



**College of Medicine**

**Survival of Low Birth Weight Babies Admitted at District and  
Private Hospitals in Chiradzulu, Malawi: A Retrospective  
Cohort Study**

**By**

**Austin Chibisa Zgambo**

*(BSc Environmental Health)*

**A Dissertation Submitted in Partial Fulfilment of the Requirements of the Master  
of Science in Epidemiology Degree**

**February 2021**

## **Declaration**

I, Austin Chibisa Zgambo, hereby declare that this dissertation is my original work and has not been presented for any other awards at the University of Malawi or any other university.

Name of Candidate: Austin Chibisa Zgambo

Signature:



Date: 23 February 2021

## **Certificate of Approval**

The dissertation of Austin Chibisa Zgambo is approved by the Dissertation Examining  
Committee:

---

Associate Professor Genesis Chowe  
(Chairman, Postgraduate Committee)

---

Dr Atupele Kapito-Tembo  
(Supervisor)

---

Dr Mwaiwawo Madanitsa  
(Internal Examiner)

---

Dr Charles Mangani  
(Head of Department)

## **Acknowledgments**

God, am grateful to you for steering me through this road up to where I am today!

To my Supervisor, Dr. Atupele Kapito-Tembo, I say thank you for shaping me with your critical thinking skills. You supported me right from proposal development to report writing. You will always be my mentor.

I would like to thank my beautiful wife, Esnart, for her understanding as well as invaluable support that she has been rendering to me throughout my study time. You are indeed my better half.

To my children Genius, Victor and Alinafe, I say thank you for your support through prayers that took me through the ‘wilderness’. May the Almighty God bless you all.

I am also grateful to the management and staff of St. Joseph’s Private Mission Hospital and Chiradzulu District Hospital for your tireless support during my data collection period.

I am also indebted to my colleague Sikhona Chipeta, and Evalister Kudowa for statistical support.

My thank you also goes to Africa Center of Excellence in Public Health and Herbal Medicine (ACEPHEM) of Kamuzu University of Health Sciences (formerly known as University of Malawi at the College of Medicine) for the partial scholarship that covered my tuition fees.

To all who wished me well, I say thank you, God bless!

## Abstract

In Malawi, there are limited studies that have studied the survival of low birth weight (LBW) babies in public hospitals and no studies have studied or compared with the survival of LBW babies in private hospitals. Understanding LBW survival and factors associated with mortality would facilitate the identification of better strategies to improve their management at health facility level. The objective of the study was to compare the survival rate of LBW babies admitted to public versus private hospital in Chiradzulu district, Malawi; and identify maternal and newborn factors associated with mortality in the two hospitals. A retrospective cohort study of LBW babies admitted to Chiradzulu District Hospital (CZDH) and St. Joseph's Private Mission Hospital (SJPMH) from 2018 to 2019. Data were collected using a data extraction checklist from the nursery ward admission registers. Kaplan Meier curves were used to estimate the survival rate. A Cox proportional hazard model was fitted to identify factors associated with mortality in LBW babies. Records for 1,343 LBW babies (698 from CZDH and 645 from SJPMH) were available for analysis. The overall survival was 87% and it was higher at SJPMH compared to CZDH (96% versus 79%;  $p < .001$ ). Delivery through vacuum extraction (VE) (adjusted hazard ratio (AHR): 11.18; 95% CI: 1.37–95.98), diagnoses of respiratory distress syndrome (RDS) (AHR: 2.12; 95% CI: 1.05–4.27) and asphyxia (AHR: 2.40; 95% CI: 1.44–4.01) increased the risk of mortality. Admission weight of the baby ranging from 1,500 to 2,499 g (AHR: 0.18; 95% CI: 0.08–0.38), and Apgar score 7 – 10 at 5 minutes (AHR: 0.48; 95% CI: 0.27–0.86) were the protective factors against mortality. Interventions to improve survival among the LBW babies should focus on managing deliveries through VE, babies diagnosed with RDS and asphyxia.

## Table of Contents

Declaration.....	i
Certificate of Approval.....	ii
Acknowledgments .....	iii
Abstract.....	iv
List of Tables .....	viii
List of Figures.....	ix
Abbreviations and Acronyms .....	x
Chapter 1: Introduction and Objectives of the Study .....	1
1.1    Introduction.....	1
1.3    Statement of the Problem.....	3
1.4    Literature Review .....	5
1.4.1    Consequences of Having LBW Infant.....	6
1.4.2    Current Interventions to Improve Survival of LBW Babies.....	7
1.4.3    Malawi’s Health Care Systems Support Towards Survival of LBW Babies	
14	
1.4.4    Public Versus Private Health Care .....	16
1.5    Justification of the Study .....	17
1.6    Objectives of the Study.....	18
1.6.1    Broad Objective.....	18
1.6.2    Specific Objectives .....	18

Chapter 2: Methodology.....	20
2.1 Study Type.....	20
2.2 Study Place .....	20
2.3 Study Population.....	22
2.4 Study Period.....	22
2.5 Sample Size.....	23
2.6 Data Collection .....	24
2.7 Data Management and Analysis .....	27
2.8 Ethical Considerations .....	28
Chapter 3: Results.....	29
3.1 Characteristics of the Study Population.....	29
3.2 Maternal and LBW Babies' Characteristics .....	30
3.3 Survival Rate for LBW Babies .....	33
3.4 Factors Associated with Mortality .....	38
3.5 Median Length of Stay for LBW Babies Admitted in Nursery Wards.....	41
3.6 Survival of Inborn versus Outborn LBW Babies.....	41
Chapter 4: Discussion.....	43
4.1 Introduction.....	43
4.2 Survival Rate of LBW Babies.....	43
4.3 Factors Associated with Mortality .....	45
4.4 Average Length of Stay .....	46

4.5	Survival of Inborn Versus Outborn LBW Babies.....	47
4.6	Study Limitations.....	47
Chapter 5: Conclusion and Recommendations.....		49
5.1	Conclusions.....	49
5.2.	Recommendations.....	49
References .....		50
Appendix 1. Data collection tool.....		61
Appendix 2: Certificate of Ethics Approval .....		63
Appendix 3: Schedule of research development and implementation .....		64

## **List of Tables**

Table 1: Demographic Characteristics for Mothers and LBW Babies to CZDH and SJPMH between January 2018 and December 2019.....	31
Table 2: Factors Associated with Mortality in Univariate and Multivariate Analysis...	39
Table 3: Median Length of Hospitalisation for LBW Babies Admitted at CZDH and SJPMH During 2018 and 2019 Period .....	41

## List of Figures

Figure 1: Trends of place of birth in Malawi from 1992 - 2016 .....	15
Figure 2: Flow Chart of LBW Babies Included in the Analysis for CZDH and SJPMH29	
Figure 3: Survival of LBW Babies at CZDH and SJPMH during 2018 and 2019 Period .....	34
Figure 4: Overall Survival of LBW Babies by Sex During 2018 and 2019 period.....	35
Figure 5: Survival by Sex Compared between Admitting Hospitals During 2018 and 2019 Period .....	36
Figure 6: Survival Plots for LBW Babies by Admission Weight Category Admitted at CZDH.....	37
Figure 7: Survival Plots for LBW Babies by Admission Weight Category Admitted at SJPMH .....	38
Figure 8: Admission Category by Admitting Hospital During 2018 and 2019 Period ..	42

## **Abbreviations and Acronyms**

ARI	Acute Respiratory Infection
CHAM	Christian Health Association of Malawi
COMREC	College of Medicine Research and Ethics Committee
CPAP	Continuous Positive Airway Pressure
CZDH	Chiradzulu District Hospital
DHIS 2	District Health Information System 2
ELBW	Extremely Low Birth Weight
HMIS	Health Management Information System
KMC	Kangaroo Mother Care
LBW	Low birth weight
MDHS	Malawi Demographic and Health Survey
MOH	Ministry of Health
NMR	Neonatal Mortality Rate
PI	Principal Investigator
RDS	Respiratory Distress Syndrome
SDG	Sustainable Development Goals
SJPMH	St. Joseph's Private Mission Hospital
TB	Tuberculosis
VLBW	Very Low Birth Weight
WHA	World Health Assembly
WHO	World Health Organization

# **Chapter 1: Introduction and Objectives of the Study**

## **1.1 Introduction**

Low birth weight (LBW) babies have an increased risk of mortality compared to their normal birth weight counterparts. [1] Few known studies in Malawi on survival of LBW babies have been conducted in public hospitals, but none in private hospitals. [2] Survival data for LBW babies would form part of a basis to track progress towards the achievement of Sustainable Development Goal (SDG) child survival targets by 2030 (end preventable deaths of newborns and children under 5 years of age). [3]

In their 65<sup>th</sup> gathering, World Health Assembly (WHA) member states recommended a 30 percent reduction (from 15.0% to 10.5%) in low birth weight globally between 2012 and 2025. [4]

LBW is defined as a birth weight of less than 2,500 g regardless of gestational age. This practical cut-off for international comparison is based on epidemiological observations that babies weighing less than 2,500 g are approximately 20 times more likely to die than those born with a weight of over 2,500 g. [1] LBW may be as a result of intrauterine growth restriction (IUGR) and/or premature birth (<37 weeks' gestation age). [5] There are multiple determinants of LBW which include early induction of labour or caesarean birth (for medical or non-medical reasons), multiple pregnancies, infections, chronic conditions such as diabetes and high blood pressure, smoking, low maternal education, younger maternal age, marital status, weight gain during pregnancy, genitourinary tract infection in pregnancy, parity and fewer prenatal consultations. [6–9]

There is considerable variation in the incidence of LBW across regions and within countries due to differing levels of care and resource availability. [10] Globally, it is estimated that 12 to 17% of all births are LBW, representing more than 20 million births in a year. [1] However, the majority (91%) of LBW babies occur in low and middle-income countries, and of concern is South Asia and sub-Saharan Africa regions where the latter has the second highest incidence of LBW (24%) after South Asia (48%). [1, 10] In Malawi, nearly 13% of babies are born with LBW. [11] More importantly, there is a high probability that the incidence of LBW is underestimated as many newborns are not weighed at birth. [1] In spite of evidence-based interventions to improve LBW outcomes, survival among these babies born in low and middle-income countries is generally lower compared to the high-income countries. Oestergaard et al. stated that without a dramatic change in the trajectory for Africa it is estimated that it will take over 150 years for an African neonate to have the same survival chance as a neonate born in Europe or North America. [12]

## **1.2 Healthcare in Public and Private Mission Hospitals in Malawi**

Malawi is rated as one of the poorest countries in the world with a gross national income per capita of less than US\$1/day. [13]

Malawi's health system is organized at four levels namely: community, primary, secondary and tertiary. An established referral system links these levels to each other. Both the public and private sectors are responsible for the provision of health care services. The public sector includes all health facilities under the Ministry of Health (MOH). Health services in the public sector are free-of-charge at the point of use. On the

other hand, private sector consists of private hospitals run by religious institutions, as well as those run by individuals. The major religious provider is the Christian Health Association of Malawi (CHAM) which provides approximately 29% of all health services in Malawi. [14] Private providers charge user fees for their services which is a major barrier to accessing health services for most poor people living in the rural areas. Only few services which includes maternal and child health services, are free to patients at Mission Hospitals under a service agreement with the government. [15]

### **1.3 Statement of the Problem**

Despite being one of the few countries in sub-Saharan Africa to achieve Millennium Development Goal 4, by reducing child mortality by two thirds between 1990 and 2015, LBW still contributes approximately 5% of the country's total deaths. [16, 17] Fortunately, solutions exist at health facility level to improve the survival and health of vulnerable preterm and LBW babies. These include neonatal resuscitation, kangaroo mother care, hygienic cord care, treatment of infections, immediate and exclusive breastfeeding. [6] However, progress in improving survival of newborn babies has been slow and the global averages hide increasing regional, national, district and even hospital disparities. [18]

It is often argued that quality of care is better in private hospitals than public hospitals partly due to differences in resource base. [19] Consequently, better patient outcomes are expected in private than in public healthcare facilities. For example, a systematic review conducted in 2011 comparing private and public strategies for health service provision for improving health outcomes in resource-limited settings showed that patients in a

private health care setting were less likely to die (mortality in general) than patients in a public health care setting (OR 0.60; 95% CI 0.41–0.88). [19] To the best of the author’s knowledge, it is not yet known whether the survival rates of LBW babies are better in private than public hospitals. Additionally, few known studies in Malawi on survival of LBW babies have been conducted in public hospitals, but none in private facilities. Besides, no study has been conducted to compare the survival outcome of LBW babies between public and private hospitals. A study conducted in Lilongwe in 2015 by Ahlsén AK, et al. compared the short-term survival (from birth to discharge) of LBW babies between public hospitals (Bwaila district hospital and Kamuzu Central Hospital). The study reported a survival rate of 7% for extremely low birth weight (ELBW) babies (< 1,000 g), 52% for very low birth weight (VLBW) babies (1,000 – 1,499 g) and 90% for babies weighing from 1,500 g up to 2,500 g. [2] In addition, studies in Malawi have mostly been conducted in central or tertiary level hospitals which contribute only 2-4% of the LBW deliveries while the remaining occur in district or secondary level health facilities in the country. [20, 21] Besides, several previous studies on LBW focused on either babies weighing under 1,000 g at birth, categorized as extremely low birth weight (ELBW); or weighing from 1,000 – 1,499 g - very low birth weight (VLBW), or both categories but leaving out the other part of below 2, 500 g. For example, Rylance S, et al. in their study that was conducted at Queen Elizabeth Central Hospital (QECH), a referral hospital in the southern region of Malawi, targeted only VLBW category. The aim was to study early mortality outcome in VLBW infants admitted at the neonatal nursery at QECH and determine duration of hospital stay of surviving infants. The study found that 42% of VLBW infants survived to discharge. Besides, VLBW infants stayed in hospital for a mean 21 days (range 5 – 44) while ELBW babies stayed for a mean 47 days (range

35 – 64). [21] Gibbs L, et al. conducted a study in South Africa at Groote Schuur Hospital, Cape Town, focusing only on VLBW category. This study was conducted at a hospital that offered level 3 of care that is equivalent to tertiary level of care in Malawi. [22] Zvenyika-Hlatywayo et al. undertook a prospective study at Harare Hospital in Zimbabwe where infants less than 2,000 g at birth through the first 28 days of life were followed up to determine the mortality rate and age-related risk factors for mortality in the follow up period. The study found that the overall mortality rate in the first 28 days was 51.2%. The factors associated with mortality in the first 12 hours of life were Respiratory Distress Syndrome (RDS) and infants born to mothers with Diabetes Mellitus. This study too, left out the other part of <2,500 g]. [23] The current study focused on the survival of all the three categories of LBW babies admitted at the two hospitals in Chiradzulu district, Malawi. The hospitals are, Chiradzulu District Hospital (CZDH) – a public institution, and St. Joseph’s Mission Hospital (SJPMH) – a private CHAM institution. Both of these institutions offer secondary level of health care to patients including LBW babies giving a better ground for comparison.

#### **1.4 Literature Review**

The literature review highlights what is already known and the gaps in as far as early survival of LBW babies is concerned. Literature from various parts of the world including Malawi has been presented. The section describes consequences of having LBW infant; Current interventions to improve survival of LBW babies; Malawi’s health care systems support towards survival of LBW babies; and comparison between public and private health care.

### **1.4.1 Consequences of Having LBW Infant**

LBW continues to be a significant public health problem globally. Numerous studies have documented the short- and long-term health and developmental consequences of LBW. [5, 24–26] It is not only a major predictor of prenatal mortality and morbidity, but also increases the risk for developing non-communicable diseases such as diabetes and cardiovascular disease later in life. [27] LBW babies exhibit increased rates of neuro-developmental, health and academic problems. These include developmental delays and behavioural difficulties in the first 3 to 5 years of life, with continuing behavioural problems and academic difficulties at later school ages. [25] Results from a meta-analysis of neurobehavioral outcomes in very preterm and/or very LBW children indicated that these children have moderate-to-severe deficits in academic achievement, attention problems, internalizing behavioural problems and poor executive functioning skills, which are adverse outcomes that were strongly correlated to their immaturity at birth. Furthermore, even during transition to young adulthood these children continue to lag behind term-born peers. [28] All these problems are more pronounced for the lowest birth weight babies. In addition, LBW babies have increased risk of mortality within the first 28 days of life and are at substantially higher risk for increased morbidity, re-hospitalization and sub-optimal breast-feeding practices during tender age than children born at normal birth weights. [26] Not surprisingly, the risk for neonatal mortality and morbidity increases substantially with decreasing birth weight. [5] A significant body of research indicates that negative outcomes experienced by many LBW children are worsened by environments characterized by poverty, low educational attainment of caregivers and poor parental stimulation and interactions with the children. [29, 30] These

babies are particularly vulnerable to complications due to impaired respiration, difficulty in feeding, poor body temperature regulation and high risk of infection. [10]

Additionally, the economic cost of LBW is high in terms of neonatal intensive care and ongoing health-care and educational needs. The social cost is also high, with many families experiencing the sudden loss of an LBW infant or a stressful hospital stay, sometimes for months. Consequently, for babies who survive, there is an increased risk of disability, which exacts a heavy load on families and health systems. [10]

#### **1.4.2 Current Interventions to Improve Survival of LBW Babies**

There is undisputed evidence that survival outcomes among LBW babies are also highly heterogeneous among countries due to differing levels of care and resource availability. [5, 10, 31] In low-income settings, over 90% of ELBW die within the first few days of life due to a lack of feasible, cost-effective care, such as warmth, breastfeeding support, and basic care for infections and breathing difficulties, while less than 10% of babies of this category die in high-income settings. [10] For example, in a study done in Germany covering data from 2008 to 2012, survival for ELBW after 180 days of life was estimated at 93%. [32] It has been further established through historical data and new analyses from USA and UK that deaths of LBW as a result of premature birth complications can be reduced by over 75% even without the availability of neonatal intensive care. [10]

Despite the availability of these interventions to improve survival of LBW, it still remains a challenge in low resource settings. Addressing LBW survival is critical for reaching the WHO's goal of a 30% reduction in the global rate of LBW by 2025 and achieving SDG

3 by 2030. [18] To demonstrate the cost-effectiveness of saving a newborn life, Save the Children conducted a Lives Saved Analysis of four inexpensive, underutilized, lifesaving products. Universal coverage of these four products in high-mortality countries could save over one million babies' lives, many on day one and most in the first seven days. [10] The products are: resuscitation devices to help babies breathe; chlorhexidine to prevent umbilical cord infections; injectable antibiotics to treat newborn sepsis and pneumonia; and corticosteroid injections for women in preterm labour to prevent breathing problems in preterm neonates. These four products have been identified by global health experts as priority interventions to immediately and effectively address avoidable newborn deaths. Other newborn health interventions, such as kangaroo mother care and early and exclusive breastfeeding, would save many more babies.

#### **1.4.2.1 Neonatal Resuscitation**

Between 5 to 10% of all newborns and a greater percentage of LBW babies as a result of prematurity need assistance to begin breathing at birth. [33] Basic resuscitation through use of a bag-and-mask or mouth-to-mask (tube and mask) will save almost 20% of the babies who need resuscitation; more complex procedures, such as endotracheal intubation, are required only for a minority of babies who do not breathe at birth and who are also likely to need ongoing ventilation. Recent randomized control trials support the fact that in most cases, assisted ventilation with room air is equivalent to using oxygen, and unnecessary oxygen has additional risks. [34] Expert opinion suggests that basic resuscitation for preterm births reduces preterm mortality by about 10% in addition to immediate assessment and stimulation. [35] Every skilled birth attendant should be able to resuscitate a non-breathing baby. However, many facilities in developing countries

lack even the most basic equipment for resuscitation, and often where it is available, health workers may not be competent in its use. An education program entitled Helping Babies Breathe has been developed by the American Academy of Pediatrics and partners for promotion of basic neonatal resuscitation at lower levels of the health system in low-resource settings and is currently in use even in Malawi and promises potential improvements for premature babies. [36] When midwives and other birth attendants are trained to help babies start breathing immediately after birth, they can help prevent one of the major causes of newborn deaths. Birth asphyxia – when babies are born not breathing – kills approximately 25% of the neonates each year. [37] The simple practice of drying the baby and gently rubbing its body will stimulate breathing and prevents death in most cases. If stimulation does not work within the first minute, a basic resuscitation device consisting of a bag and a mask is used. A study in Tanzania found training health workers in these techniques reduced newborn deaths by 47% and stillbirths by 24%. [38] Similar reductions in stillbirths were also found in India. [39] As such it is estimated that universal coverage of newborn resuscitation would save 229,000 newborn lives each year. [40]

#### **1.4.2.2 Hygienic Cord Care and Treatment of Infections**

The umbilical cord area supports growth of some innocuous or beneficial microorganisms (commensals) whereas others are harmful (e.g. *Clostridium tetani*). Sources of these bacteria include the mother's birth canal, the environment in which the neonate is delivered and hands of the person assisting with the delivery. Internationally, the WHO has advocated since 1998 for the use of dry umbilical cord care (keeping the cord clean without application of anything and leaving it exposed to air or loosely covered by a clean

cloth, in case it becomes soiled it is only cleaned with water). WHO recommends topical antiseptics (e.g. chlorhexidine) in situations where hygienic conditions are poor and/or infection rates are high. [41] However, a Cochrane review (n = 12 trials: 7 hospital-based and 5 community-based) published in March 2015 concluded that there is some uncertainty as to the effect of chlorhexidine applied to the umbilical cords of newborns in hospital settings on neonatal mortality. [42] Instead, there is high quality evidence that chlorhexidine skin or cord care in the community setting results in a 12% reduction in neonatal mortality. Two newly-published trials in Africa, one in Zambia [43] and the other in Tanzania [44] were conducted to evaluate the effectiveness of chlorhexidine umbilical cord care on neonatal mortality. In both studies chlorhexidine cord applications did not seem to provide clear benefits for newborn babies in settings with predominantly facility-based deliveries and lower (<30 deaths per 1000 live births) NMR. Meanwhile, published evidence in lower mortality settings has generally shown a lower proportion of newborn deaths attributable to sepsis than in higher mortality settings. Malawi, according to The Chlorhexidine Working Group in which she is a member, is one of the countries that is moving forward with chlorhexidine for umbilical cord care. [41] Infections, particularly sepsis (blood infection), pneumonia (lung infection) and meningitis (infection of the lining of the brain) is the second most common killer of newborns. These deaths are the easiest to prevent and treat, so rapid reductions in death rates are possible with expanded care. To prevent death, newborn infections must be identified and treated early, usually with antibiotics. [40]

### **1.4.2.3 Corticosteroids for Preterm Labour**

Worldwide, 15 million babies are born prematurely every year, and Africa accounts for 75% of deaths in these babies. [1] In high-income countries, administration of antenatal steroids is standard care for women who are at risk of preterm delivery. However, although over 1 million deaths occur annually due to preterm birth, antenatal steroids are not routine practice in low-income countries where most of these deaths occur. [45] The 2013 State of the World's Mothers report estimated that use of prenatal corticosteroids could save 340,000 newborn lives each year while advocating for a rapid scale-up of these corticosteroids. [40] However, Azad K, et al. in his comment was of the view that more studies have to be done first in low-income settings before massive roll-out citing issues of poverty, safety and evidence of more benefit versus risk. [46] Stephen Kaliti in his correspondence counter argued giving concrete example from Malawi, low-income country, of the rapid scaling up of antenatal corticosteroid treatment with dexamethasone. [47] He cited an example of Bwaila Maternity Hospital, Lilongwe, which has more than 15,000 deliveries annually with more than 2,900 preterm, where there was an increased targeted coverage of antenatal corticosteroids from 8% to 80% in 16 weeks in women at risk of preterm delivery from 24 to 34 weeks' gestation. After the pilot study, the programme was extended in three other hospitals where the coverage reached 59–83% from a baseline of 1–6% within 6 weeks. The intervention has thus far been associated with a drop in preterm neonatal mortality contribution from 60% to 24% at 0–6 days of age. A recent multi-country cluster-randomized trial was conducted with the aim of improving appropriate use of antenatal corticosteroids in low-resource settings in low-middle income countries. [48] The results seemed to agree with Azad's arguments: "...Similar reductions in case-fatality rate are highly unlikely in settings where level of

care is not available”. Not only did NMR not decrease among LBW babies but the stillbirth rates also increased overall. There were no definitive reasons for the increases in either neonatal mortality or stillbirth but through secondary analyses the researchers suggested that an increase in neonatal and maternal infections could be a possible explanation. Consequently, they recommended that trials in low income country facilities including clinics and those without newborn intensive care seem to be of the highest priority. Above all, WHO recommends antenatal corticosteroid therapy for women at risk of preterm birth from 24 weeks to 34 weeks of gestation when laid down conditions are met. [49]

#### **1.4.2.4 Kangaroo Mother Care**

In Malawi, complications from preterm birth claim more than 5,800 lives each year, roughly a third of all newborn deaths. Very small newborn babies and those with complications are best cared for in incubators where they can receive the necessary attention and care. However, in low-income settings incubators are few and often broken or misused. As soon as the general condition improves and the baby no longer needs intensive medical care, but simply warmth, protection from infections and adequate feeding to ensure growth, Kangaroo mother care (KMC) can be the method of choice. KMC is an intervention for LBW babies in which the mother acts as an “incubator” by providing skin-to-skin contact with her newborn in an effort to keep the infant’s temperature within a normal range thereby boosting survival and growth. KMC is associated with over 50% reduced risk of neonatal mortality for stable LBW babies if started in the first week and also improves post-discharge mortality, breastfeeding, weight gain and maternal bonding. [50, 51] In a randomized clinical trial conducted in

Ethiopia to study the effectiveness of early KMC before stabilization of LBW as compared with the conventional method of care, the study showed that death occurred in only 22.5% of the babies on KMC as compared to 38% that were on conventional method of care. The difference was statistically significant and concluded that survival for the preterm LBW babies was remarkably better for the early KMC group than the babies in the conventional method of care in the first 12 hours and thereafter. [52] Since 2002, Malawi has scaled-up KMC in health facilities. Despite the evidence of its cost effectiveness, KMC is hindered by a lack of support, culture and stigma although it is a rare example of a medical innovation moving from the Southern hemisphere, with recent rapid uptake in neonatal intensive care units in Europe. [51, 53] Therefore, practicing KMC on LBW would improve their survival and it has the potential to help save an estimated 32,000 premature babies each year in Malawi; and an additional 770,000 premature babies each year around the world. [54]

#### **1.4.2.5 Immediate and Exclusive Breastfeeding**

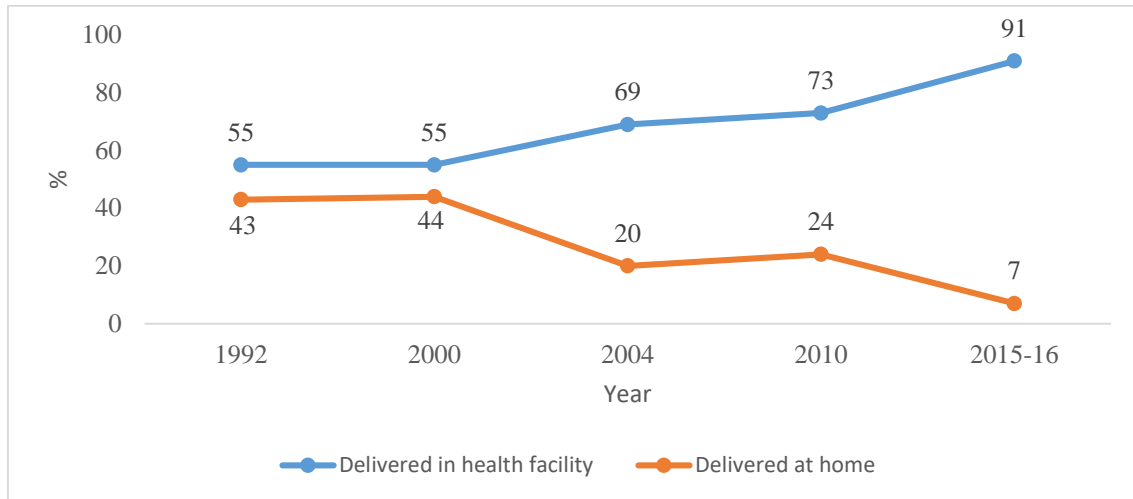
WHO defines early initiation of breastfeeding as provision of mother's breast milk to babies within one hour of birth. [55] Early initiation of breastfeeding has different health benefits like increase ability to defend infections, reduce the risk of diarrhea, and increase the survival rate of children. [56, 57] Different studies indicated that late initiation of breastfeeding leads to high neonatal morbidity and mortality. According to a systematic review study, babies who initiated breastfeeding after 1 hour were 33% at risk of neonatal mortality. [58] A study from Zimbabwe revealed that delayed breastfeeding increases the risk of developing neonatal sepsis within the first 1 week of life. [59] Neonatal morbidity

and mortality of babies who didn't feed breast milk within 1 hour is increased by threefold when compared to babies who fed breast milk within 1 hour of birth. [3, 60, 61] In Malawi, exclusive breastfeeding is being promoted in all health institutions through an initiative known as Baby friendly hospital initiative (BFHI). [62] According to Malawi Demographic and Health Survey (MDHS) 2015-16 report, 80% of babies aged 0-1 month are exclusively breastfed [16] which is 7% more than Ethiopian babies [63] but 11% less than Zambian babies. [64] Furthermore, more than three-quarters (76%) of Malawian babies were breastfed within 1 hour of birth, and nearly all babies (96%) began breastfeeding within 1 day of birth. In Ethiopia, 73% of the babies were breastfed within 1 hour of birth while 92% started breastfeeding within 1 day of birth. [63] In neighbouring Zambia, 66% of babies were breastfed within 1 hour of birth but 94% began breastfeeding within one day of birth. [62] Nevertheless, early breastfeeding initiation is a simple intervention that has the potential to significantly improve neonatal outcomes and should be universally recommended. [56]

#### **1.4.3 Malawi's Health Care Systems Support Towards Survival of LBW Babies**

In high-income countries, reductions in mortality rates in babies that were born with low weight due to prematurity have been driven largely by improved care and, more importantly, by appropriate policy changes. [49] In Malawi, much is already being done to prevent LBW and to improve outcomes for small babies. Some of the initiatives by the government of Malawi towards improving the survival of LBW babies are the passing of a law in 2007 requiring all women to give birth at a local health care facility with a skilled birth attendant (SBA) (Figure 1). Since then, there has been an increasing trend of health facility deliveries from 73% in 2010 to 91% in 2015-16; and skilled delivery from 71%

in 2010 to 90% in 2015-16 – most of these deliveries are conducted at primary level (health centres). [16]



**Figure 1: Trends of place of birth in Malawi from 1992 - 2016**

*Source: MDHS 2015-16*

The Ministry of health has also developed policies recommending the use of antenatal corticosteroids as part of the management of preterm labour, and policy for kangaroo care (recommends KMC for LBW newborns). [65, 66] Furthermore, of the 10 elements of care for improved prematurity birth outcomes recommended by WHO, antenatal administration of steroids to the mothers, tocolytics (medications to suppress premature labour), magnesium sulfate for protecting the infant against serious neurological complications, antibiotics when the fetal membranes are ruptured, vaginal birth preference, continuous positive airway pressure therapy (CPAP), and KMC are currently included in Malawi’s clinical standards of preterm care at the hospital level. [6]

#### **1.4.4 Public Versus Private Health Care**

Both public and private health service delivery systems are critical in the provision of care to accelerate progress to reach the Sustainable Development Goals (SDGs) for ending preventable maternal, newborn and child deaths. [55] People are free to choose for themselves where to access health care, either public or private health facility. The Demographic and Health Surveys show that women access maternal health care services offered in both the public and private health sectors. For example, the MDHS of 2015-2016 indicated that 91% of the mothers had given birth at a health facility. Out of these deliveries, 86% had occurred at a public health facility while 14% occurred at a private health facility. [16] The 2013-2014 Zambia Demographic and Health Survey (ZDHS) indicated that 67% of mothers had given birth at a health facility. Out of this, 93% gave birth at a public health facility while 7% delivered at a private health facility. [64] The trend was similar with Ethiopia where 26% of mothers gave birth at a health facility. Out of this percentage, 95% delivered at a public health facility while 5% gave birth at a private health facility. [63] However, there are factors that determine the choice of place to get health care. A study conducted by Waiswa P, et al. found that women delivering in private facilities were more likely to have less education, lower socio-economic status, higher parity, seeking of antenatal care late in pregnancy and having a normal delivery compared to women delivering in public facilities. [67] Lohela T.J, et al. further added that maternal age, marital status, family size, community where a person resides and the distance to health facilities help determine the place of delivery. [68]

The place of delivery may help determine the survival rate of LBW babies who are delivered either at a public or private health facility. A study done by Ballot D.E., et al.

at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) in South Africa – a public sector hospital – found that birth weight, gender, resuscitation at birth, birth before arrival at the hospital, necrotising enterocolitis, hypotension and nasal continuous positive airways pressure (NCPAP) were the factors associated with mortality among the ELBW and VLBW babies. [69] In the same study, it was estimated that mean duration of hospitalization was 25.8 days. However, there was no statistically significant difference in mortality between inborn and outborn babies (inborn – all LBW babies that were born and admitted in nursery ward at the same hospital; outborn – all LBW babies that were born at another health facility but referred for admission at a nursery ward).

In a similar study conducted by Chanvitan P, et al. to determine the mortality and morbidity rates of VLBW infants at Songklanagarind Hospital, Thailand, perinatal risk factors of mortality were identified as birth weight, gender, congenital anomalies and Apgar score at 1 minute < 5. However, the mean duration of hospitalization was longer at 49.5 days. Similar to Ballot's study, there was no statistically significant differences in mortality between the inborn and outborn babies. [70] Although several studies have been conducted to determine survival rates of ELBW as well as VLBW babies at tertiary level of care, less is known at secondary level of care. Moreover, these studies were not covering the whole category of LBW. Furthermore, these studies were conducted in public and not private health facilities.

## **1.5 Justification of the Study**

Although some data on LBW survival are available in public hospitals, the same is lacking in private hospitals. This situation would pose difficulties in monitoring progress towards

the achievement of SDG child survival targets. This current study was intended to compare survival rate of LBW babies in public versus private hospitals at secondary level of care (district hospital level); and identify maternal as well as neonatal factors associated with mortality among LBW babies in these hospitals. The results would form baseline data for hospital managers to track changes regarding LBW infant survival and inform areas of intervention if some factors are associated.

## **1.6 Objectives of the Study**

### **1.6.1 Broad Objective**

The main objective of this study was to compare the survival rates of LBW babies admitted at CZDH versus SJPMH between 1 January 2018 and 31 December 2019; and to identify factors associated with mortality in these hospitals.

### **1.6.2 Specific Objectives**

1.6.2.1 To estimate and compare survival rates for LBW babies admitted at CZDH and SJPMH.

1.6.2.2 To identify maternal and newborn factors associated with mortality among LBW babies during admission period.

1.6.2.3 To compare hospital median length of stay for LBW babies between the two hospitals.

1.6.2.4 To compare survival rates of inborn versus outborn LBW babies at the selected hospitals.

## **Hypotheses**

1. Survival of LBW babies is higher in private hospitals than in public hospitals.
2. Age of the mother, marital status, mode of delivery, admission hospital, sex of the baby, singleton birth, admission weight, admission category (being inborn or outborn), and Apgar score are associated with mortality of LBW babies.
3. LBW babies admitted at a public hospital have a higher average length of stay in a nursery ward than those admitted at a private hospital.
4. Outborn LBW babies have lower survival rates than inborn LBW babies.

## **Chapter 2: Methodology**

### **2.1 Study Type**

It was a hospital based retrospective cohort study collecting quantitative data from nursery ward registers. This design was chosen to have enough data for analysis considering time factor on the part of the researcher. The outcome measure was the number of hospital deaths among LBW babies. Study participants were followed up from the time of admission to the institution to time of exit (defined as either death, discharge or referred out).

### **2.2 Study Place**

The study was done in Chiradzulu district at CZDH and SJPMH's nursery wards. Both are referral hospitals offering secondary level of health care, and have nursery wards.

Chiradzulu district lies in the southern region of Malawi under South west zone (an extension of the central level of Ministry of health that provides technical support to districts). It shares boundaries with the following districts: Zomba to the North, Phalombe to the Northeast, Mulanje to the East, Thyolo to the South and Blantyre to the West.

The district covers a total area of 767 km<sup>2</sup> with a population of 370,579 (dominated by females – 52%); an increase from 363,978 in 2019. It is the second most densely populated district in the country (483 persons per km<sup>2</sup>) after Likoma (755 persons per km<sup>2</sup>) but with the lowest average household size of 3.9 persons per household. [16] It can be accessed mainly by road and is approximately 25 Km from Blantyre District, the major commercial and industrial centre for the country and administrative headquarters for the Southern Region. The main ethnic groups in the district are Lhomwe and Yao but Chichewa is the most spoken language. [71]

The district has 21 health facilities consisting of 2 hospitals, 11 health centers, 2 dispensaries and 6 clinics. Of the 21 health facilities, 12 are government owned and 9 are private owned. Among the private health facilities, 2 are owned by CHAM, 1 by Moslem Association of Malawi (MAM) and 6 by individual private practitioners. Furthermore, 11 out of 13 health facilities (i.e. 2 hospitals and 11 health cent) (85%) have maternity wings providing labour and delivery services. [71]

CZDH has a 300-bed capacity and was opened in 2005. It serves the district population of 370,579. [72] SJPMH, founded by a Catholic Congregation of Daughters of Wisdom Sisters, in the Archdiocese of Blantyre in 1953, is not-for-profit CHAM hospital and has a bed capacity of 200. [73] It serves a population of over 96,000, with people travelling from other districts to access care. [20] Both hospitals provide labour and delivery services. Annually, there are approximately 11,800 live births in the district of which 16% (1,888) of the live births are delivered at St. Joseph's Mission Hospital. Six percent (6%) of the district's total live births are categorized as LBW. Over 200 babies are admitted annually in nursery wards at the District and Mission hospitals. [20] Both hospitals are mainly run by midwives/ nurses, clinical officers and non-specialized doctors. To the best of the author's knowledge, there are no written standard guidelines on the minimum recommended equipment for a nursery ward in the country. However, CZDH's nursery ward has 3 CPAP machines, 1 phototherapy machine, 1 resuscitaire, 2 suction machines and 4 Oxygen concentrators. SJPMH has 1 phototherapy machine, 1 resuscitaire, 1 suction machine, 2 Oxygen concentrators, 2 incubators and no CPAP machine. Mechanical ventilation and surfactant are not available at both institutions.

## **2.3 Study Population**

In this study, the population was live births weighing below 2,500 g admitted in nursery wards at CZDH and SJPMH between 1 January 2018 and 31 December 2019. The period 2018 to 2019 was chosen with a consideration that patient files and registers would be readily available in the study places.

### **2.3.1 Admission Procedures at Both Hospitals (Chiradzulu and St. Joseph's)**

LBW babies born in health centres including the district hospital are sent to district hospital's Nursery ward for assessment. On the other hand, SJPMH admits LBW babies that are born at the facility but also some whose mothers are self-referred (either born from home or in transit to the facility). If the LBW baby has complications such as Respiratory Distress Syndrome (RDS), the infant is admitted in nursery ward under high-risk area where he/she is put under CPAP machine. Otherwise, the infant is managed under KMC during which the mother/caregiver is advised on how to support the infant. Once the baby is feeding well, maintaining stable body temperature in KMC position and gaining weight, mother and baby can go home. Since most babies would still be premature at the time of discharge, the mother/caregiver is further advised to report at the nearest health facility fortnightly for review of the infant's health until the baby attains a weight of 2,500 g or more. All babies that are in nursery ward are discharged home once they have gained weight of equal or above 1,500 g and have no complications.

## **2.4 Study Period**

The study covered eight months from COMREC submission i.e. April 2020 to December 2020 (Appendix 3: Schedule of research development and implementation).

## 2.5 Sample Size

Sample size for the study was calculated using the sample estimation formula for two-sample proportions test. The calculation was based on the assumptions that LBW survival in public hospitals is 90% (from earlier study in 2013 done by Ahlsén et al. in Lilongwe, Malawi) while in private hospitals is 95% (from estimation using a scientific reasoning from a systematic review by Montagu in 2011). [2, 74] Since twice as much admissions were reported in Malawi's District Health Information System 2 (DHIS 2) to have been done at CZDH than SJPMH, the ratio of sample size was 2:1. [20] Therefore, the planned sample size was 864 LBW infants from CZDH and 432 from SJPMH in order to have 80% power to detect the difference between public and private hospital survival rates using the 5% significance level.

Below is the formula used to calculate the required sample size.

$$n = \left( z_{\frac{\alpha}{2}} + z_{\beta} \right)^2 \frac{\{ \pi_0(1 - \pi_0) + \pi_1(1 - \pi_1) \}}{(\pi_0 - \pi_1)^2}$$

Where  $n$  is the sample size per group;  $\pi_0$  is the estimated survival rate for LBW babies at CZDH nursery ward and  $\pi_1$  is the estimated survival rate at SJPMH. Value of  $Z_{\alpha/2}$  is 1.96 (being the conventional multiplier for alpha), and  $Z_{\beta}$  is 0.842 (being the conventional multiplier for power) at 95% confidence level.

### 2.5.1 Inclusion Criteria

Neonates with birth weight below 2,500 g; and neonates admitted at the two hospitals (CZDH and SJPMH) within 48 hours of their birth (whether inborn or outborn).

### **2.5.2 Exclusion Criteria**

Neonates who had incomplete records especially without documented birth date, birth weight and hospital outcome; and revisits were excluded.

### **2.5.3 Sampling Procedure**

The physical records at the study sites did not match with data reported in DHIS 2 such that fewer physical records were found at CZDH and more at SJPMH. In view of this, all the available records at both Chiradzulu and St. Joseph's nursery wards were used for analysis. This was done in order to maximise the sample size.

## **2.6 Data Collection**

The actual data abstraction from the source documents was done by the trained research assistants under the supervision of the Principal Investigator (PI). The source documents used were Sick Neonate Register, Acute Respiratory Infection (ARI) forms, National Nursery Admission forms, Neonatal Critical Care Patient (CCP) form, Health Facility KMC Register, Neonatal Death Review form, and Child's mother files. Data were entered in Microsoft Excel (2016). No names of persons were captured but instead admission numbers were used. If a certain variable was missing in one source document, then reference was made to another data source to find the required data on the same variable.

### **2.6.1 Overview of the Data Source Documents**

**Sick Neonate register:** This is the main source of data on any admitted newborn baby. It captures data such as admission date, admission number, patient name, sex, date of birth,

place of birth, mode of delivery, diagnosis made on a baby, treatment given to the baby, and final outcome (whether discharged alive or dead).

**ARI form:** This form is used for recording information on any newborn baby that has been admitted as a result of respiratory problems such as RDS. Some of the data captured through this form include admission date of a newborn baby, name of the newborn baby, date of birth, birth weight, admission weight, sex, place of birth, admission diagnosis, treatment given, final diagnosis (cause of death), hospital results (discharged, died, absconded, transferred).

**National nursery admission form:** This form is used to capture data on a newborn baby that is admitted in nursery ward. It includes data on date of admission, date of birth, birth weight, sex, place of birth, age of mother, marital status of the mother, cause of death for a newborn baby, mode of delivery, 5-minute Apgar score, and weight on admission.

**Neonatal Critical Care Patient (CCP) form:** This form is used on all newborn babies admitted in nursery ward and have been put on CPAP for treatment. It is essential for monitoring progress of a newborn baby on the machine. It captures data on a newborn baby such as date of birth, date of admission, birth weight, 5-minute Apgar score and treatment.

**Health facility KMC register:** This register is used for recording LBW babies that have been initiated on KMC. Data captured through this register include mother's name, her address, baby's date of birth, his/her birth weight, baby's vital status at discharge (whether alive or dead), and date of discharge or death.

**Neonatal Death Review form:** This form is used whenever health workers are reviewing the death of a newborn baby in order to establish the real cause of death but also factors that had contributed to the death. It captures data on date of birth, gender, place of birth,

date of admission, date of death, mother's age, mode of delivery, Apgar score at 1 and 5 minutes, cause of death, and modifiable factors.

**Child's mother file:** This is an admission file for the mother used in labour ward and it captures data on the mother of the newborn baby. Data captured through this file include mother's name, mother's age, her home address, her marital status, mode of delivery, baby's date of birth, his/her birth weight, baby's sex, baby's Apgar score at 1 and 5 minutes, place of birth, and mode of delivery.

All these data sources were found at CZDH, however, SJPMH had all except Neonatal Death Review form, and Sick neonate register. All the data sources were found in Nursery ward except the Child's mother files that were found in Postnatal ward. The data sources had similar information and were used to assist in reducing missing data on the variables under study. If a certain variable was missing in one source document, then reference was made to another data source to find the required data on the same variable. Newborn's admission number, his/her name, and date of birth were the variables mostly used to track the newborn in all the data sources so as to avoid duplication.

### **2.6.2 Study Variables**

There are numerous factors that could affect the survival of an LBW baby but in my case, I focused on maternal and newborn data that are routinely collected in registers, partly, to check its user friendliness. The dependent variable was neonatal mortality, dichotomized into yes (died) or no (alive). Predictor variables included marital status of the mother, mode of delivery, sex of the baby, place of birth, singleton birth, admission weight,

admission category, Apgar score at 5 minutes, admission diagnosis, and treatment/intervention given.

## **2.7 Data Management and Analysis**

Data accuracy was ensured by referring to other source documents that had similar information. For example, the main source document was a Sick Neonate Register but reference could be made to ARI Inpatient Form and National Nursery Admission Form if date of admission was not clear. Data consistency was ensured by applying validation checks in Microsoft Excel using formulas to control for mismatching data. Data completeness was ensured by checking that all the variables (especially admission date, admission weight, diagnosis, treatment, hospital outcome, cause of death) were filled. Data cleaning was done, for example, by checking for duplicate records using the *Remove duplicate* command in Microsoft excel 2016; frequency distributions; and outliers that could indicate errors. Later, data coding was done before exporting to STATA 14 (College Station, TX: StataCorp LP), for analysis. The cleaned data were backed up and stored in a memory stick.

### **2.7.1 Statistical Analysis**

Cross-tabulation was used to summarise demographic characteristics for mothers and LBW babies. Kaplan Meier estimator was used to estimate survival for LBW babies as well as comparing survival between the two hospitals. The Log-rank test was used to test for equality of survival curves between categories of selected explanatory variables.

Univariate Cox proportional hazard model was first fitted, and the variables significant at  $p < .25$  in the univariate analysis were selected for the final multivariable Cox proportional

hazard model. The inclusion of variables in the model was determined using the simultaneous (enter) procedure. Variables having  $p < .05$  at 95% confidence interval (CI) in the final multivariable Cox proportional hazard model were considered as significantly associated with mortality. Schoenfeld residuals test was calculated for checking the assumption of Cox proportional hazard model. The median was calculated to compare hospital length of stay for LBW babies in the two hospitals and median test was used to test for equality.

For the sake of this analysis, admission of LBW babies in nursery wards was categorized into two: inborn and outborn. Odds ratio was used to compare survival rate of inborn versus outborn LBW babies at each study site. Fisher's exact tests were used for expected frequencies less than five, otherwise chi-squared test was used to test the significance of the independency between categorical variables. Apart from the univariate analysis, the rest of the statistical tests were conducted at a 5% significant level.

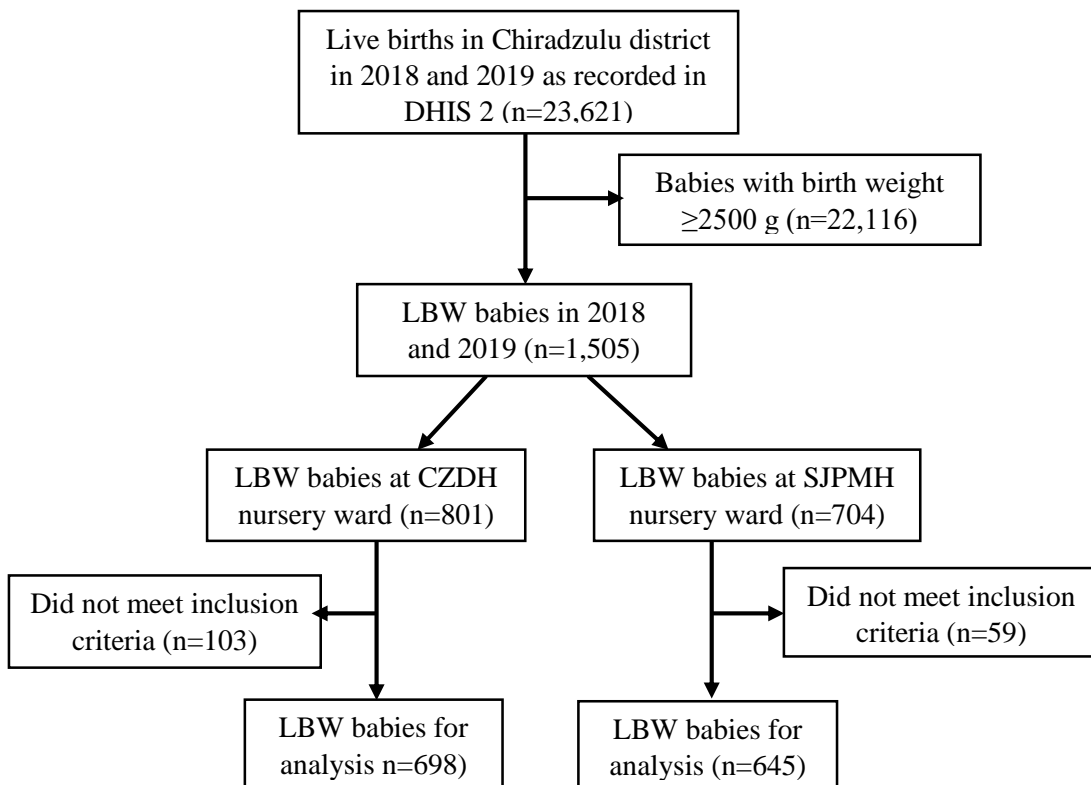
## **2.8 Ethical Considerations**

Ethical clearance was obtained from the University of Malawi's College of Medicine Research and Ethics Committee (COMREC P.02/20/2952) prior to commencement of study implementation. Written permission to conduct study in Chiradzulu district was sought from the District Commissioner through the Director of Health and Social Services and Administrator of St. Joseph's hospital. Verbal consent from in-charges of Nursery wards (at both hospitals) was sought for. Confidentiality of the collected data was observed by storing hard copies in a lockable separate room as well as use of admission numbers on the data collection tool instead of names (of neonates).

## Chapter 3: Results

### 3.1 Characteristics of the Study Population

From Health Management Information System (HMIS) reports, a total of 23,621 live births were reported in the district during 2018 and 2019. CZDH alone reported 8,419 live births while SJPMH had 3,836 live births and the rest were reported from other health facilities in the district. A total of 1,505 LBW babies (437 for SJPMH and 1,068 for other health facilities) were reported. The records of 162 babies (103 for CZDH and 59 for SJPMH) were not included because of predetermined exclusion criteria. Therefore, 698 and 645 were the actual LBW records from CZDH and SJPMH nursery wards that were retrieved for analysis, respectively (Figure 2).



**Figure 2: Flow Chart of LBW Babies Included in the Analysis for CZDH and SJPMH**

### **3.2 Maternal and LBW Babies' Characteristics**

The overall median age for mothers was 22 years (IQR: 19 – 28). There was no significant difference in age of mothers for LBW babies admitted at CZDH and SJPMH (median age: 22 years in both cases with same IQR of 19 – 28, respectively). Marital status and mode of delivery were the maternal variables that were associated with the admitting hospital such that more married mothers preferred to deliver at a public to a private hospital contrary to single mothers. On the other hand, singleton birth, admission weight, admission category, and Apgar at 5 minutes were the neonatal variables associated with the admitting hospital (Table 1).

**Table 1: Demographic Characteristics for Mothers and LBW Babies to CZDH and SJPMH between January 2018 and December 2019**

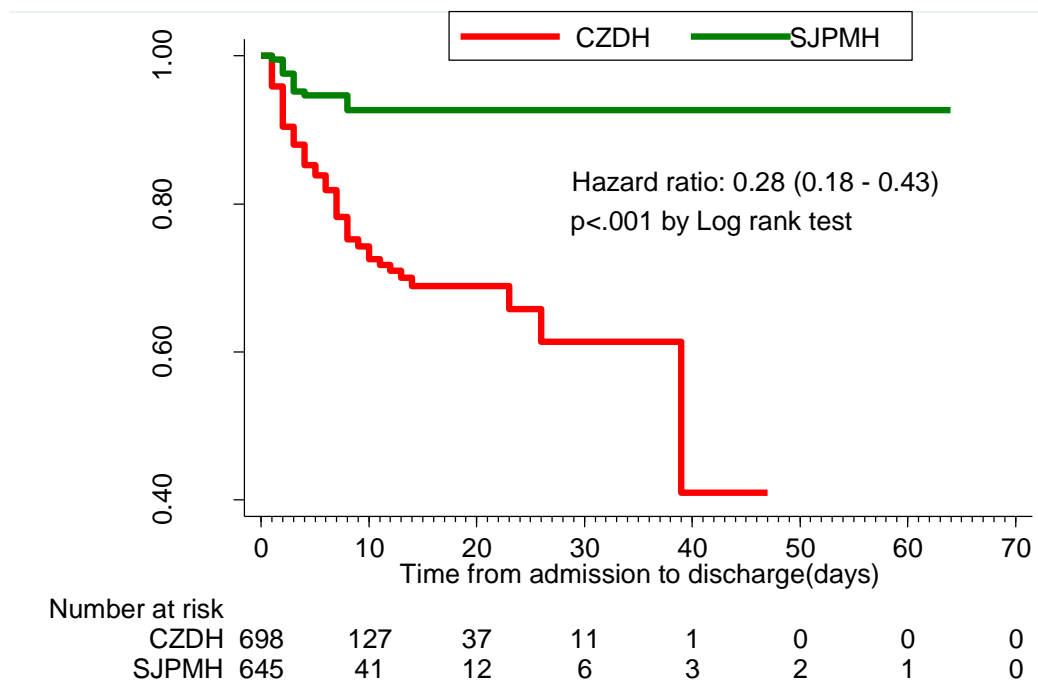
<b>Independent variables</b>	<b>Admission place</b>			<i>p</i> -value
	Total (n=1,343) n (%)	CZDH (n=698) n (%)	SJPMH (n=645) n (%)	
<b>Maternal factors</b>				
<b>Age (years) (n=1,152)</b>				
<20	375 (32.5)	163 (31.8)	212 (33.2)	
20 - 34	652 (56.6)	288 (56.1)	364 (56.9)	
≥35	125 (10.9)	62 (12.1)	63 (9.9)	.47
<b>Median (IQR)</b>	22 (19-28)	22 (19-28)	22 (19-28)	.89
<b>Marital status (n=1,130)</b>				
Married	1,042 (92.2)	479 (97.4)	563 (88.2)	<.001
Single	88 (7.8)	13 (2.6)	75 (11.8)	
<b>Delivery mode (n=1,343)</b>				
SVD	1,077 (80.2)	533 (76.4)	544 (84.3)	.001*
VE	1 (0.1)	0 (0.0)	1 (0.2)	
Breech	54 (4.0)	34 (4.9)	20 (3.1)	
CS	211 (15.7)	131 (18.7)	80 (12.4)	
<b>Neonatal factors</b>				

<b>Independent variables</b>	<b>Admission place</b>			<i>p</i> -value
	Total (n=1,343) n (%)	CZDH (n=698) n (%)	SJPMH (n=645) n (%)	
<b>Sex (n=1,343)</b>				
Male	605 (45.0)	327 (46.9)	278 (43.1)	.16
Female	738 (55.0)	371 (53.1)	367 (56.9)	
<b>Singleton (n=1,343)</b>				
Yes	1,091 (81.2)	503 (72.1)	588 (91.2)	<.001
No	252 (18.8)	195 (27.9)	57 (8.8)	
<b>Admission weight (n=1,343)</b>				
<1,000	36 (2.7)	32 (4.6)	4 (0.6)	<.001 *
1,000-1,499	181 (13.5)	148 (21.2)	33 (5.1)	
1,500-2,499	1,126 (83.8)	518 (74.2)	608 (94.3)	
<b>Median (IQR)</b>	2,050 (1,700-2,300)	1,800 (1,400-2,100)	2,200 (2,000-2,400)	<.001
<b>Admission category (n=1,343)</b>				
Inborn	1,139 (84.8)	541 (77.5)	598 (92.7)	<.001
Outborn	204 (15.2)	157 (22.5)	47 (7.3)	
<b>Apgar at 5 minutes (n=1,182)</b>				
0-6	74 (6.3)	67 (11.4)	7 (1.2)	<.001
7-10	1,108 (93.7)	519 (88.6)	589 (98.8)	

<b>Independent variables</b>	<b>Admission place</b>			<i>p</i> -value
	Total (n=1,343) n (%)	CZDH (n=698) n (%)	SJPMH (n=645) n (%)	
<b>* Fisher's exact</b>				
<b>SVD=Spontaneous Vaginal Delivery; VE=Vacuum extraction; CS=Caesarean section</b>				

### 3.3 Survival Rate for LBW Babies

It was hypothesised that survival of LBW babies would be higher in private hospitals than in public hospitals. The total accumulated time at risk was 7,309 person-years for a 2-year admission period, which yields a mortality incidence rate of 23 per 1000 person-years. The overall survival rate for LBW babies admitted in nursery wards in Chiradzulu district was 87% (1,174 out of 1,343). At hospital level, LBW babies admitted at SJPMH had significantly higher survival (96%) than their counterparts at CZDH (79%),  $p < .001$ . The overall median admission weight was 2,050 g (IQR: 1,700 – 2,300) with survivors having a statistically significantly greater median of 2,100 g (IQR: 1,800 – 2,300) compared to those who died (1,300 g, IQR: 1,000 – 1,700),  $p < .001$ . Figure 3 shows Kaplan Meier survival curves for CZDH versus SJPMH.



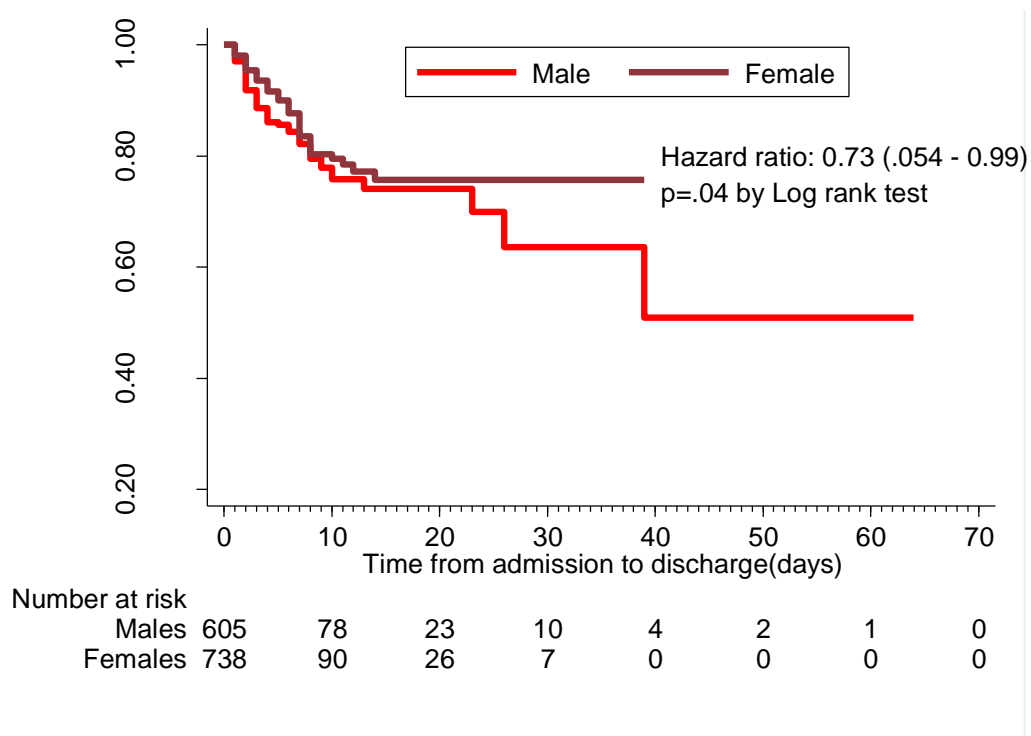
**Figure 3: Survival of LBW Babies at CZDH and SJPMH during 2018 and 2019**

**Period**

*The numbers below the figure denote the number of LBW babies ‘at risk’ in each group*

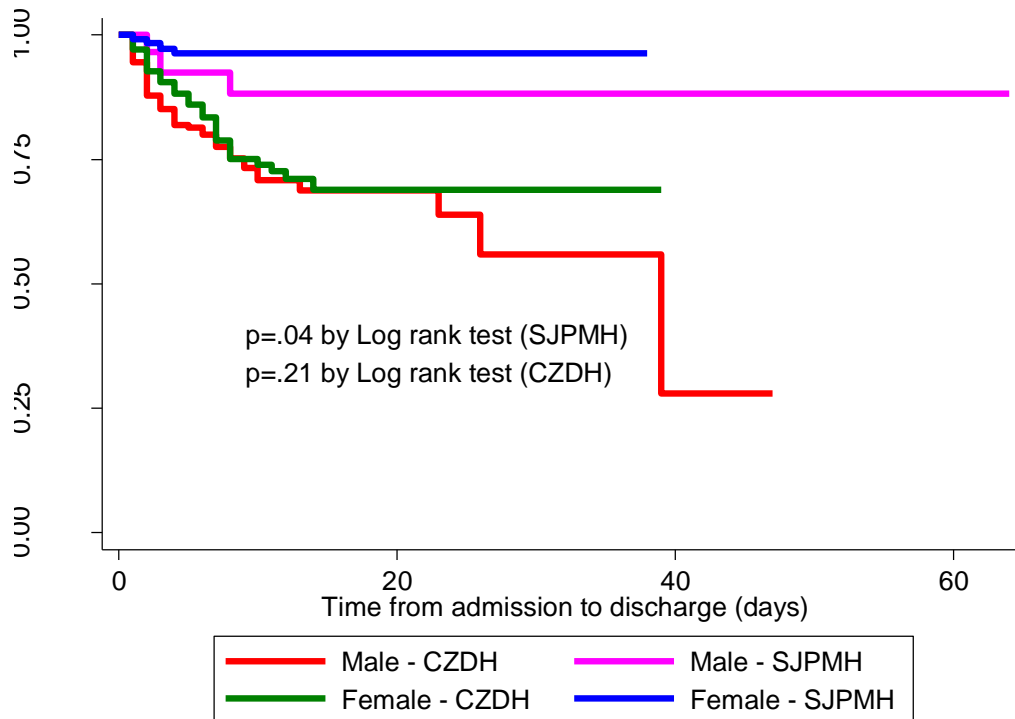
At any time during the admission period, LBW babies at SJPMH had a 72% lower risk of death compared to those admitted at CZDH (HR 0.28; 95% CI, 0.18 – 0.43). Sixty-seven percent of the deaths (97 out of 145) at CZDH occurred within 4 days of admission compared to 96% (23 out of 24) at SJPMH. The survival rate at day 7 was estimated at 77% (95% CI: 73.0 - 81.3) for CZDH compared to 93% (95% CI: 90.0 - 95.7) for SJPMH. By day 8, 100% (24) of all the deaths at SJMPH had occurred. The results of the log-rank test showed a statistically significant difference in the survival experience of LBW babies between those admitted at CZDH and SJPMH ( $p < .001$ ).

Further analysis by sex showed that male babies were at a disadvantage of having lower probability of survival than female babies at both hospitals (Figure 4). However, babies at the private hospital had better survival than at a public hospital (Figure 5).



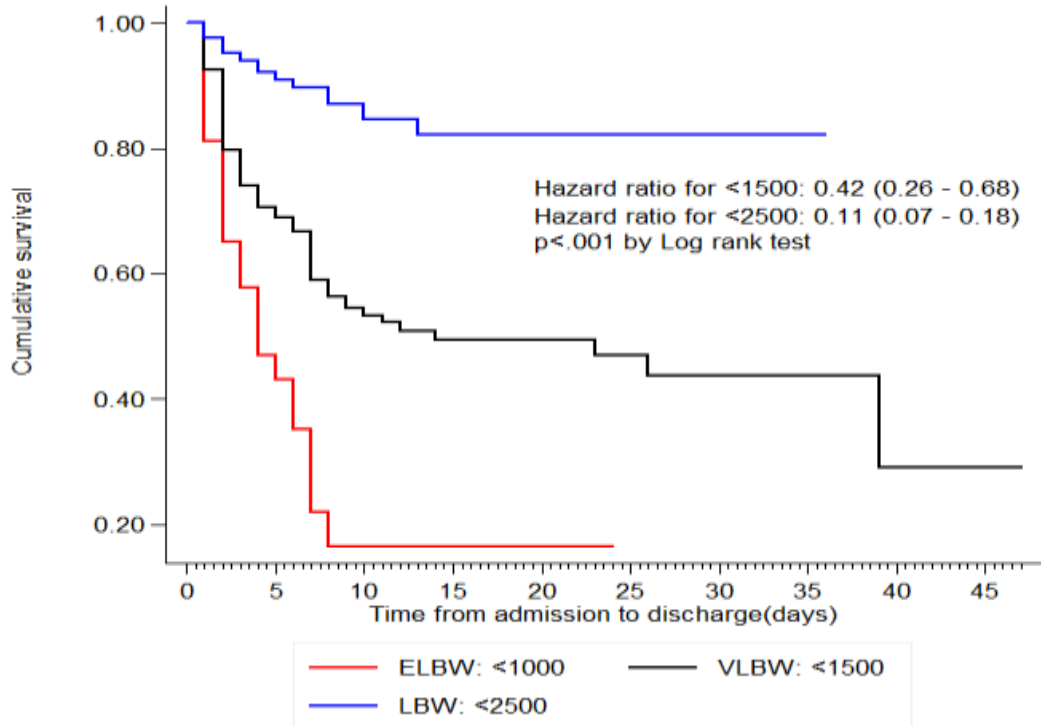
**Figure 4: Overall Survival of LBW Babies by Sex During 2018 and 2019 period**

*The numbers below the figure denote the number of LBW babies ‘at risk’ in each group*

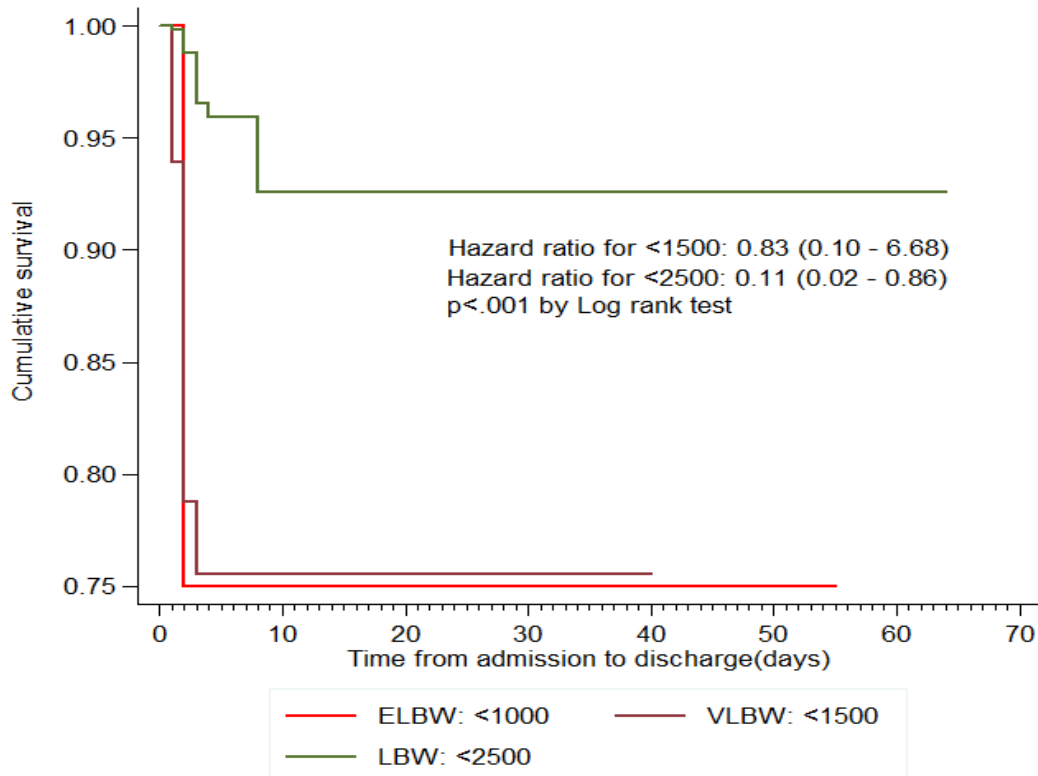


**Figure 5: Survival by Sex Compared between Admitting Hospitals During 2018 and 2019 Period**

Moreover, there was significant difference in survival between LBW categories (ELBW, VLBW and LBW). Babies with ELBW admitted at both hospitals had lower survival than VLBW and LBW babies (Figure 6 and Figure 7). By the end of week 1 of admission, survival of ELBW, VLBW and LBW babies was estimated at 20% versus 71%; 59% versus 75%; and 89% versus 95% at a public versus private hospital respectively. However, there was no clear difference in the survival between VLBW and ELBW babies admitted at SJPMH (Figure 7).



**Figure 6: Survival Plots for LBW Babies by Admission Weight Category Admitted at CZDH**



**Figure 7: Survival Plots for LBW Babies by Admission Weight Category Admitted at SJPMH**

### 3.4 Factors Associated with Mortality

It was also hypothesised that Age of the mother, marital status, mode of delivery, admission hospital, sex of the baby, singleton birth, admission weight, admission category (being inborn or outborn), and Apgar score are associated with mortality of LBW babies. Univariate analysis results for marital status of the mother; mode of delivery; sex of the baby; admission hospital; singleton birth; admission weight; admission category; Apgar at 5 minutes; diagnoses of RDS, asphyxia, and sepsis; treatment with antibiotics; oxygen supplement; and use of CPAP were significantly associated with mortality (Table 2). In multivariate analysis, delivery through vacuum extraction (VE) (AHR 11.48; 95% CI 1.37 – 95.98), admission weight of the baby from

1500 – 2499 g (AHR 0.18; 95% CI 0.08 – 0.38), Apgar score at 5 minutes (AHR 0.48; 95% CI 0.27 – 0.86), diagnoses of RDS (AHR 2.12; 95% 1.05 – 4.27) and asphyxia (AHR 2.40; 95% 1.44 - 4.01) remained significantly associated with mortality in LBW babies.

**Table 2: Factors Associated with Mortality in Univariate and Multivariate**

**Analysis**

Independent variables	Univariate analysis		Multivariate analysis	
	CHR (95% CI)	P-value	AHR (95% CI)	P-value
<b>Maternal factors</b>				
<b>Marital status</b>				
Not married	1		1	
Married	1.92 (0.71 – 5.20)	.20	1.32 (0.40 – 4.29)	.65
<b>Mode of delivery*</b>				
SVD	1		1	
VE	9.04 (1.26 – 64.88)	.02	11.48 (1.37 – 95.98)	.02
CS	0.85 (0.55 – 1.29)	.44	1.22 (0.71 – 2.08)	.47
Breech	2.09 (1.20 – 3.63)	.009	1.64 (0.73 – 3.69)	.22
<b>Neonatal factors</b>				
<b>Sex</b>				
Male	1		1	
Female	0.73 (0.54 – 0.99)	.04	0.73 (0.48 – 1.10)	.13
<b>Admission hospital</b>				
CZDH	1		1	
SJPMH	0.28 (0.18 – 0.43)	<.001	1.04 (0.54 – 1.99)	.90
<b>Singleton</b>				
No	1		1	
Yes	0.60 (0.43 – 0.83)	.002	1.05 (0.64 – 1.70)	.85
<b>Admission weight*</b>				
<1000	1		1	

Independent variables	Univariate analysis		Multivariate analysis	
	CHR (95% CI)	P-value	AHR (95% CI)	P-value
1,000-1,499	0.44 (0.28 – 0.70)	<.001	0.57 (0.27 – 1.17)	.12
1,500-2,499	0.09 (0.06 – 0.14)	<.001	0.18 (0.08 – 0.38)	<.001
<b>Admission category</b>				
Inborn	1		1	
Outborn	1.63 (1.16 – 2.29)	.005	0.87 (0.47 – 1.61)	.66
<b>Apgar at 5 minutes*</b>				
0-6	1		1	
7-10	0.23 (0.16 - 0.35)	<.001	0.48 (0.27 – 0.86)	.01
<b>Diagnosed with RDS*</b>				
No	1		1	
Yes	4.25 (3.10 – 5.83)	<.001	2.12 (1.05 – 4.27)	.03
<b>Diagnosed with asphyxia*</b>				
No	1		1	
Yes	2.28 (1.64 - 3.17)	<.001	2.40 (1.44 - 4.01)	.001
<b>Diagnosed with sepsis</b>				
No	1		1	
Yes	0.49 (0.20 – 1.20)	0.11	0.91 (0.30 – 2.70)	.86
<b>Treated with Antibiotics</b>				
No	1		1	
Yes	3.36 (2.30 – 4.91)	<.001	1.33 (0.68 - 2.58)	.40
<b>Supplied with oxygen</b>				
No	1		1	
Yes	2.70 (1.98 – 3.69)	<.001	1.36 (0.79 - 2.35)	.26
<b>Treated with CPAP</b>				
No	1		1	
Yes	4.18 (3.05 – 5.75)	<.001	1.62 (0.87 - 3.01)	.12

**\*Significant variables in both univariate and multivariate analysis; CHR= Crude Hazard Ratio, AHR=Adjusted Hazard Ratio, CI= Confidence interval**

### 3.5 Median Length of Stay for LBW Babies Admitted in Nursery Wards

Furthermore, it was hypothesised that LBW babies admitted at a public hospital have a longer stay in a nursery ward than those admitted at a private hospital. In general, LBW babies were admitted for a minimum of 1 day and maximum of 64 days at the two hospitals. The patients stayed significantly longer in admission at CZDH with a median of 6 days (IQR: 3 – 8) compared to their counterparts at SJPMH (2 days, IQR: 2 - 4),  $p < .001$  (Table 3).

**Table 3: Median Length of Hospitalisation for LBW Babies Admitted at CZDH and SJPMH During 2018 and 2019 Period**

	Admitting hospital		<i>p</i> -value
	CZDH	SJPMH	
<b>Overall (IQR)</b>	6 days (3 – 8)	2 days (2 – 4)	<.001
<b>Survived (IQR)</b>	6 days (4 – 9)	2 days (2 – 4)	<.001
<b>Died (IQR)</b>	3 days (2 – 6)	2 days (2 – 3)	.002

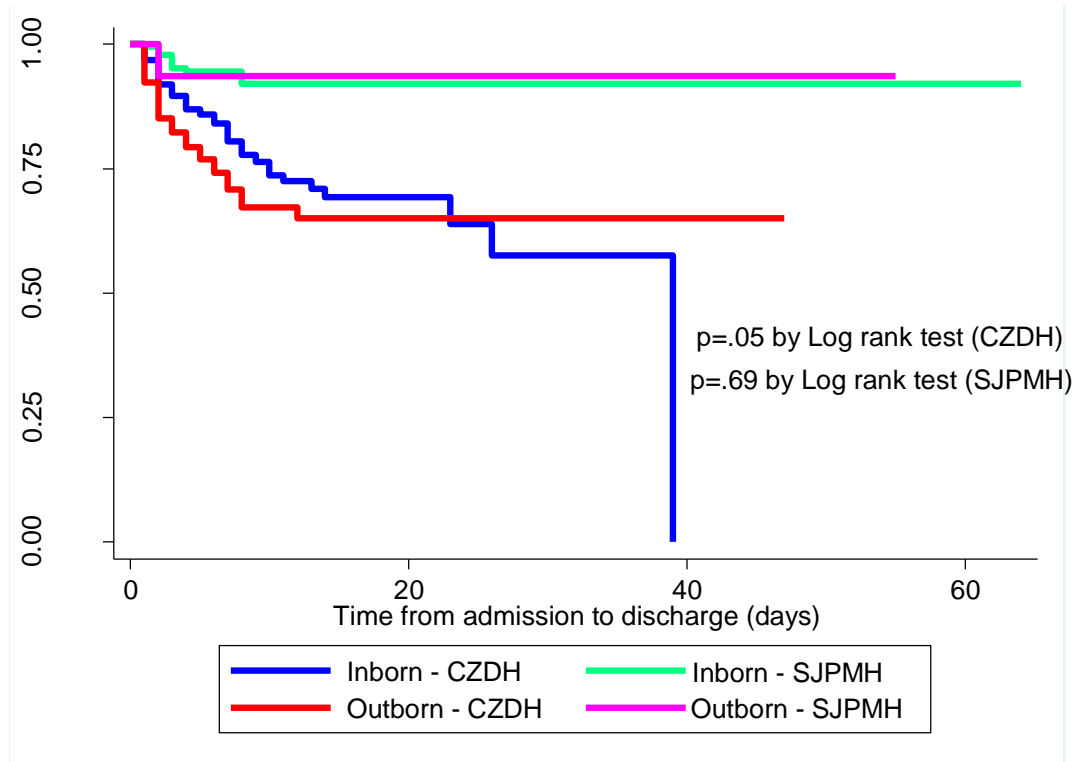
**Note: median test was used to test for equality**

### 3.6 Survival of Inborn versus Outborn LBW Babies

With respect to admission category, it was hypothesised that outborn LBW babies have lower survival rates than inborn LBW babies. Overall, 85% (1,139 out of 1,343) inborn versus 15% (204 out of 1,343) outborn LBW babies were admitted at the two hospitals. Among the inborns, 89% (1,017 out of 1,139) survived up to discharge (81% at CZDH versus 96% at SJPMH). On the other hand, 77% (157 out of 204) survived among the

outborns (72% at CZDH versus 94% at SJPMH),  $p < .001$ . However, the adjusted survival odds ratio was 0.85 (95% CI: 0.41 – 1.77) for outborn babies compared to inborns.

Further analysis between inborn and outborn babies within a hospital showed no significant difference in their survival (**Figure 8**).



**Figure 8: Admission Category by Admitting Hospital During 2018 and 2019 Period**

## **Chapter 4: Discussion**

### **4.1 Introduction**

This study compared the survival rates of LBW babies admitted at CZDH and SJPMH between 1 January 2018 and 31 December 2019; and determined factors associated with mortality in these hospitals. It has been revealed that LBW babies admitted at a private hospital have significantly higher survival than those admitted at a public hospital. Mode of delivery, admission weight of the baby, the fifth minute Apgar score, diagnoses of RDS and asphyxia are the maternal and neonatal independent factors associated with mortality in LBW babies. LBW babies admitted at a public hospital spent more days in admission before being discharged than those admitted at a private hospital. Despite the results not being statistically significant, babies referred for admission from another delivery place (outborns) had lower odds of dying during admission period compared to those admitted at the same hospital where they were delivered (inborns). To the best of the author's knowledge, this is the first study in Malawi comparing survival rate of LBW babies between public and private hospitals.

### **4.2 Survival Rate of LBW Babies**

The present study tested the hypothesis that survival of LBW babies is higher in private than in public hospitals. The results support the hypothesis. Overall survival rate was 87%, reaching 96% for SJPMH and 79% for CZDH. Studies conducted in Lilongwe, Malawi; and Johannesburg, South Africa found the survival rate of 83% and 70.5% respectively. [2,70] The current study has higher rate than the Johannesburg study because the latter focused on VLBW babies (<1,500 g) only. Regarding the Lilongwe

study, the results are almost similar with the current study because they all focused on LBW babies, but also reflecting similarity in practice.

It has been revealed that the first 7 days of admission are very critical for the survival of LBW babies. Above 80% of LBW babies admitted at a hospital in Chiradzulu lose their lives during the first week of admission. As high as 96% deaths at SJPMH and 86% deaths at CZDH occurred in these first 7 days of admission. The main cause of death being RDS at the public hospital with 74%, and asphyxia at the private hospital with 54%. The fact that over 85% of LBW neonatal deaths in the present study occurred in the first 7 days is quite consistent with global WHO findings that 75% of neonatal deaths occur in the first 7 days, given the high-risk group of LBW in a low-income country. [1] The higher survival at a private hospital compared to public hospital could be as a result of differences in birth weight, 5-minute Apgar score and RDS as several studies have consistently found that they are associated with mortality. [75–77] In the current study, heavier babies with birth weight  $\geq 1,500$  g (94% versus 74%); babies with higher Apgar score at 5 minutes (99% versus 89%); and babies who died due to RDS (4% versus 74%) were admitted at a private than public hospital respectively. This calls for special efforts to improve nutrition status of expectant mothers, as well as resuscitation skills of staff working in labour and nursery wards. For example, Lee et al. in their meta-analysis found out that providing training in neonatal resuscitation in the facility setting was associated with a 30% reduction in intrapartum-related mortality (RR=0.70; 95% CI, 0.59-0.84). [35]

With respect to birth weight, ELBW babies had lower probability of survival compared to VLBW and LBW babies. This corroborates with findings from Ahlsén et al. who reported a lower survival for ELBW babies of 7% compared to 52% and 90% for VLBW and LBW babies respectively. [2] Most babies below 1,000 g need neonatal intensive care to survive. [2] As there are no neonatal ventilators and no surfactant available at CZDH or SJPMH, the poor outcome of the ELBW babies was expected.

#### **4.3 Factors Associated with Mortality**

It was also hypothesized that age of the mother, marital status, mode of delivery, admission hospital, sex of the baby, singleton birth, admission weight, admission category, and Apgar score at 5 minutes are associated with mortality of LBW babies. The results are not in support of all the mentioned factors. The study has suggested delivery through VE, admission weight, Apgar score, diagnoses of RDS and asphyxia as the independent associated factors with mortality. Admission weight of above 1,500 g, and a 5-minute Apgar score of above 6 reduces the risk of dying during admission period. On the other hand, being born through VE, diagnosed with RDS and asphyxia increases the risk of mortality in LBW babies during admission period. Other studies have also shown similar findings for Apgar score [10, 69, 78], RDS [2, 23, 78], birth weight [76, 77] and asphyxia [2, 77]. Carns J. et al in a study to monitor CPAP usage and outcomes in newborn wards at 26 government hospitals in Malawi found out that newborns diagnosed with RDS and had been put on CPAP had their survival to discharge improved compared to others that did not benefit from CPAP (48.6% vs 54.5%;  $P = .012$ ). [79] Furthermore, it has already been suggested by others that antenatal corticosteroids, oxygen and timely access to simple CPAP treatment would prevent and treat RDS, while asphyxia can be

treated or prevented with relatively simple means of resuscitation. [2, 10] However, the present study did not find age of the mother, her marital status, sex of the baby, singleton birth, and being inborn or outborn to be associated with mortality. Some previous studies had also found the same results for age of the mother [78], marital status [80], sex of the baby [76, 77, 81], and admission category. [69]

#### **4.4 Average Length of Stay**

The study also tested the hypothesis that LBW babies admitted at a public hospital have a higher average length of stay in a nursery ward than those admitted at a private hospital. The findings support the hypothesis. It has been revealed that LBW babies admitted at a private hospital with secondary level of care spend less days in admission compared to their counterparts at a public hospital. To the author's knowledge, no study has been done to compare number of days spent by LBW babies in admission between public and private hospital. However, costs to be incurred by the mother or guardian during admission at a private hospital could be one of the factors that reduces the period of stay in admission. Additionally, since it has been revealed that higher proportion of babies admitted at a private hospital have birth weight above 1,500g as compared to those admitted at a public hospital, it can be speculated that heavier babies would quickly be discharged from the ward than their counterparts. Nevertheless, further study can be done to follow-up on babies' survival after discharge from the hospital to determine if there is any significant difference between those that were previously admitted at a public hospital versus private hospital.

#### **4.5 Survival of Inborn Versus Outborn LBW Babies**

The study further tested the hypothesis that outborn LBW babies have lower survival rates than inborn LBW babies. The current study has failed to support the hypothesis as the results have shown that there was no statistically significant difference in the odds of death between inborns and outborns. This finding is consistent with a study conducted by Arad I et al. in Israel in which they compared ELBW infants (birth weight  $\leq 1,000$  g) delivered in a hospital providing neonatal intensive care to ELBW babies delivered in a referring hospital. [82] However, it is contrary to what Gibbs et al. [22], had found in their study of a significant relationship between admission category and LBW survival. They found that only 67% of the VLBW outborns survived up to discharge compared to 87% of the inborns. The possible reason for the difference could be that the current study did not consider looking at other maternal and neonatal factors that could have possibly masked the difference such as status of antenatal steroid administration and gestational age. [22] Results further revealed that there was no statistically significant difference in survival between inborns and outborns within a hospital. Lack of statistical significance at hospital level could be as a result of small numbers that were being compared.

#### **4.6 Study Limitations**

The study had some limitations common to retrospective study designs, such as incomplete data, illegible handwriting of the personnel filling registers and forms, mismatching of information between, e.g. admission form and sick neonate register. This might have introduced some bias. However, use of several documents like ARI Inpatient Form, Neonatal Critical Care Patient (CCP) Form, and Case Notes to cross-check data assisted in overcoming some of the limitations. Admission diagnoses and causes of death

were as documented in the source documents, which could be prone to error especially from the private hospital where Neonatal Review forms were not used. Most maternal, health worker and institutional factors were not explored which may have affected the results. Furthermore, the study was based on two secondary level of care institutions limiting its generalizability.

Despite the limitations, the study had strengths in that it included a review of all the available records for the period thereby increased sample size. Besides, this study marks a baseline, in as far as the author knows that no study has been published in Malawi comparing the survival of LBW babies between a public and private hospital both at secondary level of care.

## **Chapter 5: Conclusion and Recommendations**

### **5.1 Conclusions**

LBW babies admitted in private hospitals had higher survival rates compared to their counterparts in public hospitals. Mode of delivery, admission weight of the baby, the fifth minute Apgar score, diagnoses of RDS and asphyxia were associated with mortality in LBW babies. Babies admitted in public hospitals spent longer periods in admission than those admitted in private hospitals. Admission category did not appear to have a significant effect on survival for the outborn versus inborn babies.

### **5.2. Recommendations**

Interventions to improve survival among the LBW babies should focus on managing deliveries through VE, babies diagnosed with RDS and asphyxia.

Further research is recommended to determine whether spending less days in admission at a private hospital has an effect on survival of LBW babies after discharge.

### **5.3 Sources of Funding**

The study was self-sponsored.

## References

- [1] Blencowe H, Krusevec J, de Onis M, et al. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: a systematic analysis. *Lancet Glob Heal* 2019; 7: e849–e860.
- [2] Ahlsén AK, Spong E, Kafumba N, et al. Born too small: who survives in the public hospitals in Lilongwe, Malawi? *Arch Dis Child Fetal Neonatal Ed* 2015; 100: F150–F154.
- [3] UNICEF. Briefing Note Series on SDG global indicators related to children. UNICEF data 2018; 1–73.
- [4] WHO. Global nutrition targets 2025: low birth weight policy brief (WHO/NMH/NHD/14.5). Geneva: World Health Organization, [https://apps.who.int/iris/bitstream/handle/10665/149020/WHO\\_NMH\\_NHD\\_14.5\\_eng.pdf?ua=1](https://apps.who.int/iris/bitstream/handle/10665/149020/WHO_NMH_NHD_14.5_eng.pdf?ua=1) (2014, accessed 18 July 2019).
- [5] Mallik S, Spiker D. Effective early intervention programs for low birth weight premature infants: review of the Infant Health and Development Program (IHDP). *Encyclopedia on early childhood development* 2021; 1–10.
- [6] USAID. Malawi profile of preterm and low birthweight prevention and care. 2015; 1–3.
- [7] Muula AS, Siziya S, Rudatsikira E. Parity and maternal education are associated with low birth weight in Malawi. *Afr Health Sci* 2011; 11: 65–71.
- [8] Mumbare S, Darade R, Hospital V. Maternal risk factors associated with term low birth weight neonates. *Indian Pediatr* 2014; 49: 25–28.

- [9] Ngwira A, Stanley CC. Determinants of low birth weight in Malawi: Bayesian geo-additive modelling. *PLoS One* 2015; 10: 1–14.
- [10] March of Dimes, PMNCH, Children S the, et al. Born too soon: the global action report on preterm. 2012; 112.
- [11] National Statistical Office. Malawi MDG endline survey 2014, key findings. Zomba, mics.unicef.org (2014, accessed 7 September 2021).
- [12] Oestergaard MZ, Inoue M, Yoshida S, et al. Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections, and priorities. *PLoS Med* 2011; 8: e1001080.
- [13] World Bank. GDP per capita (current US\$) - Malawi | Data, <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=MW> (2018, accessed 1 January 2021).
- [14] Malawi Ministry of Health and ICF International. Malawi service provision assessment survey 2013-14: key findings. Rockville, Maryland, USA: MMOH and ICF International, <https://dhsprogram.com/pubs/pdf/SR217/SR217.pdf> (2014).
- [15] Manthalu G, Yi D, Farrar S, et al. The effect of user fee exemption on the utilization of maternal health care at mission health facilities in Malawi. *Health Policy Plan* 2016; 0: 1–9.
- [16] National Statistical Office (NSO) [Malawi] and ICF. Malawi demographic and health survey 2015-16. Zomba, Malawi, Rockville, Maryland, USA., [http://www.nsomalawi.mw/images/stories/data\\_on\\_line/demography/mdhs2015\\_](http://www.nsomalawi.mw/images/stories/data_on_line/demography/mdhs2015_)

- 16/MDHS 2015-16 Final Report.pdf (2015, accessed 7 September 2021).
- [17] WHO. Low Birth Weight in World. World Health Organization 2014; 1–6.
- [18] Darmstadt GL, Oot DA, Lawn JE. Newborn survival: changing the trajectory over the next decade. *Health Policy Plan* 2012; 27: 1–5.
- [19] Dahlgren G. The Privatization of medical health care in Sweden. Why public health services? experiences from profit-driven health care reforms in Sweden. *Int J Heal Serv* 2014; 44: 507–524.
- [20] Malawi Government. Malawi Health Management Information System (HMIS). DHIS 2, <https://dhis2.health.gov.mw/dhis-web-reporting/showDataSetReportForm.action> (2019, accessed 14 November 2019).
- [21] Rylance S, Ward J. Early mortality of very low-birthweight infants at Queen Elizabeth Central Hospital, Malawi. *Paediatr Int Child Health* 2013; 33: 91–96.
- [22] Gibbs L, Tooke L, Harrison MC. Short-term outcomes of inborn v. outborn very-low-birth-weight neonates (<1 500 g) in the neonatal nursery at groote schuur hospital, Cape Town, South Africa. *South African Med J* 2017; 107: 900–903.
- [23] Zvenyika-hlatywayo LT. Risk factors for mortality in low birth weight infants at Harare Hospital (Maternity Unit), Zimbabwe. *Clin Pediatr Res* 2018; 2: 33–41.
- [24] Aarnoudse-Moens CSH, Weisglas-Kuperus N, Van Goudoever JB, et al. Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics* 2009; 124: 717–728.
- [25] Gladstone M, Oliver C, Van den Broek N. Survival, morbidity, growth and developmental delay for babies born preterm in low and middle income countries

- a systematic review of outcomes measured. *PLoS One* 2015; 10: e0120566.
- [26] Upadhyay K, Pourcyrous M, Dhanireddy R, et al. Outcomes of neonates with birth weight  $\leq$  500 g: a 20-year experience. *J Perinatol* 2015; 35: 768–72.
- [27] Nyirenda MJ, Byass P. Comment pregnancy, programming, and predisposition. *Lancet Glob Heal* 2019; 7: e404–e405.
- [28] Aarnoudse-Moens CSH, Weisglas-Kuperus N, Van Goudoever JB, et al. Meta-analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics* 2009; 124: 717–728.
- [29] Mahumud RA, Sultana M, Sarker AR. Distribution and determinants of low birth weight in developing countries. *J Prev Med Public Heal* 2017; 50: 18–28.
- [30] Nascimento LFC, Moreira DA. Are environmental pollutants risk factors for low birth weight? *Cad Saude Publica* 2009; 25: 1791–1796.
- [31] Patel RM, Rysavy MA, Bell EF, et al. Survival of infants born at periviable gestational ages. *Clin Perinatol* 2017; 44: 287–303.
- [32] Jeschke E, Biermann A, Günster C, et al. Mortality and major morbidity of very-low-birth-weight infants in Germany 2008–2012: a report based on administrative data. *Front Pediatr* 2016; 4: 23.
- [33] Lawn JE, Davidge R, Paul VK, et al. Born too soon : care for the preterm baby. *Reprod Health* 2013; 10: 1–19.
- [34] Saugstad OD, Ramji S, Vento M. Oxygen for newborn resuscitation: how much is enough? *Pediatrics* 2006; 118: 789–792.

- [35] Lee AC, Cousens S, Wall SN, et al. Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: A systematic review, meta-analysis and Delphi estimation of mortality effect. *BMC Public Health* 2011; 11: 1–19.
- [36] Singhal N, Lockyer J, Fidler H, et al. Helping babies breathe: global neonatal resuscitation program development and formative educational evaluation. *Resuscitation* 2012; 83: 90–96.
- [37] Kamath-Rayne BD, Berkelhamer SK, Kc A, et al. Neonatal resuscitation in global health settings: An examination of the past to prepare for the future. *Pediatr Res* 2017; 82: 194–200.
- [38] Msemu G, Massawe A, Mmbando D, et al. Newborn mortality and fresh stillbirth rates in Tanzania after helping babies breathe training. *Pediatrics* 2013; 131: 1–10.
- [39] Goudar SS, Somannavar MS, Clark R, et al. Stillbirth and newborn mortality in india after helping babies breathe training. *Pediatrics* 2013; 131: e344–e352.
- [40] Save the Children. *Surviving the first day: state of the world mothers*. State of the World'S Mothers, 2013, p. 41.
- [41] The Chlorhexidine Working Group. *Chlorhexidine for umbilical cord care: a new, low-cost intervention to reduce newborn mortality*. 2017.
- [42] Sinha A, Sazawal S, Pradhan A, et al. Chlorhexidine skin or cord care for prevention of mortality and infections in neonates. *Cochrane Database Syst Rev* 2015; 2015: 1–59.

- [43] Semrau KEA, Herlihy J, Grogan C, et al. Effectiveness of 4% chlorhexidine umbilical cord care on neonatal mortality in Southern Province, Zambia (ZamCAT): a cluster-randomised controlled trial. *Lancet Glob Heal* 2016; 4: e827–e836.
- [44] Sazawal S, Dhingra U, Ali SM, et al. Efficacy of chlorhexidine application to umbilical cord on neonatal mortality in Pemba, Tanzania: a community-based randomised controlled trial. *Lancet Glob Heal* 2016; 4: e837–e844.
- [45] Mwansa-Kambafwile J, Cousens S, Hansen T, et al. Antenatal steroids in preterm labour for the prevention of neonatal deaths due to complications of preterm birth. *Int J Epidemiol* 2010; 39: 122–133.
- [46] Azad K, Costello A. Extreme caution is needed before scale-up of antenatal corticosteroids to reduce preterm deaths in low-income settings. *Lancet Glob Heal* 2014; 2: e191–e192.
- [47] Kaliti S. Antenatal corticosteroids to reduce preterm deaths in low-income settings. *Lancet Glob Heal* 2014; 2: e445.
- [48] McClure EM, Goldenberg RL, Jobe AH, et al. Reducing neonatal mortality associated with preterm birth: gaps in knowledge of the impact of antenatal corticosteroids on preterm birth outcomes in low-middle income countries Joao Paulo Souza. *Reprod Health* 2016; 13: 1–4.
- [49] WHO. WHO recommendations on interventions to improve preterm birth outcomes. 2015; 2–4.
- [50] Conde-Agudelo A, Díaz-Rossello JL. Kangaroo mother care to reduce morbidity

- and mortality in low birthweight infants. *Cochrane Database Syst Rev*; 2016. Epub ahead of print 2016. DOI: 10.1002/14651858.CD002771.pub4.
- [51] Lawn JE, Segre J, Barker P, et al. Antenatal corticosteroids to reduce preterm deaths in low-income settings. *Lancet Glob Heal*; 2. Epub ahead of print 2014. DOI: 10.1016/S2214-109X(14)70263-3.
- [52] Worku B, Kassie A. Kangaroo Mother Care: a randomized controlled trial on effectiveness of early Kangaroo Mother Care for the low birthweight infants in Addis Ababa, Ethiopia. *J Trop Pediatr* 2005; 51: 93–97.
- [53] Chisenga JZ, Chalanda M, Ngwale M. Kangaroo Mother Care: a review of mothers' experiences at Bwaila hospital and Zomba Central Hospital (Malawi). *Midwifery* 2015; 31: 305–315.
- [54] Jack Graham. The secret to Malawi's drop in infant mortality? Kangaroos | apolitical, [https://apolitical.co/en/solution\\_article/secret-malawis-drop-infant-mortality-kangaroos](https://apolitical.co/en/solution_article/secret-malawis-drop-infant-mortality-kangaroos) (2017, accessed 31 December 2020).
- [55] UNICEF. UNICEF Briefing Note Series on SDG global indicators related to children. 2015; 56–73.
- [56] Debes AK, Kohli A, Walker N, et al. Time to initiation of breastfeeding and neonatal mortality and morbidity: a systematic review. *BMC Public Health* 2013; 13: 1–14.
- [57] Oot L, Sommerfelt AE, Sethuraman K, et al. Estimating the effect of suboptimal breastfeeding practices on child mortality: a model in PROFILES for country-level advocacy. Washington, DC, 2015.

- [58] Smith ER, Hurt L, Chowdhury R, et al. Delayed breastfeeding initiation and infant survival: a systematic review and meta-analysis. *PLoS One* 2017; 12: 1–16.
- [59] Mugadza G, Zvinavashe M, Gumbo FZ, et al. Early breastfeeding initiation and incidence of neonatal sepsis in Chipinge District Zimbabwe. *Int J Contemp Pediatr* 2018; 5: 1–5.
- [60] Edmond K, Newton S, Hurt L, et al. Timing of initiation, patterns of breastfeeding, and infant survival: prospective analysis of pooled data from three randomised trials. *Lancet Glob Heal* 2016; 4: e266–e275.
- [61] Phukan D, Ranjan M, Dwivedi LK. Impact of timing of breastfeeding initiation on neonatal mortality in India. *Int Breastfeed J* 2018; 13: 1–10.
- [62] UNICEF and WHO. Protecting, promoting and supporting breastfeeding in facilities providing maternity and newborn services: implementing the revised Baby-friendly Hospital Initiative 2018. Geneva: World Health Organization and the United Nations Children’s Fund (UNICEF), 2018. Epub ahead of print 2018. DOI: 10.1002/9780470935576.ch7.
- [63] Central Statistical Agency (CSA) [Ethiopia] and ICF. Ethiopia Demographic and Health Survey 2016. Addis Ababa, Ethiopia, and Rockville, Maryland, USA, [www.DHSprogram.com](http://www.DHSprogram.com). (2016, accessed 15 September 2019).
- [64] Central Statistical Office (CSO) [Zambia] M of H (MOH) [Zambia] and C. Zambia Demographic and Health Survey 2013-14. Rockville, Maryland, USA, <http://zambia.africadata.org>. (2013, accessed 15 September 2019).

- [65] Rasmussen DN, Unger HW, Bjerregaard-Andersen M, et al. Political instability and supply-side barriers undermine the potential for high participation in HIV testing for the prevention of mother-to-child transmission in Guinea-Bissau: a retrospective cross-sectional study. *PLoS One* 2018; 13: e0199-e819.
- [66] Malawi Government. Malawi KMC National Guidelines. 2nd ed. Lilongwe: Ministry of Health, Malawi, [heathynewbornnetwork.org](http://heathynewbornnetwork.org) (2009, accessed 31 December 2020).
- [67] Waiswa P, Akuze J, Peterson S, et al. Differences in essential newborn care at birth between private and public health facilities in eastern Uganda. *Glob Health Action* 2015; 8: 1–9.
- [68] Lohela TJ, Campbell OMR, Gabrysch S. Distance to care, facility delivery and early neonatal mortality in Malawi and Zambia. *PLoS One* 2012; 7: e52110.
- [69] Ballot DE, Chirwa TF, Cooper PA. Determinants of survival in very low birth weight neonates in a public sector hospital in Johannesburg. *BMC Pediatr* 2010; 10: 1–11.
- [70] Chanvitan P, Ruangnapa K, Janjindamai W, et al. Outcomes of very low birth weight infants in Songklanagarind Hospital. *J Med Assoc Thail* 2010; 93: 191–198.
- [71] Malawi Government. Chiradzulu District Council, Social Economic Profile 2017-2022. Unpublished. 2020.
- [72] Malawi Government. 2018 Malawi population and housing census, population projections 2018-2050 report. Zomba, [www.nsomalawi.mw](http://www.nsomalawi.mw) (2020, accessed 26

October 2020).

- [73] Barber GD. ‘Giving birth in rural Malawi’: perceptions, power and decision-making in a matrilineal community, a thesis submitted in satisfaction of the degree of Doctor of Philosophy in Social Anthropology. Goldsmiths College, University of London, 2004.
- [74] Montagu D, Anglemeyer A, Tiwari M, et al. Private versus public strategies for health service provision for improving health outcomes in resource limited settings: a systematic review. *San Fr CA Glob Heal Sci Univ California, San Fr* 2011; 1–81.
- [75] Haghghi L, Nojomi M, Mohahbatian B, et al. Survival predictors of preterm neonates: Hospital based study in Iran (2010-2011). *Iran J Reprod Med* 2013; 11: 957–964.
- [76] Coulibaly A, Baguiya A, Millogo T, et al. Predictors of mortality of low birth weight newborns during the neonatal period: a cohort study in two health districts of Burkina Faso. *Int J Gynecol Obstet* 2016; 135: s89–s92.
- [77] Orsido TT, Asseffa NA, Berheto TM. Predictors of neonatal mortality in Neonatal Intensive Care Unit at referral Hospital in Southern Ethiopia: a retrospective cohort study. *BMC Pregnancy Childbirth* 2019; 19: 1–9.
- [78] Annan GN, Asiedu Y. Predictors of neonatal deaths in Ashanti region of Ghana: a cross-sectional study. *Adv Public Heal* 2018; 2018: 1–12.
- [79] Carns J, Kawaza K, Liaghati-mobarhan S, et al. Neonatal CPAP for respiratory distress across Malawi and mortality. *Pediatrics* 2020; 144: e20190668.

- [80] Avoka JA, Adanu RM, Wombeogo M, et al. Maternal and neonatal characteristics that influence very early neonatal mortality in the Eastern Regional Hospital of Ghana, Koforidua: a retrospective review. *BMC Res Notes* 2018; 11: 1–5.
- [81] Tette EMA, Nartey ET, Nuerthey BD, et al. The pattern of neonatal admissions and mortality at a regional and district hospital in the Upper West Region of Ghana; a cross sectional study. *PLoS One* 2020; 15: e0232406.
- [82] Arad I, Braunstein R, Bar-Oz B. Neonatal outcome of inborn and outborn extremely low birth weight infants: relevance of perinatal factors. *Isr Med Assoc J* 2008; 10: 457–461.

### Appendix 1. Data collection tool

#### LOW BIRTH WEIGHT SURVIVAL ADMISSION DATA EXTRACTION TOOL

**Instructions:**

- 1 There are two sheets for each participant, please make sure that all are completed
- 2 Please fill in all the required spaces with the right information

Date of data collection: \_\_\_\_\_

Hospital Name: \_\_\_\_\_

District: **CHIRADZULU**

Total live births: \_\_\_\_\_ Total nursery admissions: \_\_\_\_\_

Admission #	Age of mother (years)	Marital status		Mode of delivery (please tick under appropriate column)				Birth date (DD/MM/YYYY)	Admission date (DD/MM/YYYY)	Birth weight (kg)	Sex: M/F	Single: Y/N	Place of birth (please tick under appropriate column)				Admission weight (kg)	Apgar score at 5 minutes	
		Marr	Singl	SVD	VE	Bre	CS						Hosp	Health	Home	Unkn			
		ied	e			ech							ital	Centre		own			

SVD = Spontaneous Vaginal Delivery; VE = Vacuum Extraction; CS = Caesarian Section; PCP = Pneumocystis Pneumonia; RDS = Respiratory Distress Syndrome; TTN = Transient Tachypnea of Newborn; CPAP = Continuous Positive Air Pressure; KMC = Kangaroo Mother Care

**LOW BIRTH WEIGHT SURVIVAL ADMISSION DATA EXTRACTION TOOL**

**Instructions:**

- 1 There are two sheets for each participant, please make sure that all are completed
- 2 Please fill in all the required spaces with the right information

Date of data collection: \_\_\_\_\_

Hospital Name: \_\_\_\_\_

District: **CHIRADZULU**

Total live births: \_\_\_\_\_ Total nursery admissions: \_\_\_\_\_

Admission #	Admission diagnosis (please tick where necessary)									Treatment given (please tick where necessary)				Hospital results		
	Severe pneumonia	PCP	RDS	Tetanus	Meconium aspiration	TTN	Neonatal sepsis	Birth asphyxia	other	Antibiotics	Oxygen	CPAP	KMC	Discharged alive date (DD/MM/YYYY)	Death date (DD/MM/YYYY)	Cause of death

SVD = Spontaneous Vaginal Delivery; VE = Vacuum Extraction; CS = Caesarian Section; PCP = Pneumocystis Pneumonia; RDS = Respiratory Distress Syndrome; TTN = Transient Tachypnea of Newborn; CPAP = Continuous Positive Air Pressure; KMC = Kangaroo Mother Care

## Appendix 2: Certificate of Ethics Approval



**CERTIFICATE OF ETHICS  
APPROVAL**

This is to certify that the College of Medicine Research and Ethics Committee (COMREC) has reviewed and approved a study entitled:

P.02/20/2952 - Survival of low birth weight babies admitted at Chiradzulu district hospital (public) and St. Joseph Mission hospital (private) in Malawi: A retrospective cohort study by Austin Chibisa Zgambo

*On 13-May-20*

*As you proceed with the implementation of your study, we would like you to adhere to international ethical guidelines, national guidelines and all requirements by COMREC some of which are indicated on the next page for your study*

  
Prof. E. Umar - Chairperson (COMREC)

13-May-20  
Date

Approved by  
College of Medicine  
13-May-2020  
(COMREC)  
Research and Ethics Committee

**Appendix 3: Schedule of research development and implementation**

No.	Activity	Apr- 20	May- 20	Jun- 20	Jul- 20	Aug- 20	Sep- 20	Oct- 20	Dec- 20
3	COMREC Submission								
4	COMREC Approval								
5	Data Collection								
6	Data Analysis								
7	Drafting of Thesis								
8	Finalisation of Thesis								
9	Submission of Thesis								
10	Dissemination of Thesis								