SURVIVAL OF VERY LOW BIRTH WEIGHT BABIES BORN AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL: RETROSPECTIVE STUDY

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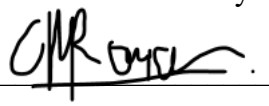
A research report presented to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial completion for the degree of Master of Medicine in Paediatrics and Child Health

DECLARATION

I, Chrisenda Melony Roman, hereby declare that this research report is my own original work and has not been submitted for any degree or examination at any other university. It is submitted in fulfilment of the partial requirements for the degree of Master of Medicine in Paediatrics at the University of the Witwatersrand, Johannesburg.



Chrisenda Melony Roman

Date: 19 September 2025

Place: Johannesburg, Gauteng Province, South Africa

DEDICATION

To our Heavenly Father, for His guidance, strength and grace that made this journey possible. To my parents, Christie and Magdeleen, your unwavering faith in me, endless support, and belief in my dreams have shaped every step of this journey. To my sister, Meryl, your constant support and confidence in me have been a source of strength. To my family, thank you for always being there, offering love and support. To my husband, Tanaka, for standing beside me through the most challenging years of my medical career, for your love, patience and quiet strength. I could not have done this without you. With deep gratitude, I dedicate this work to all of you.

PRESENTATIONS

1. PRESENTED ABSTRACT AT DEPARTMENTAL RESEARCH DAY

   Survival of very low birth weight babies born at Chris Hani Baragwanath Academic Hospital: Retrospective Study. Paediatric Research Day, 7 December 2023, Len Miller Auditorium, University of the Witwatersrand, Johannesburg, South Africa

2. ABSTRACT PRESENTED AT A CONFERENCE

   Survival of very low birth weight babies born at Chris Hani Baragwanath Academic Hospital: Retrospective Study. USANA Conference, 5-8 September 2024, Champagne Sports Resort, Drakensberg

GUIDELINES FOR SUBMISSION FOR PUBLICATION

Survival of very low birth weight babies born at Chris Hani Baragwanath Academic Hospital: Retrospective Study

Planned for submission: South African Medical Journal (SAMJ)

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Research

Guideline word limit: 4 000 words

Research articles describe the background, methods, results and conclusions of an original research study. The article should contain the following sections: introduction, methods, results, discussion and conclusion, and should include a structured abstract (see below). The introduction should be concise – no more than three paragraphs – on the background to the research question and must include references to other relevant published studies that clearly lay out the rationale for conducting the study. Some common reasons for conducting a study are to fill a gap in the literature, a logical extension of previous work, or to answer an important clinical question. If other papers related to the same study have been published previously, please make sure to refer to them specifically. Describe the study methods in as much detail as possible so that others would be able to replicate the study should they need to. Results should describe the study sample as well as the findings from the study itself, but all interpretation of findings must be kept in the discussion section, which should consider primary outcomes first before any secondary or tertiary findings or post-hoc analyses. The conclusion should briefly summarise the main message of the paper and provide recommendations for further study.

Select figures and tables for your paper carefully and sparingly. Use only those figures that provided added value to the paper, over and above what is written in the text.

Do not replicate data in tables and in text.

Structured abstract

This should be 250-400 words, with the following recommended headings:

Background: why the study is being done and how it relates to other published work.

Objectives: what the study intends to find out

Methods: must include study design, number of participants, description of the intervention, primary and secondary outcomes, any specific analyses that were done on the data.

Results: first sentence must be brief population and sample description; outline the results according to the methods described. Primary outcomes must be described first, even if they are not the most significant findings of the study.

Conclusion: must be supported by the data, include recommendations for further study/actions.

Please ensure that the structured abstract is complete, accurate and clear and has been approved by all authors.

Do not include any references in the abstracts.

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I would like to extend my sincere gratitude to my supervisor, Prof FL Nakwa, whose guidance, mentorship and support have been instrumental not only throughout this work, but from the very beginning of my journey as a Paediatrician. Your insight, dedication and encouragement have had a lasting impact on my professional and personal development.

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ABBREVIATIONS

CHBAH	Chris Hani Baragwanath Academic Hospital
CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
ELBW	Extreme low birth weight
HIC	High income countries
HIV	Human immunodeficiency virus
HREC	Human Research Ethics Committee
IPC	Infection prevention and control
IVH	Intraventricular haemorrhage
KMC	Kangaroo mother care
LMIC	Low middle income countries
nCPAP	Nasal continuous positive airway pressure
NHLS	National Health Laboratory Services
NMR	Neonatal Mortality Rate
NICU	Neonatal intensive care unit
PPIP	Perinatal Problem Identification Programme
SA	South Africa
VLBW	Very low birth weight

SUBMISSIBLE MANUSCRIPT FORMAT

SURVIVAL OF BABIES WEIGHING 1500G AND LESS BORN AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL: RETROSPECTIVE STUDY

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Abstract

SURVIVAL OF VERY LOW BIRTH WEIGHT BABIES AT BORN AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL: RETROSPECTIVE STUDY

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Background: Prematurity remains a leading cause of neonatal deaths, particularly in resource limited settings. Very low birth weight (VLBW) neonates face significant challenges in adapting to extrauterine life. Survival outcomes vary based on the quality and availability of neonatal care.

Objective: To assess the survival outcomes and associated risk factors of neonates with birth weights less than 1500g admitted to Chris Hani Baragwanath Academic Hospital (CHBAH) in 2020.

Methods: A retrospective, descriptive study at CHBAH's neonatal unit. All neonates weighing between 750g and 1500g admitted between January and December 2020 were included. Potential maternal and neonatal risk factors were analysed.

Results: Of 756 neonates, 280 (37%) were extremely low birth weight (ELBW) and 476 (63%) VLBW. The mean gestational age was 32 weeks (SD 5.2), with a median birthweight of 1162g (IQR 9701355g). Majority of the neonates were inborn 560 (74.1%). The mean length of stay was 33 days (SD 36.8), with a median of 25 days (IQR 7-47 days). Neonates were at greater risk of death if they had IVH [OR 3.20 (95% CI: 1.47 – 6.93); p=0.003), sepsis [OR 5.73 (95% CI: 3.02 – 10.88); p<0.001], were lower birthweight or ELBW (<1000g) [OR 5.40 (95% CI: 3.05- 9.57); p<0.001], had received surfactant [OR 1.94 (95% CI: 1.13-3.32); p=0.01], had lower Apgar scores [OR 2.16 (95% CI: 1.20-3.88); p=0.01] and a hospital stay of less than 7 days [OR 31.93 (95% CI: 14.84-68.72); p<0.001]. ELBW neonates had lower gestational ages [OR 0.16 (95% CI: 0.10-0.26); p<0.001], lower 5 min Apgar scores of < 7 [OR 1.67, (95% CI: 1.04–2.65); p=0.03) and shorter length of ICU stays (<7 days) [OR 2.26 (95% CI 1.30-3.97); p=0.004]. The risk of dying in ELBW neonates was 4.9 times greater than the VLBW neonates when adjusting for these confounding factors [OR 4.90 (95% CI: 2.91 – 8.23); p<0.001].

Conclusion: This study identified key factors associated with improved survival in VLBW neonates, including absence of culture-positive sepsis, timely surfactant administration and longer hospital stay. These findings reinforce the importance of early intervention, effective infection control and comprehensive neonatal care in improving outcomes for premature neonates. Strengthening these clinical practices may contribute to reducing mortality in this vulnerable population.

Words: 399

Keywords: prematurity, survival, very low birthweight, outcomes

Introduction

The first 28 days of life represent a critical phase for a neonate to adapt to life outside the womb. [2,3] A neonate's birth weight is recognized as a crucial marker of maternal and foetal health. [4] However, their underdeveloped organ systems and limited ability to adapt to the external environment heighten their risk of mortality. [4] Data from Statistics South Africa (Stats SA), Perinatal Deaths in South Africa, 2016 - 2020, highlights the ongoing concern regarding neonatal mortality, particularly within the first week of life. [16] Early neonatal mortality has shown an upward trend, increasing from 7039 cases in 1997 to 8121 cases in 2020. [16] Alarmingly, one third of these early neonatal deaths occur on the first day of life. [16]

The survival of neonates with very low birth weight (VLBW) remains a challenge, especially in low middle income countries (LMIC). In 2022, Sub-Saharan Africa accounted for 57% of global under-five deaths, an estimated 2.8 million despite representing only 30% of the world's live births. The region reported the highest neonatal mortality rate, globally at 27 deaths per 1000 live births, followed by Central and Southern Asia, which recorded 21 deaths per 1000 live births. [6] Currently, the neonatal mortality rate in South Africa is 10.6 per 1000 live births. [7]

Survival rates have shown improvement in recent years, but available data remains limited. A study published in 2005 at Chris Hani Baragwanath Academic Hospital (CHBAH) reported that 63% of neonatal deaths were linked to prematurity, with the primary cause of death being immaturity, followed by infections. [8] According to the World Health Organization (WHO), prematurity, intrapartum complications, neonatal infections and congenital anomalies continue to be the primary causes of neonatal mortality. [6] The majority of deaths within the first 28 days of life are attributable to conditions and illnesses linked to inadequate quality of care during childbirth, as well as insufficient access to skilled care and timely interventions in the immediate postnatal period. [6] Improving the health and survival of neonates is achievable through increased access to quality antenatal care, skilled care during childbirth, postnatal care for both mother and newborn. Targeted interventions must be implemented to enhance the survival of neonates, especially VLBW babies. A study conducted at a hospital in Cape Town demonstrated improved survival rates for ELBW neonates when resources were allocated to ventilatory support, surfactant replacement therapy, neonatal resuscitation, and increased availability of neonatal intensive care unit beds. [9] In South Africa, the HAPPI-ness strategy has been proposed and adopted to enhance neonatal survival. This strategy focuses on improving the knowledge and expertise of healthcare workers in maternal and neonatal care as well as reducing mortality rates associated with asphyxia, prematurity and sepsis. The objective of this study is to assess the survival outcomes of neonates weighing between 750g and less than 1500g.

Methods

Study design

This study is a retrospective, descriptive study analysis focused on the survival outcomes of neonates with very low birth weight.

Study setting

The study was conducted in the neonatal unit at CHBAH, a tertiary public academic hospital located in Soweto, Johannesburg. Recognized as the largest hospital in Africa and the third largest globally, it provides care to an estimated 1.5 million people in the Soweto region. The

neonatal unit consists of 185 beds, including 18 neonatal intensive care unit (NICU) beds, 48 high-care beds, a 6-bed surgical high-care unit, a 100-bed standard care nursery unit, and a Kangaroo Mother Care (KMC) unit with capacity for 19 neonates and their mothers.

Study population

The study included all neonates with a birth weight between 750g and 1500g admitted to the Neonatal unit at CHBAH from 1 January 2020 to 31 December 2020. Neonates with incomplete or missing records were excluded from the analysis. Those <750g were excluded as they were offered supportive care based on the unit's protocol. Extremely low birthweight (ELBW) neonates were defined as those neonates between 750g and <1000g and very low birthweight (VLBW) as those between 1000g and 1500g.

Study procedures and data collection

Data which included both maternal and neonatal variables, were obtained from the Neonatal Redcap database and neonatal medical records. Relevant information was extracted and entered on a structured data collection sheet. Blood results (blood culture) were obtained from the NHLS Labtrack system.

Maternal variables included age, gravidity, parity, booking status, HIV status, administration of antenatal steroids and mode of delivery. The neonatal variables included gestational age, birth weight, place of birth (inborn or outborn), need for resuscitation at birth, Apgar scores, surfactant administration, diagnosis of neonatal sepsis, length of hospital stay and outcome (discharge or death). All data were anonymised through the exclusion of names and hospital numbers.

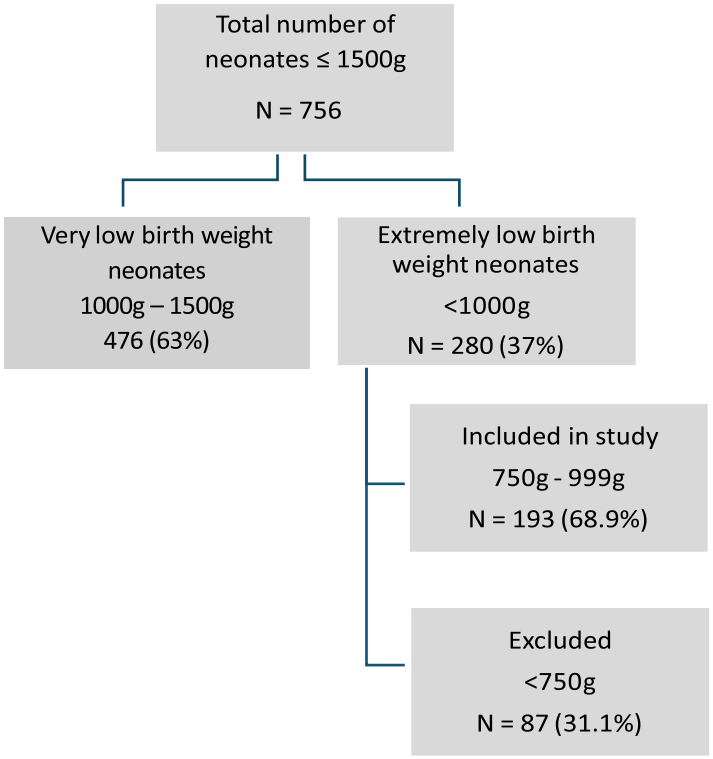
Data analysis

Statistical analysis was conducted using Statistica (TIBCO Software Inc. (2020). Data Science Workbench, version 14. http://tibco.com). Categorical variables were represented as proportions and percentages, while continuous variables were summarized as means with standard deviations or medians with interquartile ranges, depending on the normality of the data distribution. The Chi-square or Fisher's exact test and Student's t-test were used to compare categorical and continuous variables, respectively. Logistic regression analysis was performed to identify risk factors associated with survival, morbidity and mortality. Differences with p-values <0.05 were considered statistically significant. Approval to conduct the study was obtained from the Human Research Ethics Committee (HREC) at the University of the Witwatersrand (M221147). Permission to access laboratory data was obtained from NHLS Academic Affairs and Research Management.

Results

During the study period, 756 neonates with a birth weight ≤1500g were born alive.
This was 4% of the total live births (19101). Among them, 280 (37%) were ELBW while 476 (63%) were VLBW neonates. Figure 1

Figure 1. Flow diagram of neonates included and excluded from the study



Maternal Demographics

The majority of mothers were older than 18 years, with a median age of 29 (IQR 24-33) years. A small percentage (3.7%) were nulliparous mothers and delivered ELBW neonates. HIV-positive mothers were a third of all VLBW admissions (VLBW 32.0% vs ELBW 36.1%; p=0.2). Antenatal steroids were given to 126 (42.2%) of the VLBW neonates, with no difference between the 2 groups. The majority of mothers delivered via caesarean section (VLBW 52.6% vs ELBW 53.0%; p=0.9). Table 1

Table 1: Maternal demographics and characteristics

	Total N = 669 n (%)	ELBW neonates N = 193 n (%)	VLBW neonates N = 476 n (%)	p-value
Maternal Age *maternal age ▪maternal age <18yrs ≥18 yrs	651 (97.3) 29 (6.2) 29 (24-33)	 7 (3.7) 183 (96.3)	 16 (3.4) 445 (96.5)	0.9
Gravida *gravida ▪gravida Primigravida Multigravida	 643 (96.1) 3 (1.4) 2 (2-3)	 45 (24.1) 142 (75.9)	 112 (24.6) 344 (75.4)	0.9
HIV status Positive Negative Unknown	660 (98.7)	69 (36.1) 117 (61.3) 5 (2.6)	150 (32.0) 313 (66.7) 6 (1.3)	0.2
Antenatal Steroids Yes No Unknown	412 (61.6)	 52 (45.6) 52 (45.6) 10 (8.7)	 126 (42.2) 147 (49.3) 25(8.4)	0.6
Mode of delivery Caesarean section Normal Vaginal Delivery	649 (97.0)	 98 (53.0) 87 (47.0)	 244 (52.6) 220 (47.4)	0.9

*****Mean with standard deviation
▪Median with interquartile ranges

Neonatal Demographics

The mean gestational age for the whole cohort was 32 weeks (SD 50.2) with most neonates in the ELBW group < 30 weeks gestation (p<0.001). (Table 2) A higher proportion of the neonates were inborn in ELBW group compared to VLBW (175 (90.7%) vs 385 (80.9%); p=0.002). A similar proportion required resuscitation at birth in both groups. Almost half of the ELBW neonates (89 (48.9%)) had an Apgar score at 5-minutes of less than 7, compared to 93 (21.6%) in the VLBW group (p<0.001). A higher proportion received surfactant in the ELBW compared to VLBW group (p<0.001). There were similar proportions of ELBW and VLBW neonates with intraventricular haemorrhage (IVH) and patent ductus arteriosus (PDA) as shown in Table 2. During the study period, a higher percentage of cases of culture-proven

neonatal sepsis were observed in the ELBW compared to the VLBW (92 (56.1%) vs 183 (43.5%); p=0.005).

Table 2: Neonatal demographics and characteristics

	Total N = 669 n (%)	**ELBW neonates N = 193 n (%)**	**VLBW neonates N = 476 n (%)**	**p-value**
Gestational Age	666 (99.6)			
*gestational age	32 (50.2)			
▪gestational age	30 (28-31)			
<30 weeks		161 (83.8)	170 (35.9)	<0.001
≥ 30 weeks		31 (16.1)	304 (64.1)	
Sex	669 (100)			
Male		89 (46.1)	247 (51.9)	
Female		103 (53.4)	227 (47.7)	0.4
Ambiguous		1 (0.5)	2 (0.4)	
Place of birth	649 (97)			
Inborn		175 (90.7)	385 (80.9)	0.002
Outborn		18 (9.3)	91 (19.1)	
Resus at birth	668 (99.9)			
Yes		185 (95.9)	443 (93.3)	0.2
No		8 (4.1)	32 (6.7)	
Apgar score	613 (91.7)			
*At 5 min	8 (1.9)			
▪At 5 min	9 (7-10)			<0.001
Score ≤ 7		89 (48.9)	93 (21.6)	
Score > 7		93 (51.1)	338 (78.4)	
Surfactant	644 (96.3)			
Yes		85 (44.7)	109 (24.0)	
No		105 (55.3)	344 (75.8)	<0.001
Unknown			1 (0.2)	
IVH	621 (92.8)			
Yes		25 (14.0)	45(10.2)	
No		153 (86.0)	398 (89.8)	0.2
PDA	634 (94.8)			
Yes		12 (6.6)	37 (8.2)	
No		171 (93.4)	414 (91.8)	0.5

Neonatal Sepsis Yes No	585 (87.4)	 92 (56.1) 72 (43.9)	 183 (43.5) 234 (56.5)	0.005
Length of stay *length of stay ▪length of stay ≤ 7days > 7 days	645 (96.4) 33 (36.7) 25 (7-47)	 97 (50.5) 95 (49.5)	 66 (14.6) 387 (85.4)	<0.001
Outcome Discharge Died	657 (98.2)	 53 (28.5) 133 (71.5)	 368 (78.1) 103 (21.8)	<0.001

*Mean with standard deviation

▪Median with interquartile ranges

Outcomes

The mean length of stay in the ELBW group was 29 days (SD 45) and VLBW group was 35 days (SD 33). Majority of VLBW neonates (387 (85.4%)) were hospitalized for more than 7 days, compared to 95 (49.5%) ELBW neonates; p <0.001. Mortality was highest amongst neonates in the ELBW compared to the VLBW group (133 (71.5%) vs 103 (21.8%); (p<0.001)). Those with a birth weight of less than 1000g demonstrated a higher risk of mortality compared to those weighing between 1000g to 1500g (OR: 8.96 (95% CI: 6.09 – 13.19; p <0.001).

Risk factors of mortality

In adjusted odds ratio analyses for risk of mortality (n=466), neonates were at greater risk of death if they had IVH [OR 3.20 (95% CI: 1.47 – 6.93); p=0.003), sepsis [OR 5.73 (95% CI: 3.02 – 10.88); p<0.001], were lower birthweight or ELBW (<1000g) [OR 5.40 (95% CI: 3.05- 9.57); p<0.001], had received surfactant [OR 1.94 (95% CI: 1.13-3.32); p=0.01], had lower Apgar scores [OR 2.16 (95% CI: 1.20-3.88); p=0.01] and a hospital stay of less than 7 days [OR 31.93 (95% CI: 14.84-68.72); p<0.001). Table 3

Table 3. Adjusted odds ratio analyses for risk of mortality

Variable	aOdds Ratio	p-value
IVH	3.20 (1.47 – 6.93)	0.003
Neonatal sepsis	5.73 (3.02 – 10.88)	<0.001
Birth weight (<1000g)	5.40 (3.05 – 9.57)	<0.001

Apgar score at 5 min (<7)	2.16 (1.20 – 3.88)	0.01
Surfactant received	1.94 (1.13 – 3.32)	0.01
Length of stay (< 7 days)	31.93 (14.84 – 68.72)	<0.001

In adjusted odds ratio analyses for ELBW vs VLBW neonates (n=582), females had a 1.6 times greater risk of being ELBW [OR 1.57 (95% CI: 1.01-2.43); p=0.04). Table 4, shows that ELBW neonates had lower gestational ages, lower 5 min Apgar scores of < 7 and shorter length of ICU stays (<7 days). The risk of dying in ELBW neonates was 4.9 times greater than the VLBW neonates when adjusting for these confounding factors [OR 4.90 (95% CI: 2.91 – 8.23); p<0.001].

Table 4. Adjusted odds ratio analyses for ELBW vs VLBW neonates

Variable	aOdds Ratio	p-value
Sex (Female)	1.57 (1.01 – 2.43)	0.04
Gestational age	0.16 (0.10 – 0.26)	<0.001
Apgar score at 5min (<7)	1.67 (1.04 – 2.65)	0.03
Length of stay (<7 days)	2.26 (1.30 – 3.97)	0.004
Demised	4.90 (2.91 – 8.23)	<0.001

Discussion

This study describes the outcomes of VLBW neonates in comparison to ELBW born at CHBAH over a one-year period and demonstrated better outcomes in the VLBW neonates. Among all admissions of ELBW and VLBW neonates, 19.9% and 15.4% respectively did not survive. Several studies have demonstrated that gestational age and birth weight are directly linked to the survival of VLBW and ELBW neonates. [1,2,5,8] ELBW neonates, in particular, have a lower survival rate compared to those weighing more than 1000g, especially in the LMICs. [2,5,8,10] This highlights the important role of birth weight and gestational age in

improving survival outcomes among neonates. Longer hospital stay in the ELBW also showed better outcome in this weight category. It is also important to acknowledge that this study was conducted during COVID-19 pandemic, which may have impacted neonatal outcomes, particularly increased neonatal sepsis and the majority of deaths occurring during COVID-19 waves.
Majority of the neonates were born at CHBAH, accounting for approximately 83.7%, similar to observations from earlier research in the unit. [8] In LMICs, it has been observed that neonates born at home tend to have poorer outcomes compared to those born in hospitals. [14] Most of the neonates were born at the facility reflecting the high-risk nature of these pregnancies and the effectiveness of referral pathways for preterm deliveries.

Resuscitation at birth and 5 min Apgar scores plays a significant role in the outcome of neonates. [8,17] Healthcare providers must be adequately trained and well-equipped to perform resuscitation, which can lead to positive outcomes. However, in resource-limited settings, challenges such as lack of equipment and staffing norms can hinder this process. Studies have shown that neonates with lower Apgar scores (less than 5 or 6) tend to have poorer survival outcome. [8,15] In Korea, a study has also shown that low Apgar scores at birth is associated with an increased risk of mortality. [11] Our analysis shown that neonates with an Apgar score less than 7 at 5 minutes had a higher risk of mortality, which is consistent with the previous study conducted more than a decade ago, which reported that Apgar scores below 6 at 1 and/or 5 minutes were associated with poorer outcomes. [8] Neonates who required resuscitation at birth demonstrated a clinical significance towards increased mortality.

Antenatal steroids has been shown to be significant impact on survival of premature neonates. [10,17] Ballot et al. demonstrated in their study at a tertiary hospital in Johannesburg, equivalent in service profile to our unit, that antenatal steroids contributed to improved survival in ELBW neonates by reducing the severity of respiratory distress syndrome. [10] Antenatal steroid coverage in the neonatal unit was lower than desired. Documentation regarding whether antenatal steroids were administered was frequently incomplete or missing, contributing to uncertainty about overall coverage. This may be due to late booking or mothers arriving in precipitous labour. The health seeking behaviour during COVID 19 may have impacted on the steroid coverage. [20] The matter requires further investigation and some intervention to improve the coverage of antenatal steroids.

Although many neonates had not received surfactant, these findings highlight the opportunity to improve early recognition and prompt administration of surfactant. Surfactant administration when used alongside nasal continuous positive airway pressure (nCPAP) in selected cases, has been associated with better survival rates in ELBW neonates, as shown by study done at Tygerberg Hospital with a 63.3% survival to discharge rate. [9] However, this study has shown that there was a greater risk of mortality in those that received surfactant probably more related to their extreme prematurity.

Poor socioeconomic status, predisposing chronic illnesses in mothers, smoking and alcohol or drug use are associated with low birth weight, which increases the risk of preterm deliveries. [12,13] Unfortunately, these demographic factors were not included in our study but could be addressed in possible future research.

Patent ductus arteriosus (PDA) were observed to be low in our study. PDA were not found in most babies, in the ELBW category neonates noted to not have a PDA was 171 (93.4%) and in the VLBW category it was 414 (91.8%). In contrast to our study, high income countries

have reported greater morbidity related to PDA, with notably higher incidence observed among neonates with a lower gestational age, especially those born before 28 weeks. [18]

The majority of neonates (85.4%) in the VLBW categories required hospitalization for more than seven days. In the ELBW category, the length of stay was nearly evenly distributed between those neonates admitted for 7 days or less and those who stayed longer than 7 days. Shorter hospital stay was linked to higher mortality, a finding consistent with previous studies. [2,3] The early mortality in the ELBW category may reflect the severity of illness and the unit's policy of not offering ventilation for those weighing less than 900g. In contrast, the later deaths observed among VLBW neonates may be attributed to neonatal sepsis and COVID-19 pandemic waves. These findings highlight the need to strengthen infection prevention and control (IPC) measures in the unit, as well as to improve access to surfactant therapy and nCPAP in the unit.

Our study demonstrated a higher burden of sepsis, with 56.1% culture-proven sepsis in the ELBW category and 43.5% in the VLBW category, indicating an overall increase in sepsis within the unit. These findings suggest that smaller neonates may be more vulnerable to sepsis, due to their immature innate and adaptive immune system. [8]

This study was done in the COVID 19 era and the mortalities were at the highest during the different waves of COVID 19. There have been studies documenting the temporal effects of COVID 19 on neonatal outcomes. [19] This study reflects what has been happening nationally where the neonatal mortality rate (NMR) is stagnant. The cut-off for ventilation was at 1000g during 2020, this has subsequently decreased in the unit to 900g. In order to decrease the mortality rate in ELBW neonates in the 750-900g weight bands; more resources need to be made accessible such as staff, equipment and infrastructure.

Limitations of the study

As a retrospective descriptive study, findings depended on existing clinical records. A key limitation was the presence of missing or incomplete data, particularly in neonatal records, which impeded the retrieval of comprehensive clinical and demographic information for both neonates and their mothers. Additionally, some laboratory results could not be retrieved due to missing hospital numbers, which prevented successful matching of patient data within the NHLS Labtrack system. These challenges may have compromised the completeness and accuracy of the dataset, emphasizing the need for improved record-keeping and prospective data collection in future research.

Conclusion

This study provides important insights into the outcomes of VLBW compared to ELBW neonates born at CHBAH. The findings confirm that lower birth weights (especially less than 1000g), poor Apgar score at 5 minutes, the presence of IVH and sepsis are significant factors associated with increased neonatal mortality. These factors highlight the severity of illness in these neonates and stresses the importance of early interventions to improve survival rates. Expanding antenatal steroid coverage and administration of surfactant could play a key role in enhancing survival, particularly among ELBW babies. The study also reinforces the importance of neonatal resuscitation and the role of healthcare provider training and equipment in improving outcomes, particularly in resource-limited settings. Further research is needed to explore the long-term impact of these interventions and identify additional strategies to optimize neonatal care and outcome.

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APPENDICES

APPENDIX A: STUDY PROTOCOL

SURVIVAL OF VERY LOW BIRTH WEIGHT BABIES BORN AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL: RETROSPECTIVE STUDY

Chrisenda Melony Roman (MB,ChB Stell), DCH (CSMA)

Student number: 2563937

Degree: Master of Medicine in Paediatrics

Supervisor: Dr F. L Nakwa, MBbCH (Wits), FCPaed (SA), MMed Paeds (Wits), Certificate of Neonatalogy (SA), Certificate of Paediatric Neurology (SA)

Contents

Abbreviations

CHBAH:	Chris Hani Baragwanath Academic Hospital
CPAP:	Continuous positive airway pressure
C/S:	Caesarean section
ELBW:	Extremely low birth weight
GA:	Gestational age
HBB:	Helping Babies Breathe
HIV:	Human Immunodeficiency Virus
IMR:	Infant Mortality Rate
IVH:	Intra-ventricular haemorrhage
IUGR:	Intra-uterine growth restriction
KMC:	Kangaroo mother care
MDG:	Millennium Development Goal
MgSO4:	Magnesium Sulphate
nCPAP:	Nasal continuous positive airway pressure
NEC:	Necrotising enterocolitis
NICU:	Neonatal intensive care unit
NMR:	Neonatal mortality rate
NNS:	Neonatal sepsis
NOS:	Nosocomial sepsis
NRP:	Neonatal Resuscitation Programme
PDA:	Patent ductus arteriosus
PVL:	Periventricular Leukomalacia

RDS: Respiratory distress syndrome

ROP: Retinopathy of prematurity

RPR: Rapid plasma regain

SDG: Sustainable Development Goals

VLBW: Very low birthweight

2. Introduction

2.1 Background Information

The sustainable development goals (SDG) are a global call to action to end poverty, improve the wellbeing of nations and impact on climate and environment. SDG 3.2 focuses on the reduction of neonatal mortality to 12 per 1000 live births by 2030 and under 5 mortality to 25 per 1000 by 2030.(1)

Epidemiology

According to the World Health Organization, in 2020, all under-5 deaths was 47% that occurred in the neonatal period. “Sub-Saharan Africa has the highest neonatal mortality rate in the world, which is 27 per 1000 live births, followed by central and Southern Asia with 23 deaths per 1000 live births.(2) Globally 2.4 million children died in the first month of life in 2020.”(1) During the first week of life, most of the neonatal deaths occur and in 2019, about 1 million neonates did not survive the first 24 hours of life.(2) According to the Rapid Mortality Survey, “South Africa’s infant mortality rate (IMR) has declined from 29 deaths per 1000 live births in 2014 to 25 deaths per 1000 live births.”(10) The neonatal mortality rate in South Africa had a reduction in 2011 but has plateaued since then(7). The current neonatal mortality for South Africa is cited as 10.6 per 1000 live births.(4)

The first 28 days of life is a crucial time for a neonate to adjust to life outside the uterus. It is seen as the most critical period because of various conditions.(3,5,6) These include birth asphyxia, infection and prematurity, which are the most common causes of neonatal death.(5) Neonatal death is defined as, “death that occurs within 28 days after the baby has been born.”(2) In the rapids survival or PPIP data mortality in the first week has been reported as 75%.(2)

A neonate’s birth weight is regarded as “an important marker of maternal and fetal health.”(7) Due to their underdeveloped organ system and the lack of their physiologically response to their external environment, increases their risk of mortality.(7) Globally, “60 – 80% of neonatal mortality was due to low birth weight.”(7)

Preterm birth complications are stated as one of the primary causes of death. The 2016 PPIP data cited the complications of prematurity as one of the main causes of neonatal mortality.(8,9) Limited resources such as ventilatory support and the lack of surfactant are related to increase mortality in the neonatal period.(11) Other factors associated with increased mortality in neonates are hypothermia, resuscitation at birth and emergency C/S.(11)

The survival of low birth weight neonates is still a problem, especially in developing countries.(12) A study in Kwazulu-Natal reported prematurity and low birthweight and its

sequelae as the main reason of hospital admission. In this cohort, 45% of all deaths were found among the VLBW infants and 67.7% of the neonates who died were born prematurely.(5)

Survival of ELBW neonates have improved over the last few years, but there is limited data evaluating the survival in ELBW neonates in resource limited settings in South Africa.(7) A study done at Chris Hani Baragwanath Academic Hospital(CHBAH) in, 2005, found that 63% of deaths within the neonatal period were related to prematurity and the commonest cause of death was classified as immaturity followed by infection.(13) In a review of the PIPP data for South Africa Rhoda et al reported that infection was on the increase and that most deaths occurred in the district.(9)

"It is possible to improve the health and survival of a neonate by reaching a higher coverage of quality antenatal care, skilled care at birth, postnatal care for mother and neonate, and appropriate care of premature neonates."(7) Studies have shown that the use of ventilatory support such as nasal continuous positive airway pressure (nCPAP) with or without surfactant, have improved neonatal survival.(14) Antenatal corticosteroids have also shown to be of great benefit.(11,14,16) A study done in hospitals in Tanzania, reported that neonates exposed to antenatal steroids, the perinatal mortality rate was lower at, 13,77%.(15)

Improved survival of babies less than 1500g has let to increased morbidity, including necrotizing enterocolitis (NEC), intraventricular haemorrhage (IVH), patent ductus arteriosus (PDA), retinopathy of prematurity (ROP), periventricular leukomalacia (PVL) and sepsis.(11) In a study done at a hospital in Cape Town, showed an improved survival of extremely low birthweight (ELBW) neonates when, resources were assigned to ventilatory support, surfactant replacement management, neonatal resuscitation and increased availability of NICU beds.(17) Similar findings were found in a study done in a tertiary hospital in Limpopo Province; "with an increase in the survival rate due to prompt administration of surfactant and mechanical ventilation with or without surfactant."(14) A study done at a tertiary public hospital in Johannesburg, Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) reported an overall survival rate in very low birthweight (VLBW) neonates at 70.5%, with the most significant cause of neonatal death being extreme prematurity.(3)

Interventions are to be put into place to improve the survival of neonates and especially VLBW and ELBW babies. These interventions include improving antenatal care and improving maternal health; training on neonatal resuscitation with programmes such as the Helping Babies Breathe (HBB) and the neonatal resuscitation programme (NRP) initiatives for healthcare workers; provision of kangaroo mother care (KMC), increasing the coverage of antenatal steroids and the use of non-invasive ventilatory support such as nCPAP; increasing the number of neonatal beds with dedicated neonatal trained staff to provide care and the; prevention and management of hypothermia and hypoglycaemia.(7) In South Africa the HAPPI-ness strategy has been proposed and adopted to improve neonatal survival. This strategy includes; improving the knowledge and expertise of health care workers in maternal and neonatal care; reducing mortalities due to asphyxia; reducing mortalities due to prematurity and reducing mortalities due to sepsis. "Regular neonatal auditing is vital and

needed as disease patterns and contributions to neonatal deaths varies between regions and countries."(7)

The neonatal unit at CHBAH is the largest in the country and has instituted measures to reduce neonatal mortality. The low birthweight rate is at 20% of all deliveries and 15% of all deliveries are premature. The last study on survival in preterm neonates was in 2003 and the purpose of this study would be to report on survival of neonates <1500g more than a decade later.(13)

3. Aim

The aim of this study is to review the survival of very low birth weight neonates (VLBW), with a birth weight of ≤1500g, that were admitted to a tertiary public hospital in South Africa, Chris Hani Baragwanath Academic Hospital, from 1 January 2020 to 31 December 2020.

4. Objectives

1. To determine the incidence of VLBW neonates during the study period.
2. To determine the maternal and neonatal demographics of VLBW neonates during the study period.
3. To determine the co-morbidities of VLBW neonates during the study period.
4. To determine the length of stay and survival of VLBW neonates during the study period. *
5. To determine the length of stay and outcome to discharge of VLBW neonates during the study period.
6. To determine factors that lead to an improved survival, morbidity and mortality of VLBW during the study period.

5. Methodology

This study will be conducted in the neonatal unit at Chris Hani Baragwanath Academic Hospital. The hospital is a tertiary academic public hospital situated in the heart of Soweto, Johannesburg. "It is the largest hospital in Africa and third largest in the world. The hospital serves an immediate population of at least 1.5 million people in surrounding Soweto."(19) The neonatal department is a 185 bed unit, with 18 NICU-beds and 48 High Care beds, a 6 bed surgical high care unit (SHCA), ward 66 that is 100-bedded ward and a KMC unit that can accommodate 19 neonates and mothers.

5.1 Study Design

This study will be a retrospective study, looking at all the neonates that were admitted to the Neonatal Unit at CHBAH with a birth weight between 750g to 1500g, during the time period 1 January 2020 to 31 December 2020.

5.2 Study Population

It will consist of all VLBW neonates, with birth weight of ≤1500g, born at CHBAH or referred to CHBAH for admission and were admitted to the Neonatal unit from 1 January 2020 to 31 December 2020.

5.3 Study Sample

The study consists of all neonates admitted to Chris Hani Baragwanath Academic Hospital, Neonatal Department with a birth weight of less than 1500g (VLBW). There were 757 neonates, with a birth weight of ≤ 1500g born at CHBAH during the study period.

5.4 Inclusion Criteria

1. All the inborn and outborn neonates admitted to the neonatal unit with a birth weight between 750g and 1500g between the 1 January 2020 to 31 December 2020

5.5 Exclusion Criteria

1. Neonates with incomplete and/or missing records will be excluded from the study.
2. Neonates born with a birth weight of <750g during the study period.

6. Anonymity and Confidentiality

Only the researcher and the supervisors will have access to the study data (patient records) to ensure confidentiality. Data will be analysed without using identifying information, a study identification number/code will be used to maintain anonymity of the study subjects. The study code/number will link the identifiers with the main data set. All information and data will be encrypted with a password protection and will be secured

7. Data Collection and Handling

Data will be collected using the Neonatal Redcap database and neonatal files. The relevant data will be extracted and transcribed onto a prepared data collection sheet. (see Appendix A). Blood results (Blood culture results) will be obtained from the NHLS Labtrak. (See Appendix B)

Data that will be recorded electronically and will include both maternal variables and neonatal variables.

7.1 Maternal Variables

The following maternal variables will be collected: age, gravida, parity, booked, HIV status,

RPR status, antenatal steroid status, if mother received magnesium sulphate antenatally, if mother received antibiotics antenatal, underlying maternal illness (hypertension, diabetes mellitus or infection) and mode of delivery: C/S or NVD.

7.2 Neonatal Variables:

The following neonatal variables will be collected: gestational age, birth weight, place of birth (inborn/BBA/our), resuscitation required at birth, Apgars, admission temperature, admission HGT, Respiratory distress syndrome, received surfactant, Intervention needed (N/prongs O2/High flow O2/NCPAP/Mechanical ventilation), presence of IVH, diagnosed with NEC, presence of PDA, early or late onset neonatal sepsis, NICU admission and duration of hospital stay, death or discharge.

Data Analysis

All data collection will be captured onto a Microsoft excel spreadsheet. Statistica (version 16) will be used to analyse data. The categorical and continuous variables will be represented as proportions and percentages and/or means and standard deviation or medians and interquartile ranges depending on whether data was normally or not normally distributed. Chi-square or Fischer's exact test and Student's t-test will be performed to compare categorical and continuous variables respectively. Logistic regression analysis will be performed to identify risk factors associated with survival, morbidity and mortality. Differences with p-values <0.05 will be considered to be statistical significant.

9. Ethical Considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (HREC) and the University of the Witwatersrand prior to commencing the study. Approval to conduct the study will be requested from the CEO, the Paediatric Head of the Department and the Neonatal Unit Head, of the CHBAH. The permission to access laboratory data will be sought from the NHLS Academic Affairs and Research Management for all NHLS data. The patient identifiers will be anonymized. A unique study number will be assigned to every neonate and link the identifiers to the databases. These will be password protected.

Potential Limitations of the study

The sample size might be smaller than expected. Data collection will be reliant on note keeping from neonatal files. Missing data and inability to retrieval files may be limited. If > 50% of the data variables are missing per participant these will be excluded.

10. Project Outline

Activity/Duty	Sept 2022	Oct 2022	Nov 2022	Dec 2022	Jan 2023	Feb 2023	March 2023	April 2023	May 2023	June 2023	July 2023	Aug 2023	Sept 2023	Oct 2023
Preparation of proposal														
Literature review														
Submission of proposal														
Approval: Ethics														
Approval: Post graduate														
Data collection														
Analysis of data														
Draft article														
Submission														

11. Budget

The cost involved in this study would involve a few expenses, that will be covered by me personally. The article will be submitted for publishing, funding will be applied for through University of the Witwatersrand Faculty of Health Sciences MMed fund.

Please see the following table below.

ITEM	DESCRIPTION OF ITEM	ESTIMATED AMOUNT/COST
Travel	Research block Home → CHBAH	R27.4 (diesel)per liter/19km R1500
Printing	Documents, letters etc	R1000
Material and supplies	Office supplies, stationary, poster, folders ect	R250
Equipment	Laptop	Personal laptop
Other expenses	Unexpected expenses	R250

Total		**R 3000**

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APPENDIX B: DATA COLLECTION SHEET

SURVIVAL RATE OF VERY LOW BIRTH WEIGHT BABIES BORN AT CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL: RETROSPECTIVE STUDY

MATERNAL VARIABLES AND NEONATAL VARIABLES

1 JANUARY 2020 – 31 DECEMBER 2020

PATIENT DETAILS	
STUDY IDENTIFCATION NR	
SEX	MALE ☐ FEMALE ☐
BIRTH WEIGHT	_____ GRAMS

MATERNAL INFORMATION	
MATERNAL AGE	
GRAVIDA	
PARITY	
BOOKED	YES ☐ NO ☐ UNKNOWN ☐
HIV STATUS	POSITIVE ☐ NEGATIVE ☐ UNKNOWN ☐
ANTENATAL STEROIDS ANTENATALL	YES ☐ NO ☐ UNKNOWN ☐
MgSO4 ANTENATALLY	YES ☐ NO ☐
ANY UNDERLYING MATERNAL ILNESSES PRESENT	PREGNANCY INDUCED HYPERTENSION ☐ DIABETES MELLITUS ☐ INFECTION ☐
MODE OF DELIVERY	C/S ☐ NVD ☐

NEONATAL INFORMATION BIRTH HISTORY

GESTATIONAL AGE AT BIRTH		
PLACE OF BIRTH	INBORN ☐	OUTBORN ☐
RESUSCITATION REQUIRED AT BIRTH	YES ☐	NO ☐
APGARS AT 5 MINUTES	≤ 7 AT 5 MINUTES ☐	> 7 AT 5 MINUTES ☐
ADMISSION INFORMATION		
ADMISSION TEMPERATURE	≤ 36.5 ◦C ☐	> 36.5◦ C ☐
ADMISSION HGT		
CLINICAL INFORMATION		
RESPIRATORY DISTRESS SYNDROME	YES ☐	NO ☐
RECEIVED SURFACTANT	YES ☐	NO ☐
INTERVENTION REQUIRED DURING HOSPITAL STAY	NPO2 ☐ HFNO2 ☐ NCPAP ☐ MCV ☐	
IVH	YES ☐	NO ☐
PDA	YES ☐	NO ☐
PRESENCE OF NNS	YES ☐ IF YES: EARLY ONSET NNS ☐ LATE ONSET NNS ☐	NO ☐
REQUIRED NICU ADMISSION	YES ☐	NO ☐
LENGTH OF STAY		
OUTCOME		
OUTCOME	DISCHARGE ☐ DEMISED ☐	
IF DEMISED: CAUSE OF DEATH		

APPENDIX C: ETHICS APPROVAL CERTIFICATE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R49 Dr CM Roman

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M221147

NAME: (Principal Investigator)	Dr CM Roman
DEPARTMENT:	School of Clinical Medicine Department of Paediatrics and Child Health Medical School University
PROJECT TITLE:	*Survival rate of very low birth weight babies born at Chris Hani Baragwanath Academic Hospital: retrospective study*
DATE CONSIDERED:	2022/11/25
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Dr FL Nakwa
APPROVED BY:	Professor P Ruff, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2023/08/21 **EXPIRY DATE:** 2028/08/20

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

×

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **November** and therefore reports and re-certification will be due in the month of **November** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator Date 21/08/2023

✓

APPENDIX D: APPROVAL FROM NATIONAL HEALTH LABORATORY SERVICES (AARMS)

Academic Affairs and Research
1 Modderfontein Road, Sandringham, 2031 Tel: +27 (0)11 555 0367/0406
Email: babatyi.kgokong@nhls.ac.za
academic.research@nhls.ac.za
Web: www.nhls.ac.z
a

10 August 2023

Applicant: Chrisenda Roman
Institution: University of the Witwatersrand **E-mail Address:**
chrisenda.roman@gmail.com **Cell:** 083 442 4340

Project Title: Survival of very low birth weight babies born at Chris Hani Baragwanath Academic Hospital:

Retrospective study

Reference Number: PR2345774 **Research**

Application Type(s):

1. Request for Data

RE: APPROVAL LETTER: REQUEST TO ACCESS NHLS RESOURCES FOR RESEARCH PURPOSES

This letter serves to advise that the application requesting permission to conduct the above-mentioned research using the listed NHLS resources has been reviewed and **"Approved"**. Please note that the approval is granted on the condition that you comply with the NHLS Research Material and Data Access Policy and requirements stated below.

1. All material and data requested shall be used as per the research protocol submitted to the NHLS and as approved by the relevant Health Research Ethics Committee (HREC) in South Africa.
2. Access to the NHLS material and/or data shall be limited to the minimum required for successful completion of the approved study and shall be made available ***without patient names and other patient identifiers (including, but not limited to, national identity numbers, hospital/clinic file numbers, addresses and telephone numbers)***.
3. Confidentiality shall be maintained at the participant and institutional level and there shall be no disclosure of personal information or confidential information.
4. Data and/or material shall not be shared with other parties unless approved by the NHLS

Dr Babatyi Malkgokong
National Manager: Academic Affairs and Research

APPENDIX E: DECLARATION ON PLAGIARISM

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I **Chrisenda Melony Roman** (Student number **2563937**) am a student registered for the degree of

Masters of Medicine in Paediatric and Child Health in the academic year 2025.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
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