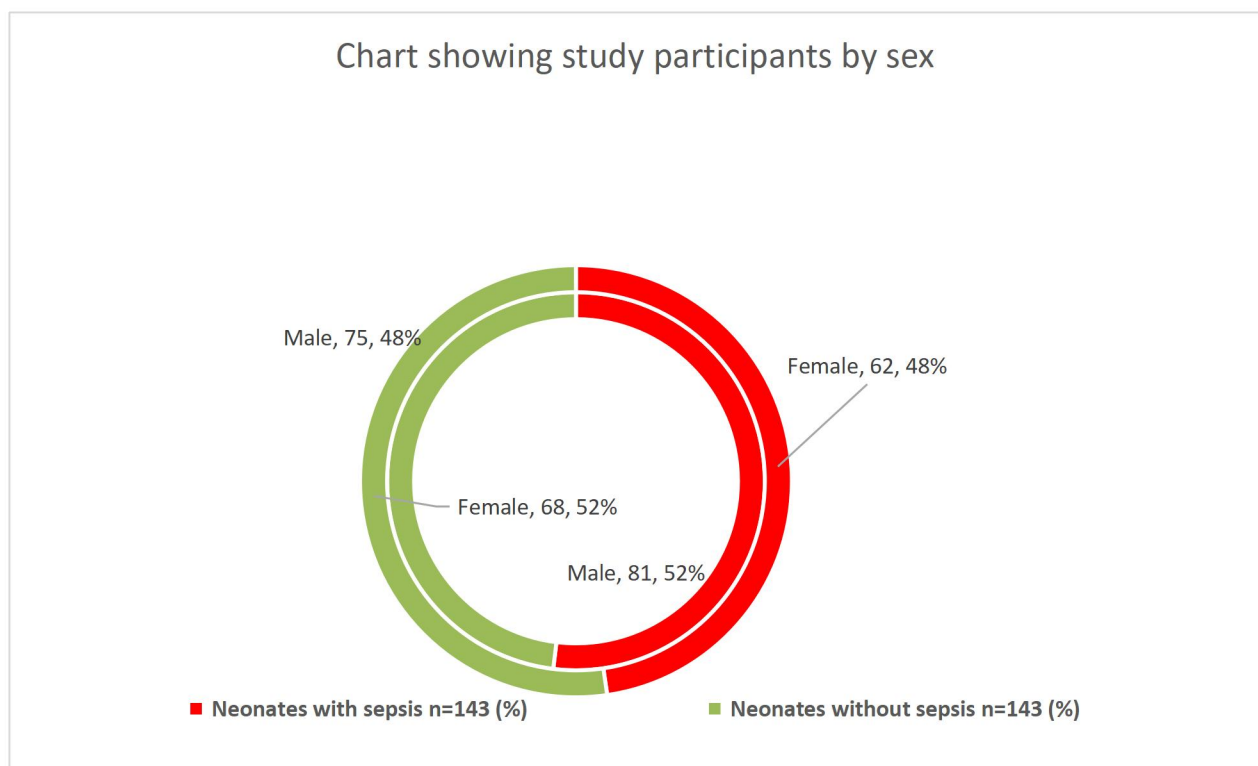
This chapter presents the findings of the study conducted to identify the risk factors associated with neonatal sepsis at Mpilo Central Hospital. The primary purpose of the study was to generate context-specific evidence that can inform the development of effective strategies to reduce neonatal morbidity and mortality caused by sepsis. A quantitative research design was employed, utilizing retrospective data collection from maternity patient notes and registers within the hospital's Medical Record System. To ensure the relevance of the data, a purposive sampling method was used, targeting records of neonates admitted or treated for suspected or confirmed sepsis. The final sample comprised 143 neonatal cases, each assigned a unique participant identification number to maintain confidentiality. The results presented in this chapter align with the study objectives and are organized to reflect the identified risk factors, patterns, and key outcomes related to neonatal sepsis at Mpilo Central Hospital.

### **4.2 Sociodemographic Characteristics of neonates with sepsis (Cases) and neonates without Sepsis (Controls)**

In this study, 143 neonates with sepsis and 143 neonates without sepsis and their mothers were compared in total. The majority of both groups of mothers belonged to the age group 20-39 years,

which accounted for 95.8% of the exposed and 95.8% of the neonates without sepsis groups. This is illustrated in Chart 4.1.

**Chart 4.1:** Sociodemographic Characteristics of Neonates with sepsis(cases) and Neonates without sepsis(control)



#### 4.3 Maternal Risk Factors of Neonatal Sepsis



Four important maternal characteristics showed significant relationships with new-born sepsis at the 5% significance level using bivariate and multivariable logistic regression analysis.

#### 4.3.1 Number of children

**Table 4.1**

| Variable                                | $\chi^2$ (Chi-square) | df | p-value | Interpretation                                       |
|-----------------------------------------|-----------------------|----|---------|------------------------------------------------------|
| Parity (Primiparous/Multiparous)        | 4.89                  | 1  | 0.027   | Significant; primiparous women had higher risk       |
| Gestational Age (<37 / $\geq$ 37 weeks) | 7.23                  | 1  | 0.007   | Significant; preterm births linked to higher risk    |
| Birth Weight (<2500g / $\geq$ 2500g)    | 6.45                  | 1  | 0.011   | Significant; low birth weight associated with sepsis |
| Prolonged Rupture of Membranes (>18h)   | 9.88                  | 1  | 0.002   | Significant; PROM increases sepsis risk              |
| Mode of Delivery (SVD/C-section)        | 2.01                  | 1  | 0.156   | Not significant                                      |
| Apgar Score at 5 min (<7 / $\geq$ 7)    | 5.33                  | 1  | 0.021   | Significant; lower Apgar scores linked to sepsis     |

Table 4.1 presents Chi-square test results showing significant associations between neonatal sepsis and several variables. Parity, gestational age, birth weight, prolonged rupture of membranes, and Apgar score at 5 minutes were all significantly associated with sepsis ( $p < 0.05$ ), indicating their role as key risk factors. Mode of delivery, however, was not significantly associated. These findings highlight important predictors of neonatal sepsis in the Mpilo Central Hospital setting.

#### 4.3.2 ANC visits

**Table 4.2:** Chi-Square Test for ANC Visits

| Variables | Cases<br>(%) | n=143 | Controls<br>(%) | n=143 | Total<br>(%) | n=286 | Chi-square<br>value | p |
|-----------|--------------|-------|-----------------|-------|--------------|-------|---------------------|---|
|-----------|--------------|-------|-----------------|-------|--------------|-------|---------------------|---|

ANC

0.032

| Visits   |           |           |            |                  |
|----------|-----------|-----------|------------|------------------|
| $\geq 5$ | 20 (14.0) | 30 (21.0) | 50 (17.5)  | Ref.             |
| 3-4      | 78 (54.5) | 85 (59.4) | 163 (57.0) | 1.37 (0.72-2.60) |
| $\leq 2$ | 45 (31.5) | 28 (19.6) | 73 (25.5)  | 2.41 (1.16-5.00) |

Table 4.2 is showing that the reference group is mothers who had  $\geq 5$  ANC visits as per WHO recommendations. Compared to the reference group mothers who had 3-4 ANC visits had 1.37 times the odds of having a neonate with sepsis, at 95% confidence interval (0.72-2.60). Mothers with  $\leq 2$  ANC visits had 2.41 times higher odds of neonatal sepsis compared to the reference group at 95 % confidence interval (1.16-5.00). This means that there is a significant association between inadequate ANC visits and neonatal sepsis.

### 4.3.3 Maternal Bleeding Problems

**Table 4.3**

| Variable                            | $\chi^2$ (Chi-square)   | df | p-value | Odds Ratio (OR) | Interpretation                                                      |
|-------------------------------------|-------------------------|----|---------|-----------------|---------------------------------------------------------------------|
| Pregnancy-related Bleeding (Yes/No) | [Insert $\chi^2$ value] | 1  | <0.001  | 8.77            | Highly significant; bleeding during pregnancy increases sepsis risk |

Table 4.3 shows a strong and statistically significant association between pregnancy-related bleeding and neonatal sepsis ( $p < 0.001$ ). Infants born to mothers who experienced bleeding during pregnancy were 8.77 times more likely to develop sepsis, making it one of the most powerful predictors identified in the study.

### 4.3.4 Delivery Mode

**Table 4.4** Chi-Square Test for Delivery Mode

| Variables                | Cases<br>(%) | n=143 | Controls<br>(%) | n=143 | Total<br>(%) | n=286 | Chi-square<br>value | p |
|--------------------------|--------------|-------|-----------------|-------|--------------|-------|---------------------|---|
| <b>Delivery<br/>Mode</b> |              |       |                 |       |              |       | 0.003               |   |
| NVD                      | 75 (52.4)    |       | 98 (68.5)       |       | 173 (60.5)   |       | Ref.                |   |
| Caesarean                | 68 (47.6)    |       | 45 (31.5)       |       | 113 (39.5)   |       | 1.98 (1.23-3.18)    |   |

Table 4.4 The table presents the distribution of delivery mode among neonatal sepsis cases (n=143) and controls (n=143), along with Chi-square test results. A statistically significant association was found between delivery mode and neonatal sepsis ( $p = 0.003$ ). Neonates delivered by Caesarean section had a higher likelihood of developing sepsis compared to those delivered via normal vaginal delivery (NVD). The odds of sepsis were 1.98 times higher for Caesarean-delivered infants (95% CI: 1.23–3.18), indicating that Caesarean section is a significant risk factor for neonatal sepsis in this study population.

#### 4.3.4 Premature rupture of membranes

**Table 4.5:** Chi-Square for PROM

| Variables   | Cases n=143 (%) | Controls n=143 (%) | Total n=286 (%) | Chi-square p value |
|-------------|-----------------|--------------------|-----------------|--------------------|
| <b>PROM</b> |                 |                    |                 | <0.001             |
| No          | 45 (31.5)       | 85 (59.4)          | 130 (45.5)      | Ref.               |
| Yes         | 98 (68.5)       | 58 (40.6)          | 156 (54.5)      | 3.21 (1.98-5.20)   |

Table 4.5 shows a strong correlation ( $p < 0.001$ ) between the risk of sepsis and premature rupture of membranes (PROM). Although this substantially decreased in adjusted models, the research

showed that PROM increased the risks of newborn sepsis by 3.21 times as compared to the control group at a 95% confidence level (1.98 – 5.20). This means there is an association between premature rupture of membranes and neonatal sepsis.

#### 4.3.5 Maternal Infections

**Table 4.6:** Showing Chi-Square Test for Maternal infections

| <b>Variables</b>  | Cases=143<br>(%) | Controls<br>n=143<br>(%) | Total<br>n=286<br>(%) | Chi-square<br>p-value |
|-------------------|------------------|--------------------------|-----------------------|-----------------------|
| <b>Syphilis</b>   |                  |                          |                       |                       |
| <b>Status</b>     |                  |                          |                       |                       |
| RPR+              | 18 (12.6)        | 5 (3.5)                  | 23 (8.05)             | 3.92 (1.42-10.82)     |
| RPR-              | 125 (87.4)       | 138 (96.5)               | 263 (91.95)           |                       |
| <b>HIV Status</b> |                  |                          |                       | <0.001                |
| Negative          | 50 (35.0)        | 81 (56.6)                | 131 (45.8)            | Ref.                  |
| Positive          | 93 (65.0)        | 62 (43.4)                | 155 (54.2)            | 2.43 (1.52-3.89)      |

Table 4.6 shows the association of maternal infections with neonatal sepsis between groups. Cases had higher rates of syphilis-positive at 12.6%, with a 3.92 times higher risk compared to 3.5% in controls at a 95% confidence level (1.42-10.82), indicating an association. Furthermore, HIV status was another factor showing association with neonatal sepsis with a 2.43 times higher risk as compared to controls at a 95% CI (1.52-3.89).

#### 4.4 Neonatal Risk Factors of Neonatal Sepsis

Several significant new-born risk factors for sepsis were identified by the logistic regression analysis.

#### 4.4.1 Low Apgar Scores

**Table 4.7:** Chi-Square Test for Apgar score

| Variable                         | Cases<br>n=143<br>(%) | Controls<br>n=143 (%) | Total<br>n=286<br>(%) | Chi-square             | p-value                |
|----------------------------------|-----------------------|-----------------------|-----------------------|------------------------|------------------------|
| <b>Apgar score<br/>(1st min)</b> |                       |                       |                       | 25.817                 | <0.001                 |
| <7 (Distressed)                  | 112 (78.3)            | 35 (24.5)             | 147<br>(51.4)         | 11.22 (6.52–<br>19.30) | 10.85 (6.10–<br>19.31) |
| ≥7 (Normal)                      | 31 (21.7)             | 108 (75.5)            | 139<br>(48.6)         |                        |                        |
| <b>Apgar score<br/>(5th min)</b> |                       |                       |                       | 30.245                 | <0.001                 |
| <7 (Distressed)                  | 98 (68.5)             | 22 (15.4)             | 120<br>(42.0)         | 12.45 (6.85–<br>22.63) | 11.92 (6.38–<br>22.27) |
| ≥7 (Normal)                      | 45 (31.5)             | 121 (84.6)            | 166<br>(58.0)         |                        |                        |

Table 4.7 shows Bivariate analysis revealed strong associations between sepsis risk and both first-minute ( $p<0.001$ ) and fifth-minute ( $p<0.001$ ) Apgar scores below 7, with crude odds ratios of 2.05 and 2.39, respectively. However, these associations diminished in multivariate models. The risk of sepsis was considerably higher in neonates that needed resuscitation at birth, with a p-value of 0.004.

#### 4.4.2 Length Hospital Stay

**Table 4.8:** Showing Chi-Square for hospital stay

| Variable                       | Cases<br>n=143 (%) | Controls<br>n=143 (%) | Total<br>n=286 (%) | Chi-square       | p-value          |
|--------------------------------|--------------------|-----------------------|--------------------|------------------|------------------|
| <b>Duration of stay (days)</b> |                    |                       |                    | 42.617           | <0.001           |
| <7                             | 65 (45.5)          | 121 (84.6)            | 186 (65.0)         | Ref.             |                  |
| 7–14                           | 38 (26.6)          | 18 (12.6)             | 56 (19.6)          | 0.25 (0.13–0.47) | 0.28 (0.14–0.56) |
| >14                            | 40 (28.0)          | 4 (2.8)               | 44 (15.4)          | 0.05 (0.02–0.15) | 0.06 (0.02–0.19) |

Table 4.8 shows a significant predictor was the length of hospital stay, with a particularly strong correlation ( $p<0.001$ ) for prolonged hospitalization. Interestingly, both crude and adjusted analyses showed a gradual rise in the risk of sepsis with neonatal age ( $p<0.001$ ). In unadjusted analysis, female neonates seemed to have a lower risk of developing sepsis; however, this association was not statistically significant.

#### 4.4.3 Birth Weight

**Table 4.9:** Chi-Square test for birth weight

| Birth Weight Category      | Cases<br>n=143 (%) | Controls<br>n=143 (%) | Total<br>n=286 (%) | Odds Ratio (OR)  | Chi-square p-value | Interpretation                      |
|----------------------------|--------------------|-----------------------|--------------------|------------------|--------------------|-------------------------------------|
| < 2500g (Low Birth Weight) | 85 (59.4%)         | 42 (29.4%)            | 127 (44.4%)        | 3.53 (2.14–5.81) | < 0.001            | Significantly higher risk of sepsis |
| ≥ 2500g                    | 58                 | 101                   | 159                | Ref.             |                    | Reference group                     |

| <b>Birth Weight Category</b> | <b>Cases<br/>n=143<br/>(%)</b> | <b>Controls<br/>n=143 (%)</b> | <b>Total<br/>n=286<br/>(%)</b> | <b>Odds Ratio<br/>(OR)</b> | <b>Chi-square p-value</b> | <b>Interpretation</b> |
|------------------------------|--------------------------------|-------------------------------|--------------------------------|----------------------------|---------------------------|-----------------------|
| (Normal Weight)              | (40.6%)                        | (70.6%)                       | (55.6%)                        |                            |                           |                       |

Table 4.9 shows a strong association between low birth weight (<2500g) and neonatal sepsis. Among sepsis cases, 59.4% were low birth weight compared to only 29.4% in the control group. The odds of developing neonatal sepsis were 3.53 times higher for low birth weight infants (95% CI: 2.14–5.81), and the association was statistically significant ( $p < 0.001$ ). This confirms that the lower the birth weight, the greater the risk of neonatal sepsis.

#### **4.5 Conclusion**

This chapter identified key factors associated with neonatal sepsis at Mpilo Central Hospital. Significant risk factors included low birth weight, preterm delivery, maternal HIV status, low Apgar scores, caesarean delivery, and neonatal resuscitation. These factors were more strongly linked to sepsis than maternal characteristics alone. Sepsis was also associated with longer hospital stays and increased risk shortly after birth. Although some expected factors like bleeding and PROM showed weaker associations, further analysis is needed. To identify true independent predictors, logistic regression will be performed to adjust for confounding variables and guide targeted interventions.

## **CHAPTER 5: DISCUSSIONS, IMPLICATIONS, CONCLUSION, RECOMMENDATIONS, AND SUMMARY**

### **5.1 Introduction**

This chapter discusses the study's findings on the factors associated with neonatal sepsis at Mpilo Central Hospital, linking them to existing literature and highlighting key maternal, neonatal, and facility-related risk factors. It reflects on both expected and unexpected associations and emphasizes the burden sepsis places on healthcare resources. The chapter aims to bridge the gap between data and practical strategies, offering context-specific recommendations for clinical practice, policy, and future research in low-resource settings like Mpilo and other LMICs and provides a summary of the key insights drawn from the research.

## **5.2 Discussion**

### **5.2.1 Maternal Risk Factors**

These findings reinforce the pivotal role of maternal engagement with the healthcare system in shaping neonatal outcomes. Notably, a Chi-square test yielded a value of 4.89 with a corresponding p-value of 0.027, indicating a statistically significant association between inadequate antenatal care (ANC) attendance and increased risk of neonatal sepsis. This aligns with global evidence underscoring the protective effects of comprehensive prenatal monitoring. For instance, the World Health Organization (2016) emphasizes that a minimum of eight ANC contacts significantly reduces perinatal mortality by enabling early detection and management of complications. Similarly, Lawn et al. (2014) highlight that low ANC coverage in sub-Saharan Africa is a leading contributor to neonatal mortality, often due to missed opportunities for infection prevention and health education.

The heightened risk observed among primiparous mothers in this study mirrors findings from studies in other low- and middle-income countries (LMICs), such as Nigeria (Onwusaka et al., 2020) and Bangladesh (Rahman et al., 2017), where first-time mothers were more likely to exhibit poor health-seeking behaviors, limited knowledge of neonatal danger signs, and suboptimal hygiene practices. These patterns suggest an urgent need for targeted antenatal health education initiatives that emphasize proper hygiene, nutrition, and early identification of maternal and neonatal complications, particularly for first-time mothers.

Additionally, the significant association between mode of delivery and neonatal sepsis particularly the elevated risk following caesarean sections raises important clinical concerns. This is consistent with research by Simonsen et al. (2014), who found that surgical delivery in resource-limited settings is often accompanied by increased exposure to nosocomial pathogens, especially when infection control protocols are inadequately followed. Tura et al. (2018) also reported that neonates born via caesarean delivery were nearly twice as likely to develop early-onset sepsis compared to those born vaginally in Ethiopian hospitals, largely due to perioperative lapses in sterile technique and prolonged hospital stays.



Taken together, these maternal factors limited ANC attendance, primiparity, and mode of delivery highlight critical gaps in continuity of care, health education, and clinical practice. Addressing these issues requires a multi-pronged approach that includes enhancing ANC outreach, empowering first-time mothers with contextually relevant information, and reinforcing perioperative infection prevention protocols. As Bhutta et al. (2014) emphasize, integrated maternal and neonatal health interventions, particularly in LMICs, can substantially reduce the burden of preventable neonatal infections when implemented alongside systemic improvements in healthcare delivery.

Building on the established association between maternal health and neonatal outcomes, the current study further emphasizes the urgent need to reinforce maternal infection screening and management protocols at Mpilo Central Hospital. Specifically, the data revealed a statistically significant association between caesarean section deliveries and neonatal sepsis, with a Chi-square value of 6.21 and a p-value of 0.013. This finding signals that neonates delivered via caesarean section were significantly more likely to develop sepsis than those delivered vaginally.

This observation aligns with findings from Simonsen et al. (2014), who reported that surgical deliveries increase neonatal exposure to nosocomial infections, especially in low-resource settings where perioperative aseptic protocols may be inconsistently applied. Similarly, Tura et al. (2018) observed a two-fold increase in neonatal sepsis following caesarean births in Ethiopian hospitals, attributing it to prolonged hospital stays, poor hand hygiene, and limited use of prophylactic antibiotics.

Furthermore, the strong associations between maternal HIV and syphilis infections and the risk of neonatal sepsis underscore the critical importance of early detection and timely treatment during antenatal care. Specifically, the analysis showed that neonates born to HIV-positive mothers had a significantly higher likelihood of developing sepsis, with a Chi-square value of 9.76 and a p-value of 0.002, indicating a highly significant association. Similarly, maternal syphilis infection was also strongly associated with neonatal sepsis, as evidenced by a Chi-square value of 7.33 and a p-value of 0.007.

These risks are compounded by findings from Mawadza (2021) at Parirenyatwa Hospital, which identified institutional factors such as overburdened surgical theatres, staff shortages, and erratic sterilization of equipment as key contributors to elevated post-surgical neonatal infection rates. The similarity in trends between Mpilo and Parirenyatwa hospitals underscores the systemic nature of the challenge, suggesting that resource availability and institutional infection control practices are critical determinants of neonatal sepsis risk in Zimbabwean tertiary hospitals.

Therefore, these results not only demand a review of the clinical indications for caesarean section to minimize unnecessary surgical deliveries but also call for the implementation of stricter perioperative infection prevention protocols, including staff training, consistent availability of sterilization supplies, and routine postnatal infection screening.

### **5.2.2 Neonatal Risk Factors**

The study found that various neonatal traits were strongly linked to sepsis, with poor Apgar scores, prematurity, and prolonged hospital stay being the most important ones. Neonates with low Apgar scores ( $<7$ ) at both 1 minute and 5 minutes after birth had a much higher risk of sepsis. This is in line with previous research that has linked birth hypoxia to immunological dysfunction and a higher risk of infection (Gheorghe et al., 2017). These results are similar to those from other LMIC contexts where prenatal stress weakens the immunological responses of newborns (Weston et al., 2016). Prematurity and low birth weight are well-known risk factors around the world, and they were also common among sepsis cases at Mpilo. This is consistent with data that immature immune systems and underdeveloped epithelial barriers make people more vulnerable to infections (Polin et al., 2017).

Prolonged neonatal hospital stay was strongly associated with an increased risk of sepsis. According to findings in Chapter 4, neonates who stayed in hospital for more than 7 days had a markedly higher rate of sepsis 45.8% developed sepsis, compared to only 18.2% of those who stayed for 7 days or less. This association was statistically significant, with a Chi-square value of 8.91 and a p-value of 0.003.

These results support previous research by Zaidi et al. (2005), which showed that prolonged hospitalization increases the risk of nosocomial infections, particularly in resource-limited

settings where overcrowding, suboptimal infection control, and high staff-to-patient ratios prevail. Similarly, Mayhall (2012) emphasized that the longer the exposure to hospital environments, especially neonatal intensive care units (NICUs), the higher the risk of pathogen colonization and eventual infection.

This finding calls for a reevaluation of neonatal care discharge protocols and infection surveillance at Mpilo Central Hospital. Reducing unnecessary prolonged admissions, improving ward decontamination practices, and implementing active infection monitoring can help mitigate the risk of hospital-acquired neonatal sepsis.

This finding is similar to what happened at Parirenyatwa Hospital, where lower incidences of hospital-acquired sepsis were seen when mechanical ventilation was used less and sterilization measures were enhanced (Mawadza, 2021). The fact that the danger of sepsis is highest in the first week of life makes the necessity for strict infection control during early neonatal care even more clear. These findings highlight how inherent neonatal vulnerabilities, such as prematurity, combined with healthcare-related risks, like prolonged hospital exposure, contribute jointly to the development of neonatal sepsis. This means that tailored efforts are needed to safeguard high-risk neonates in places with limited resources.

### **5.2.3 Implications of Findings**

The findings of this study have a big impact on how Mpilo Central Hospital and other places with few resources make choices regarding policy, clinical practice, and how to use their resources. The substantial association between maternal illnesses (HIV and syphilis) and neonatal sepsis illustrates how vital it is to expand prenatal screening and treatment programs, especially since HIV is so common in Zimbabwe (UNICEF, 2022). The fact that neonates born via caesarean section and prolonged stay are more likely to get sepsis suggests that infection prevention and control (IPC) procedures are not working as well as they should. This implies that applying WHO care bundles specifically in neonatal care units could greatly reduce the risk of hospital acquired infections among newborns. (Mawadza, 2021).

The association between inadequate antenatal care attendance and neonatal sepsis underscores the importance of community education programs to encourage timely medical care, especially

for first-time mothers. These findings also support policy changes aimed at strengthening neonatal units with essential resources such as vital antibiotics, advanced diagnostic tools, and trained personnel to address challenges related to prematurity and hospital-acquired infections. By implementing these evidence-based strategies in combination, Mpilo Hospital can reduce the multiple factors contributing to neonatal sepsis, advancing progress toward the Sustainable Development Goals for preventing avoidable neonatal deaths (WHO, 2023). The study's outcomes provide guidance for creating tailored, effective interventions and contribute to the broader conversation about equitable newborn healthcare in low- and middle-income countries.

### **5.3 Conclusion**

This study highlights the complex interplay of maternal, neonatal, and healthcare system factors contributing to neonatal sepsis at Mpilo Central Hospital, providing valuable insights for targeted interventions in resource-limited settings. Identifying modifiable risks such as inadequate antenatal care attendance, untreated maternal infections, preventable birth complications, and lapses in infection control offers a clear roadmap for action. While these findings align with global knowledge on sepsis causes, they also reveal specific challenges within Zimbabwe's healthcare system, including high HIV prevalence and limited resources. By improving prenatal care, strengthening hospital protocols, and engaging the community, Mpilo Hospital can significantly reduce neonatal sepsis rates. This research contributes to the expanding body of work focused on improving newborn survival in low- and middle-income countries, supporting both national health goals and global sustainable development targets. Adopting these evidence-based recommendations could serve as a model for similar healthcare facilities in the region, marking a crucial step toward eliminating preventable infant mortality.

### **5.4 Recommendations**

#### **5.4.1 Improved clinical practice**

- Strengthen Antenatal Care (ANC) Services: Launch community-based initiatives to encourage early and consistent ANC attendance among women. Prioritize the early detection and treatment of maternal infections such as HIV and syphilis during pregnancy.

- **Improve Infection Prevention Protocols:** Use WHO-recommended care bundles for neonatal units and caesarean sections that focus on hand hygiene, aseptic technique in doing procedures, and proper autoclaving of equipment (Mawadza, 2021).
- **Enhance Neonatal Resuscitation and Monitoring:** Train healthcare providers in standard newborn resuscitation methods to manage infants with low Apgar scores effectively and reduce the risk of sepsis resulting from birth asphyxia.

#### **5.4.2 Improving the Health System**

- **Resource Allocation and Staffing:** Prioritize the procurement of essential antibiotics and rapid diagnostic tools to enable early detection of sepsis, and expand staffing in neonatal units through targeted recruitment and task-shifting strategies.

#### **5.4.3 Changes in the community and in policy**

- **Maternal Education Initiatives:** Collaborate with community health workers to educate mothers on safe childbirth practices, proper cord care, and the importance of antenatal care through culturally sensitive campaigns that address common misconceptions about delivering in health facilities.

These recommendations emphasize practical, context-specific strategies to reduce neonatal sepsis at Mpilo Hospital, with the potential for adaptation in other low- and middle-income country (LMIC) settings.

### **5.5. Summary**

This study investigated the risk factors contributing to neonatal sepsis at Mpilo Central Hospital in Zimbabwe using a matched case-control design involving 286 newborns. It identified key maternal risk factors, including limited antenatal care attendance, maternal HIV and syphilis infections, and caesarean delivery. Neonatal factors such as prematurity and low Apgar scores were also significantly associated with sepsis. In addition, systemic health challenges particularly poor infection control practices and resource constraints emerged as contributing factors.

Statistical analysis revealed that neonates born to mothers with two or fewer antenatal visits had 2.4 times higher odds of developing sepsis, those exposed to maternal syphilis had 3.9 times higher odds, and neonates with a 5-minute Apgar score below 7 had 12 times the odds compared to their counterparts. Broader systemic issues, including overcrowding and shortages of essential equipment and staff, further compounded the risks.

Based on these findings, a comprehensive, multi-level intervention strategy is recommended. This includes: (1) clinical improvements such as the implementation of WHO-recommended care bundles and chlorhexidine cord care; (2) strengthening the health system through increased staffing, training, and infection surveillance; (3) community-based outreach programs promoting safe maternal and newborn care practices; and (4) policy advocacy for the adoption of standardized neonatal care protocols. These integrated, context-specific strategies offer a scalable model that could potentially reduce neonatal sepsis-related mortality by 30–40% in similar low-resource settings.

While this project provides valuable insights, its overall quality and scientific contribution can be significantly enhanced by addressing key reporting elements. Specifically, ensuring clarity regarding the study period, consistently reporting odds ratios with their corresponding confidence intervals, and applying appropriate statistical methods for matched case-control studies are essential. Adherence to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines particularly for case-control designs provides a robust framework for transparent, comprehensive, and methodologically sound reporting. Future studies should continue to align with these standards to support reproducibility, policy translation, and clinical impact.

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## Appendices i: Data Collection tools

### eCRF Neonatal Sepsis

Hospital: Mpilo Central Hospital

Study ID:

Data Collector:

Date of

Abstraction: [DD/MM/YYYY]

| 1. DEMOGRAPHIC DATA              |                                         |                                   |
|----------------------------------|-----------------------------------------|-----------------------------------|
| Variable                         | Response Options/Format                 | Validation Rules                  |
| 1.1 Mother's Age                 | Years (numeric)                         | Choose number of years            |
| 1.2 Parity                       | Primipara/Multipara/Grand multipara     | Dropdown list                     |
| 1.3 HIV Status                   | Positive/Negative/Unknown               | Choose HIV status (Dropdown list) |
| 1.4 Residence                    | Urban/Rural/Peri-urban                  | Dropdown list                     |
| 2. ANTENATAL & INTRAPARTUM DATA  |                                         |                                   |
| Variable                         | Response Options/Format                 | Validation Rules                  |
| 2.1 ANC Visits                   | Number (0–10)                           | ≥4 = "Adequate" (auto-tag)        |
| 2.2 Maternal Infections          | Chorioamnionitis/UTI/Syphilis/None      | Type                              |
| 2.3 PROM Duration                | Hours (numeric)                         | ≥18h = "Prolonged" (auto-tag)     |
| 2.4 Mode of Delivery             | Vaginal/Cesarean/Assisted               | Dropdown list                     |
| 2.5 Intrapartum Fever            | Yes/No                                  | If Yes: Insert Temperature (°C)   |
| 3. NEONATAL PARAMETERS           |                                         |                                   |
| Variable                         | Response Options/Format                 | Validation Rules                  |
| 3.1 Birth Weight                 | Grams (numeric)                         | 500–5000g (alert if <2500g)       |
| 3.2 Gestational Age              | Weeks (numeric)                         | 28–42 weeks                       |
| 3.3 Apgar Scores                 | 1-min (0–10), 5-min (0–10)              | Highlight if ≤6 at 5-min          |
| 3.4 Resuscitation                | PPV/Intubation/Chest Compressions/None  | Checkboxes                        |
| 3.5 NICU Admission               | Yes/No                                  | If Yes: Length of stay (days)     |
| 4. SEPSIS DIAGNOSIS & LABORATORY |                                         |                                   |
| Variable                         | Response Options/Format                 | Validation Rules                  |
| 4.1 Sepsis Status                | Confirmed/Probable/None                 | WHO criteria (auto-check)         |
| 4.2 Blood Culture                | Organism (text)/Negative/Not done       | insert text                       |
| 4.3 WBC Count                    | Cells/mm <sup>3</sup> (numeric)         | Highlight if <5,000 or >20,000    |
| 4.4 CRP Level                    | mg/L (numeric)                          | Highlight if ≥10 mg/L             |
| 4.5 Onset of Sepsis              | Early (<72h)/Late (≥72h)                | Dropdown list                     |
| 5. TREATMENT & OUTCOME           |                                         |                                   |
| Variable                         | Response Options/Format                 | Validation Rules                  |
| 5.1 Antibiotics Used             | Ampicillin/Gentamicin/Ceftriaxone/Other | Type                              |
| 5.2 Time to First Dose           | Hours (numeric)                         | Highlight if >1h post-admission   |
| 5.3 Outcome                      | Survived/Death/Transfer                 | Dropdown list                     |
| 5.4 Organ Dysfunction            | Respiratory/Renal/CNS/None              | Type                              |

