SEVERE MATERNAL OUTCOMES OF CAESAREAN DELIVERY IN SOUTH AFRICA: A SCOPING REVIEW

CHINELO OBIAGELI EZENWAMMA

4002782

A mini-thesis submitted in partial fulfilment of the requirements for the Degree of Master of Public Health in the School of Public Health,

University of the Western Cape

Supervisor: Dr Anam Nyembezi

Co-Supervisor: Dr Kristian Leisegang

November, 2022

DECLARATION

Hereby I, Chinelo Obiageli Ezenwamma, declare that *Severe Maternal Outcomes of Caesarean Delivery in South Africa: A Scoping Review* is my own work and that all sources have been accurately reported and acknowledged, and that this document has not previously in its entirety or in part been submitted at any university in order to obtain an academic qualification.

Full names: Chinelo Obiageli Ezenwamma

Signature: 

Date: November 2022

ACKNOWLEGEMENTS

Firstly, I would like to appreciate my husband for his overwhelming support, patience and understanding, and my family and friends for their words of advice and encouragement on the days it got tough.

I am thankful to my daughters, Zinachino and Olanna, for being patient with me throughout this period while I had to struggle with balancing motherhood, my studies and a plethora of other things that I felt needed my attention.

My sincere gratitude goes to my supervisors, Dr Anam Nyembezi and Dr Kristian Leisegang. Thank you for your time, your guidance and your suggestions without which I would not have completed this work at the time that I did. Thank you for your tolerance on the weekends I intruded with emails and drafts that needed your review, for feedback on short notice, and for the impromptu meetings. Your contributions have been invaluable and deeply appreciated.

To the administrative staff, Ms Corinne Carolissen and Ms Janine Kader, thank you for all the support and assistance.

Anyone I failed to mention that contributed in one way or another to the completion of this work, I thank you.

Finally, I would like to appreciate myself a little for never giving up despite the challenges I encountered during the period of this study and ultimately, I appreciate God for making everything possible in the first place.

DEDICATION

I dedicate this work to every mother in the past, present and future, we are a blessing.

KEYWORDS

Caesarean delivery

Severe maternal outcome

Maternal mortality

Maternal morbidity

Vaginal delivery

Haemorrhage

Infection

South Africa

ABSTRACT

Background:

Caesarean delivery is a surgical intervention carried out in order to save the life of a pregnant woman and her child, however, this has led to its indiscriminate usage over the decades, with rates as high as 73.6% in the South African private sector. A concerning issue is the increasing evidence that caesarean delivery at a certain threshold does not yield any maternal or fetal benefits, but rather, is associated with severe maternal morbidity and mortality, especially when performed without medical necessity. This creates a challenge for meeting the sustainable development goal 3.1 that focuses on reducing global maternal mortality. Achieving a maximum beneficial rate for caesarean delivery in South Africa requires a deep understanding of the possible outcomes associated with it. Therefore, this scoping review systematically maps out evidence on the effects of caesarean delivery on maternal morbidity and mortality in South Africa in women with term pregnancy.

Methodology:

This study is a scoping review of existing literature on maternal morbidity and mortality that are related to caesarean delivery in South Africa. Arksey and O'Malley's 5-step methodological framework, along with the checklist by the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR), guided this study. A systematic search of SCOPUS, MEDLINE, PUBMED, and CINAHL was conducted between July and September 2022. Eligible study designs included observational studies and experimental studies printed in the English language from 2000 until present. The primary outcomes of interest were maternal mortality and severe maternal morbidity that occurred after caesarean delivery. Relevant studies were screened by the author and verified independently by two supervisors based on the eligibility criteria. Data was extracted into a charting table and a narrative synthesis approach was used to describe findings.

Results:

The severe maternal outcomes found after caesarean delivery in this study include haemorrhage at 6.6%, 1.8% and 0.6%; wound infection at 7.7%, 2.8%, 3.9%, and 5.2%; sepsis at 15.2%; fever at 4.7% and 15.4%; and thromboembolic event at 0.6%. In two studies, 2.6% and 4.7% of the women were admitted to intensive care unit after caesarean delivery. Blood transfusion was required by 3.8%, 11.3%, and 9.3% women in three studies. Laparotomy was performed

at a rate of 1.3% and hysterectomy was 1.2% and 1.3% in two studies. The women in this study were younger aged and mostly nulliparous. Maternal mortality was found at a rate of 2.6% in women that had caesarean delivery at the second stage of labour.

Conclusion:

Varying rates of severe maternal morbidity and maternal mortality were found in women that had caesarean delivery in South Africa. It is recommended that caesarean delivery be avoided when not medically necessary.

DEFINITION OF TERMS

First stage of Labour Caesarean Delivery: the first stage of labour in a pregnant woman refers to the period from the onset of regular painful contractions associated with descent of the presenting part and progressive dilatation of the cervix until the cervix is fully dilated ("Management of the second stage of labor", 2012). Caesarean delivery performed at any point in this stage is known as first stage (of labour) caesarean delivery.

Haemorrhage: Haemorrhage is commonly defined as abnormal intra- or post-operation bleeding (1000 ml or more) or any bleeding with hypotension or blood transfusion (Villar et al., 2007; Fawcus & Moodley, 2013; Maswime & Buchmann, 2017a).

Hysterectomy: Hysterectomy is the surgical removal of the uterus following infection or haemorrhage (WHO, 2011).

Laparotomy: Laparotomy is a surgical procedure that involves an incision through the abdominal wall to gain access into the abdominal cavity other than caesarean delivery (Witteveen et al., 2018).

Maternal mortality: maternal mortality is defined as death from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and anatomic site of the pregnancy (WHO, 2011).

Second stage of Labour Caesarean Delivery: the second stage of labour is the time from full dilatation of the cervix up to the birth of the singleton baby or the last baby in a multiple pregnancy ("Management of the second stage of labor", 2012). When caesarean delivery is performed during this stage, it is called second stage (of labour) caesarean delivery.

Sepsis: WHO defined puerperal sepsis as an infection of the genital tract occurring at any time from the time of onset of rupture of membranes or labour and the 42nd day after deliver, in which fever and one or more of the following are present: pelvic pain, abnormal vaginal discharge, abnormal smell/foul odour of discharge and delay in the rate of reduction of the size of the uterus. Alternately, the International Classification of Diseases (ICD-10) defined puerperal sepsis as a rise in body temperature above 38.08C (100.48F) for over 24 hours or is frequent during the period from the end of the first to the end of the 10th day after childbirth or abortion (Maharaj, 2007; van Dillen et al., 2010).

Thromboembolic event: A thromboembolic event (TE), also known as a venous thromboembolism (VTE), is defined as deep vein thrombosis (DVT), pulmonary embolism (PE) or both (Beckman et al., 2010), and occurs when a blood clot (thrombus) formed in the veins breaks loose and gets transported by the blood stream to another blood vessel (embolus) where it obstructs the flow of blood (Centers for Disease Control and Prevention (CDC), n.d.).

Vaginal Delivery: Vaginal delivery is the natural birth of offspring in mammals or babies in humans, through the vagina or "birth canal" (Omona, 2021).

Wound infection: Wound infection is commonly referred to as surgical site infection (SSI) and is defined by the CDC as an infection occurring within 30 days from the operative procedure in the part of the body where the surgery took place (Horan et al., 1992 as cited in (Zuarez-Easton et al., 2017).

TABLE OF CONTENTS

List of Tables

List of figures

LIST OF ACRONYMS

Acronym	Meaning
BDACS	Bleeding During and After Caesarean Section
BT	Blood Transfusion
CD	Caesarean Delivery
CDC	Centers for Disease Control and Prevention
DVT	Deep Vein Thrombosis
Lap	Laparotomy
LMIC	Low- and Middle-Income Country
Haem	Haemorrhage
HIC	High Income Country
Hyst	Hysterectomy
ICD	International Classification of Diseases
ICU	Intensive Care Unit
IQR	Interquartile Range
MDG	Millennium Development Goals
Mort	Mortality
NDoH	National Department of Health
NP	Not Provided
PE	Pulmonary Embolism
PICO	Population, Intervention, Comparison and Outcomes
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta Analyses extension

PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews
PPH	Postpartum Haemorrhage
SD	Standard Deviation
SDG	Sustainable Development Goals
SMO	Severe Maternal Outcome
SSI	Surgical Site Infection
TE	Thromboembolic Event
VBAC	Vaginal Birth After Caesarean delivery
VD	Vaginal Delivery
VTE	Venous Thromboembolism
WI	Wound Infection
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION

1.1. Background

Optimum maternal and child health during pregnancy and childbirth is a major focus in public health, hence, the need to perform Caesarean Delivery (CD) when there is any threat to the safety of labour and delivery. A CD is a surgical procedure that involves an incision on the abdomen of a pregnant woman in order to deliver her unborn foetus (Robertson & White, 2021). CD can effectively prevent maternal and neonatal morbidity and mortality when performed for medical reasons (WHO, 2015). However, the growing rate of CD has been a cause for concern in the global healthcare community, giving rise to debates about its appropriateness, safety and the ideal rate for CD both globally and locally (Betran et al., 2016).

Over the past 3 decades, the global frequency of CD has had a prolific increase. A study by Betran et al. (2021) revealed that the worldwide rate of CD increased from 7% in 1990 and presently accounts for 21% (1 in 5) of all childbirths throughout the world. This number is estimated to increase to one-third (29%) by 2030. There is inequity in the rate of CD across different countries, with rates as high as 58% in high-income countries (HICs) and 1% in developing countries (Betran et al., 2021), which reflects overuse on one hand and inadequate access on the other.

In South Africa, the rate of CD in the public sector increased from 15.1% in 2006 to 27.4% in 2017 (National Department of Health (NDoH), 2017 as cited in Solanki et al., 2020). In contrast, the rate of CD was 73.6% in the private sector in 2015 (Solanki et al., 2020), which is one of the highest rates around the world. Govender et al. (2019) and Govuzela (2020) propounded that this high rate is possibly driven by indiscriminate use without medical indication and the perceived convenience, painlessness and harmlessness by both pregnant women and physicians. Other determinants that have been associated with the increasing rise in CD rate include older maternal age, higher socioeconomic status and a higher level of education (Gebremedhin, 2014; Sun et al., 2020)

On the contrary, there is no proven advantage associated with a high rate of CD during the different stages of pregnancy and labour; rather, there is evidence that beyond a certain threshold, CD is associated with short and long-term health complications for both mother and baby even in future deliveries (WHO, 2018). Additionally, there are substantial healthcare costs associated with high rates of CD, which can be a burden for countries with weak and overloaded health systems (Byamugisha & Adroma, 2020; WHO, 2018).

The maternal outcomes related to CD vary depending on whether it was planned or urgent or at what stage of labour it was initiated. The most common severe maternal outcomes (SMOs) associated with CD include maternal mortality, haemorrhage, infection, injury to pelvic organs and thromboembolic disorders (Becher et al., 2013; Ekanga et al., 2019; Kongwattanakul et al., 2020; Mascarello et al., 2017b). In addition to the above, the WHO (2021) added complications such as slower recovery times after childbirth, delays in establishing breastfeeding and skin-to-skin contact, and increased likelihood of complications in future pregnancies. A systematic review on the maternal and foetal outcome of CD in Africa found that women are 50 times more likely to die following CD than in HICs (Bishop et al., 2019). In South Africa, a survey of maternal deaths from 2008 to 2010 revealed CD as the most common cause of death by obstetric haemorrhage, additionally, the saving mother's 2005 to 2007 report showed a 2.5 risk of dying from CD than vaginal delivery (NDoH, 2013). Many interventions and policies have been employed to reduce the rate of CD and its most common complications in South Africa (NDoH, 2016); these however did not stabilise the increasing rate of CD in the country. The Sustainable Development Goal (SDG)'s target 3.1 aims to reduce the global maternal mortality rate to less than 70 per 1000 live births by 2030, with no country exceeding 140. South Africa is far from achieving this goal. To work towards the SDG for maternal mortality rate in Africa, more robust data that describe the association between maternal obstetric interventions and the resulting maternal outcomes are needed. It is, therefore, necessary to look at studies from different regions and settings in South Africa to understand the overall nature of the negative outcomes of CD.

1.2. Problem Statement

South Africa is a middle-income country with CD rate higher than some high-income countries (Solanki et al., 2020). Associated with this growing frequency of CD are potential consequences to maternal and foetal health along with heavy health expenditure on families and the national health system. CD in South Africa have been linked with increased maternal morbidity and mortality (Pattison, 2012 as cited in Gebhardt et al., 2015; Heitkamp et al., 2020), making this an important public health issue. Although there have been studies conducted on the outcome of CD in South Africa, the impact of CD on SMOs has not been systematically synthesised. Therefore, a scoping review of relevant literature on the issue is required. The identification and exploration of these studies will contribute to the nature and range of existing literature on the evidence on SMOs occurring after CD in South Africa. It will additionally identify gaps in literature on the topic.

1.3. Significance of the Study

The plethora of potential consequences of CD can result in healthcare practitioners having incongruous information about its risks and benefits. Achieving a maximum beneficial threshold of CD along with meeting the SDG target 3.1 in South Africa requires a deep understanding of the risks and possible outcomes of CD. Therefore, a literature review on the SMOs associated with CD in South Africa is critical as a precondition for developing strategies to reduce its increasing frequency and potentially harmful consequences on maternal health outcomes. This study can equally serve to inform policy makers on the appropriateness of performing a systematic review on the topic. Additionally, this study will improve the knowledge of healthcare workers on the risks of CD, which is essential when informing pregnant women on the possible risks and benefits associated with CD for considerations on the mode of delivery that will lead to the best health outcome. It will also add to the literature for future research on CD in South Africa.

1.4. Research Question

What is the effect of Caesarean Delivery on maternal morbidity and mortality in pregnant women with > 36 weeks gestation?

1.5. Research Aim

The aim of this scoping review was to systematically map out evidence on the effects of Caesarean Delivery on maternal morbidity and mortality in pregnant women with gestation > 36 weeks in South Africa.

1.6. Research Objectives

1) To identify relevant studies on severe maternal outcomes associated with Caesarean Delivery in South Africa using pre-determined keyword searches in literature databases: SCOPUS, PUBMED, MEDLINE and CINAHL
2) To examine the identified literature for CD and the associated severe maternal outcomes in South Africa
3) To collate, summarize and discuss the outcomes of the included studies
4) To make recommendations for future research on CD and its outcomes in South Africa

CHAPTER 2: LITERATURE REVIEW

2.1. History of Caesarean Delivery

CS is one of the oldest operations in the history of medicine as tales of birthing infants through an opening in the mother's abdomen have been recorded in many cultures since ancient times (Sewell, 1993; Van Dongen, 2009). In spite of this, the exact account of its origin is shrouded in obscurity. Even the origin of the term "caesarean" remains debatable. While it is commonly believed that it was derived from the surgical birth of Julius Caesar, this is however unlikely since CS at the time is presumed to have a maternal mortality rate of 100% and Julius Caesar's mother was known to have lived long after his birth (Sewell, 1993).

Prior to the nineteenth century, CS was commonly performed on a dead or dying woman in a bid to save the child or in some religions and cases where both are dead, to bury them separately (Sewell, 1993; Todman, 2007). It was never intended for the purpose of saving the mother's life and it was not until 1581, after the work of Francis Rousset that CS allegedly began to be performed on a living woman in order to save her life and the baby's life (Low, 2009; Van Dongen, 2009).

In South Africa, the first ever and first successful CS was performed on the 25th of July 1826 by a female army surgeon disguised as a man, Dr James Barry (also Margaret Ann Bulkley) in Cape Town (Van Dongen, 2009). In recent times, CS is a vital obstetric procedure that significantly improves maternal and fetal outcome during labour and delivery. Innovations in the medical field and improvements in patient management has led to soaring rates of CS widely because of reduced complications. However, this does not erase the fact that maternal mortality and morbidity is higher when compared with vaginal delivery (Van Dongen, 2009).

2.2. Rate of Caesarean Delivery

In 1985, given the uncurbed rise in the rate of CD, the WHO made the follwoing recommendation with the available evidence at the time: *"there is no justification for any region to have a rate higher than 10 to 15%"* (WHO, 1985 p.437). However, three decades later, they restated that all efforts should focus on providing CD to every woman in need instead of striving to meet a specific target (Betran et al., 2016). Simultaneously, CD rates have soared more than ever (Betrán et al., 2007; Boerma et al., 2018).

At a global level, CD rate increased from 6.7% in 1990 to 19.1% in 2014 (Betrán et al., 2016). Currently, it accounts for 21.1% of all deliveries (Betran et al., 2021). The author projected that the global CD rate would reach 28.5% by 2030 if the current pace of increase remains unmitigated. Dominican Republic (58.1%), Brazil (55.7%), Cyprus (55.3%), Egypt (51.8%) and Turkey (50.8%) have the highest rates in the world (Betran et al., 2021). The same article also found that Chad (1.4%), Niger (1.4%), Ethiopia (1.9%), Madagascar (2%) and Cameroon (2.4%) have the lowest rates in Africa and in the world. This significant disparity pinpoints the inequity of CD between countries and is indicative of inadequate access in low- and middle-income countries. The same trend can equally be found within countries where CD rate is particularly high in private facilities and among women of high socioeconomic class (Boerma et al., 2018).

CD rates in the South African private sector is one of the highest in the world, almost three times (61%) more when compared with that of the public sector (NDoH et al., 2019). The overall national CD rate was 26.2% and 24% in district hospitals (Massyn et al., 2016), this 2222was from 18% in 1998, indicating a 50% increase within an 18-year period (NDoH et al., 2019). Solanki et al. (2019), in his study on CD rate in the private sector, found an even higher rate of 73.6%. He proposed that the major driving factor is elective CD by maternal choice without medical indication.

2.3. Severe Maternal Outcomes and Caesarean Delivery

According to the WHO, severe maternal outcome (SMO) is defined as a maternal near-miss case and maternal mortality (WHO, 2011). WHO further described maternal near-miss as having survived a life-threatening condition due to pregnancy. Studies have positively correlated CD with SMOs (Bishop et al., 2019; Jamshed et al., 2022; Souza et al., 2010). However, due to variations in definitions of outcomes used in the studies, arriving at a definite conclusion has proved challenging. The most common SMOs associated with CD are maternal mortality (Bishop et al., 2019; Souza et al., 2010) and haemorrhage (Bishop et al., 2019; Gupta & Saini, 2018). Other SMOs that have been identified with CD include infection, uterine rupture, anaesthetic complications, venous thromboembolism, hysterectomy, blood transfusion and ICU admission (Bishop et al., 2019; Gupta & Saini, 2018; Jamshed et al., 2022; Souza et al., 2010).

2.4. Maternal Mortality and Caesarean Delivery

WHO defined maternal mortality as death from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and anatomic site of the pregnancy (WHO, 2011). Studies assessing the relationship between national rates of CD and maternal mortality ratio have found that maternal mortality ratio decreases with an increasing rate of CD (Geleto et al., 2020; Molina et al., 2015; Uzuncakmak & Ozcam, 2016). Contrary to this, studies assessing the outcome for different modes of delivery in both high-income and low- and middle-income countries have been consistent in associating a higher rate of maternal mortality with CD. In a population-based case control study in Brazil, the risk of postpartum maternal mortality was almost three times higher with CD than vaginal delivery (VD). The deaths were mainly from postpartum haemorrhage (PPH) and complications of anaesthesia (Esteves-Pereira et al., 2016). In another population-based case control study in France, the risk of postpartum death was 3.6 times higher after CD than after VD (Deneux-Tharaux et al., 2006). In India, a hospital-based cohort study revealed that CD was associated with a 3-fold increase in the risk of maternal mortality when compared with VD and maternal death occurred mainly from complications of anaesthesia, puerperal infection and venous thromboembolism (VTE). Another study in Ethiopia found maternal mortality to be higher in CD when compared with VD (Eyowas et al., 2016). In South Africa, only a few studies have been conducted on maternal mortality in relation to CD, and although the findings are in line with global results which show an inverse relationship between the rate of CD and maternal mortality rate (Gebhardt et al., 2015), the data was from a single triennial review conducted from 2011 to 2013.

2.5. Haemorrhage and Caesarean Delivery

The commonly used definition for haemorrhage in CD is intra- or post-operative bleeding, with at least one of the following: perceived abnormal bleeding (1000 ml or more) or any bleeding with hypotension or blood transfusion (Maswime & Buchmann, 2017; Villar et al., 2007). In the African surgical, maternal and neonatal outcomes study in patients having caesarean delivery in 183 hospitals across 22 countries, the most common severe maternal complications were intraoperative and postoperative bleeding (Bishop et al., 2019). Another study in Nigeria assessing the outcome of caesarean section demonstrated that haemorrhage at a rate of 59.7% is the major maternal complication (Daniel & Singh, 2016). When compared with other modes

of delivery, the risk of haemorrhage is found to be higher in VD than CD (Holm et al., 2012). A study in Iran on the maternal outcomes of vaginal versus caesarean delivery demonstrated that PPH was higher in VD than in CD (Zandvakili et al., 2017). However, in Thailand, severe PPH was higher in primary and repeat CDs than in VD (Kongwattanakul et al., 2020)

South African studies report that majority of the women who undergo CD in South Africa have risk factors for bleeding during and after CD (Maswime & Buchmann, 2017). A population-based cohort study in Cape Town additionally revealed that complications of CD were a major cause of obstetric haemorrhage (Heitkamp et al., 2020).

2.6. Other Maternal Outcomes Associated with Caesarean Delivery

There are variations in the prevalence and type of outcomes reported in the available literature; this can be attributed to the differences in study design and the definitions of variables being measured. In Denmark, a population-based cohort study revealed no significant difference in SMOs between planned CD and planned VD (Otkjær et al., 2019). Contrary to this, a systematic review on maternal complications and CD without indication found that postpartum infection and ICU hospitalisation were higher in CD than in VD (Mascarello et al., 2017). A case-control study in Thailand revealed that postpartum infection was more in VD, but the odds of SMOs were significantly higher in CDs (Kongwattanakul et al., 2020). Thromboembolic events are known major complications of CD, and the risk of VTE has been shown to occur at higher rates following CD than following VD (Blondon et al., 2016; Schimidt Evangelista et al., 2018). Hysterectomy and laparotomy have also been associated with CD. A population-based retrospective study in Italy found that women undergoing primary CD were more likely to have a peripartum hysterectomy than women having a VD without prior CD (Stivanello et al., 2010). Another study comparing the incidence of emergency peripartum hysterectomy found a greater than ten-fold increase in women that had CD than in those that had VD (Forna, Miles & Jamieson, 2004). The authors concluded that CD and previous CD are known risk factors for peripartum hysterectomy. In Netherlands, the risk of postpartum laparotomy was more than sixteen-fold higher in women who had CD versus those who gave birth vaginally. Even though laparotomy was lower with planned CD, the authors noted a significantly higher rate when it was compared with VD (Witteveen et al., 2018).

The lack of randomised controlled trials on CD and maternal outcome implies an inadequacy in the strength of evidence available to establish a meaningful association between CD and

SMOs. The majority of studies are retrospective observational studies, and a good number of them did not consider SMOs that could arise as a result of the medical reason for conducting the CD in the first place; in other words, they did not account for "indication bias". South African studies have investigated the evidence on the SMO associated with CD. Most of the studies are observational studies that compared the outcome of CD with VD and have degrees of variation in their findings. One study in a tertiary hospital found PPH to be significantly higher in CD than in VD. They added that women who had CDs were more likely to have a hysterectomy and relook laparotomy (Guidozzi et al., 2018). A different study by Rubgega et al. (2021) found no significant difference in PPH between CD and VD. Notwithstanding, Konrad-Asghar et al. (2022), in their study, demonstrated that CD is associated with an increased likelihood of PPH and infection. The major limitation of these studies is that the results are dependent on the setting, hence strictly limited to the institutions they were conducted in and therefore cannot be generalised to other settings in the country.

Although previous studies showed varied findings in the outcomes found after CD, one common theme from the studies is that the implementation of CD should be approached with caution due to associated risks or should be totally avoided where possible. However, none of the studies synthesized the outcomes of caesarean mode of delivery in different regions in South Africa to elicit a general knowledge of the maternal effects of CD across the country. Hence, this review aims to systematically assess and identify the SMOs that occur as a result of CD in South Africa.

CHAPTER 3: METHODOLOGY

3.1.Study Design

A scoping review seeks to provide in-depth coverage of available literature by following a systematic protocol laid out prior to the review, it is conducted for the purpose of examining the nature and range of existing literature on a particular subject, and it can equally aid in the identification of gaps in evidence (Arksey & O'Malley, 2007).

This scoping review was conducted based on the Arksey and O'Malley (2007) 5-step methodological framework for conducting scoping reviews thus: 1) Identifying the research question 2) Identifying relevant studies 3) Study screening and selection 4) Charting the data 5) Collating, summarising and reporting the results. Additionally, the checklist provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018) was used in this review.

3.2. Ethics Statement

The study proposal was approved by the University of the Western Cape Biomedical Research Ethics Committee with reference number BM22/6/24.

3.3. Methodological Framework

3.3.1. Identification of Relevant Studies

For guidance of search strategy and to ensure a broad coverage of literature, the research question was formulated using the Population, Intervention, Comparison and Outcomes (PICO) framework as illustrated in Table 3.1 below.

Table 3.1: PICO Framework for the Scoping Review

Population	Human females with pregnancies greater than 36 weeks
Intervention	Caesarean delivery
Control/Comparison	Any; none
Outcomes	Primary outcomes: haemorrhage, fever, sepsis, wound infection, thromboembolic events and maternal mortality that occurred due to CD. Secondary outcomes: Critical interventions that are required in the management of CD complications thus: blood transfusion, admission to ICU, hysterectomy, laparotomy.

The primary investigator (C.E) searched SCOPUS starting from the 7th of July, 2022. Pubmed and CINAHL were searched on the 8th and 10th of July respectively. Medline was searched on the 5th of August. The search results were exported into an excel sheet on the 18th of July, 22nd of July, 8th of August and the 18th of August for Pubmed, CINAHL, Medline and SCOPUS, respectively.

The search terms used were ("maternal" OR "birth" OR "obstetric" OR "delivery") AND ("outcome" OR "risks" OR "morbidity" OR "near-miss" OR "nearmiss" OR "near miss" OR "complications" OR "effects" OR "haemorrhage" OR "hemorrhage" OR "bleeding" OR "sepsis" OR "infection" OR "uterine rupture" OR "laceration" OR "ICU" OR "intensive care unit" OR "transfusion" OR "laparotomy" OR "hysterectomy" OR "mortality" OR "death") AND ("caesarean section" OR "cesarean operation" OR "operative delivery") AND ("South Africa").

3.3.2. Study Screening and Selection (Eligibility)

Screening of eligible studies was done in two stages by the primary investigator (C.E). Firstly, titles and abstracts of selected studies was screened using the inclusion criteria as enumerated in the eligibility criteria (Table 3.2). This was followed by a full-text eligibility determination by applying the inclusion and exclusion criteria (Table 3.2). Inclusion criteria were observational or experimental studies in South Africa reporting the maternal outcomes or complications of caesarean mode of delivery with or without the outcome of other modes of delivery. Published and grey literature printed in English language only were eligible due to the lack of resources required for translation of other languages. Eligible studies were published from 2000 until the present because this period marks the establishment of the millennium development goals (MDGs), which underpinned the reduction of maternal mortality in South Africa. Studies were excluded if pregnancy was less than 36 weeks. Verification of included studies and resolving any conflicts of studies for inclusion or exclusion was done independently by two supervisors (A.N. & K.L). Additionally, the references of the selected articles were searched for studies that might have been missed.

Table 3.2: Eligibility criteria

Inclusion	Exclusion
Observational or experimental studies in South Africa, including published and grey literature	Studies on pregnancies that are not up to term (less than 36 weeks)
Studies reporting the maternal outcomes or complications of caesarean mode of delivery with or without the outcome of other modes of delivery	
Studies printed only in the English from January 1, 2000 until August 5, 2022	

3.3.3. Data Charting

Data was abstracted from the selected studies into a table format. The primary investigator (C.E.) extracted the following information from the articles: author, year of publication, study design, study setting, comparator (if any), mean age of participants, number of participants, gestational age, parity, number of previous CD, maternal mortality, maternal outcomes (haemorrhage, sepsis, thromboembolic events, wound infection, fever, admission to ICU, laparotomy, hysterectomy, blood transfusion). The extraction was verified by the supervisors (A.N & K.L).

CHAPTER 4: RESULTS

4.1. Database Search Results

The initial search yielded 3109 publications in total: 2707 from SCOPUS, 165 from PUBMED, 210 from MEDLINE and 27 from CINAHL. From this, 278 duplicates were excluded. Subsequently, 2831 publications were screened by title and abstract by the investigator where 2758 non-relevant articles were removed. The remaining 73 articles were included for full text eligibility based on the inclusion and exclusion criteria (Table 3.2), where 69 articles were excluded. Therefore, a total of 4 articles met the eligibility criteria for the scoping review. The flowchart for the selection of articles is shown in Figure 4.1.

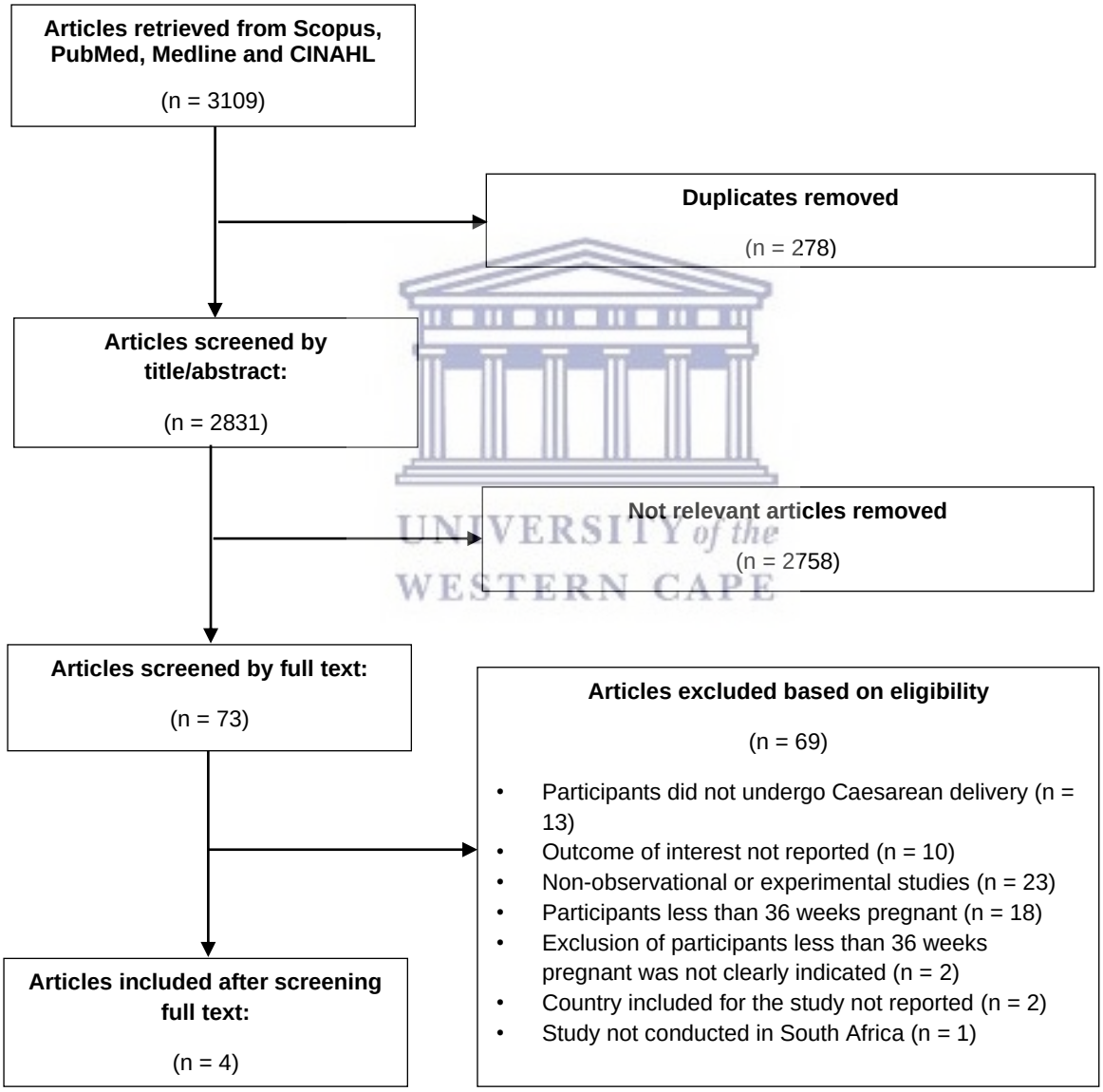

Figure 4.1. PRISMA flow diagram for study identification and selection adapted from Moher et al. (2009)

4.2. Included Studies Descriptive Data

4.2.1. Description of Studies

The description of the studies and the study cohorts is summarized in Table 4.1. The four studies included in the review are all observational studies: specifically, two retrospective chart reviews (Moodley et al., 2009; Moodley, Khedun & Devjee, 2010) and two case-control cross-sectional studies (Diarra & Theron, 2011; Cebekulu & Buchmann, 2006). Two of the studies were conducted in an undisclosed district hospital in Durban (Moodley et al., 2009; Moodley, Khedun & Devjee, 2010), one study was in a provincial hospital in an urban area in Johannesburg (Cebekulu & Buchmann, 2006), and another study was conducted in a tertiary hospital in an urban region in Cape Town (Diarra & Theron, 2011). None of the studies included in the review was conducted in a private hospital.

Three studies compared CD performed in the first stage of labour with CD performed in the second stage of labour (Cebekulu & Buchmann, 2006; Moodley et al., 2009; Diarra & Theron, 2011). One study assessed women with breech presentation in pregnancy that booked for antenatal care compared to those that did not book for antenatal care (Moodley, Khedun & Devjee, 2010). In this study, only data from patients with CD was extracted, and not data from patients with other modes of delivery.

4.2.2. Age of Participants

Age of the participants was not reported in one study (Diarra & Theron, 2011), another study reporting age did not specify the age for participants that gave birth solely by CD (Moodley, Khedun & Devjee, 2010). The remaining two studies reported the age of the women separately for the different cohorts only. In Cebekulu & Buchmann (2006), the participants that had CD in the first stage of labour had a mean ± SD age of 22.6 ± 4.7 years, and those that had CD in the second stage of labour were a mean ± SD age of 23.7 ± 6.3 years. Moodley et al. (2009) reported a mean ± SD age of 23.8 ± 5.7 years for participants that performed CD in the first stage of labour, and a mean ± SD age of 20.2 ± 4.2 years for participants that performed CD in the second stage of labour.

Table 4.1: Study and Cohort Description

Reference	Design	Setting	Cohort	n	Age (Years)	Gestational Age	Parity
Cebekulu et al. (2006)	Cross-sectional case-control study	Provincial hospital in Johannesburg (Chris Hani Baragwanath Hospital)	CD in 1st stage of labour	39	Mean ± SD: 22.6 ± 4.7	Mean ± SD: 39.3 ± 1.7	Median (Range): 0 (0 – 2)
			CD in 2nd stage of labour	39	Mean ± SD: 23.7 ± 6.3	Mean ± SD: 39.3 ± 1.5	Median (Range): 0 (0 – 5)
Moodley et al. (2009)	Retrospective chart review	Undisclosed district hospital in Durban	CD in 1st stage of labour	53	Mean ± SD: 23.8 ± 5.7	Median (IQR): 39 (38-40)	Median (IQR): 0 (0 -1)
			CD in 2nd stage of labour	53	Mean ± SD: 20.2 ± 4.2	Median (IQR): 39 (38-40)	Median (IQR): 0 (0 -1)
Moodley et al. (2010)	Retrospective chart review	Undisclosed district hospital in Durban	Breech presentation booked for antenatal care	303	NP	NP	NP
			Breech presentation unbooked for antenatal care	79	NP	NP	NP
Diarra & Theron (2011)	Cross-sectional case-control study	Tertiary hospital in Cape Town (Tygerberg Academic Hospital)	CD in 1st stage of labour	86	NP	Mean: 39.9	NP
			CD in 2nd stage of labour	85	NP	Mean: 39.6	NP

CD = Caesarean Delivery; NP = Not Provided

4.2.3. Parity of the Participants

The four studies included only women with term pregnancy. The mean gestational age for the study by Diarra & Theron (2011) was 39.6 weeks for the study group and 39.9 weeks for the control group, but variation of this mean was not reported. In Cebekulu & Buchmann (2006), the gestational age was reported as a mean ± SD of 39.3 ± 1.7 weeks for participants with CD in the first stage of labour, and 39.3 ± 1.5 weeks for participants with CD in the second stage of labour. Moodley et al. (2009) reported a median (IQR) of 39 (38 – 40) weeks in both groups. Moodley, Khedun & Devjee (2010) did not specify gestational age for CD participants.

Parity was unreported in one study (Diarra & Theron, 2011) and unspecified for the CD subgroup participants in the study by Moodley, Khedun & Devjee (2010). In the remaining two studies, the median parity was reported as zero in all categories of the CD participants, with an IQR of 0 - 1 (Moodley et al., 2009) and 0 - 2 (Cebekulu & Buchmann, 2006) for participants who had CD in the first stage of labour, and 0 - 1 (Moodley et al., 2009) and 0 - 5 (Cebekulu & Buchmann, 2006) for participants who had CD in the second stage of labour. None of the studies made any report on the status of previous caesarean delivery of the participants.

4.3. Maternal Outcomes of Included Studies

The description of the studies reporting severe maternal outcomes is summarized in Table 4.2. Figure 4.2 shows the percentage of maternal outcomes of CD as reported in the participants of the studies.

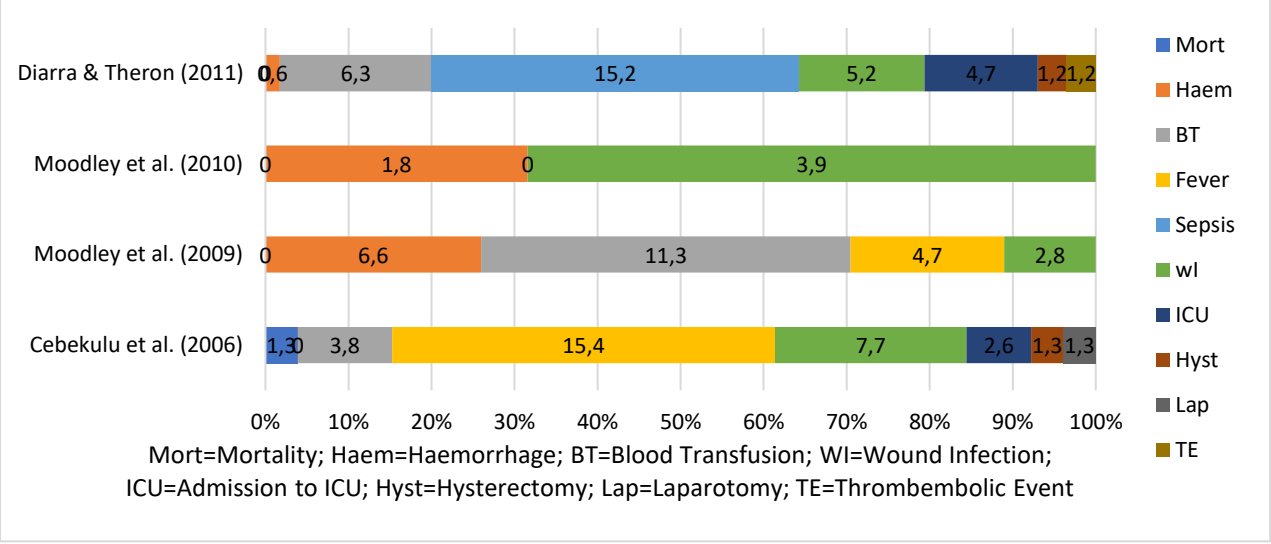

Figure 4.2. Severe Maternal Outcomes reported in the participants of each study

None of the studies defined the outcomes measured or specified any criteria for identification of the outcomes, however, they reported intrapartum and postpartum complications that occurred due to CD. As a result, many outcomes of interest were not reported by the various studies. Table 4.2 reports on the separate groups as provided in each study, with a combination of the groups conducted by the researcher.

Given that the individual studies did not report the rate of the complications, the prevalence of SMO in each study was calculated as the total number of occurrences of the outcomes in that study divided by the total number of participants in the study. In the included studies, 26 outcomes of interest were reported in Cebekulu & Buchmann (2006), giving an outcome prevalence of 33.3% in the individual study. In Moodley et al. (2009), 27 outcomes were reported giving a prevalence of 25.5%. Moodley, Khedun & Devjee (2010) reported 22 outcomes which yielded a prevalence of 5.6%. Finally, 64 outcomes were reported in Diarra & Theron (2011), giving a prevalence of 37.4%.

The majority (3 out of 4) of the studies did not report any maternal mortality. Cebekulu & Buchmann (2006) reported mortality in one woman (2.6%) who had CD in the second stage of labour (1.3% when both cases and controls are combined), and it occurred as a result of severe intraoperative haemorrhage.

In the study by Diarra & Theron (2011), 1.2% of the participants who had CD in the second stage of labour (0.6% of the combined cohort) were reported to have had haemorrhage, and Moodley et al. (2009) observed it in both cases and controls at a rate of 5.7% and 7.5%, respectively (6.6% as a combined cohort). Although Moodley, Khedun & Devjee (2010) did not clearly indicate the rate of haemorrhage in the subgroup of participants that had CD, haemorrhage was reported in 1.8% of the full cohort. All cases of haemorrhage were reported to have occurred during the postpartum period, after the surgery. Cebekulu & Buchmann (2006) reported blood loss that ranged from 300ml to 3000ml in the cases, however, the authors did not specify the number of cohorts with blood loss above 1000ml.

Three studies reported women who required blood transfusion (Cebekulu & Buchmann, 2006; Moodley et al., 2009; Diarra & Theron, 2011). Moodley et al. (2009) observed blood transfusion was 13.2% in the CD in second stage of labour cohort, and 9.4% in the CD in first stage of labour cohort (11.3% as a combined cohort). This was mostly as a result of PPH. Cebekulu & Buchmann (2006) reported a rate of 7.7%, observed only in participants that had CD in the second stage of labour (3.8% as a combined cohort). In Diarra & Theron (2011),

11.8% of the group that had CD in second stage of labour and 7.0% of the first stage group required blood transfusion (9.3% as a combined cohort).

Two studies reported postoperative fever in the participants (Cebekulu & Buchmann, 2006; Moodley et al., 2009). A common occurrence is the higher number of cases observed in participants that had CD in the second stage of labour. 7.5% of the cohort in Moodley et al. (2009) and 25.6% of the cohort in Cebekulu & Buchman (2006) had CD in the second stage of labour, this is significantly high when compared to 1.9% and 5.1%, respectively, for the cohort that had CD in the first stage of labour. In the combined groups, fever was 4.7% (Moodley et al., 2009) and 15.4% (Cebekulu & Buchman, 2006).

Sepsis was reported in a single study. 15.2% of the combined cohort in Diarra & Theron, (2011) were reported to have had puerperal sepsis, this was 20% of the participants that had CD in the second stage of labour and 10.5% of those that had CD in the first stage of labour. The remaining three studies did not make any report on maternal sepsis.

Wound infection was a common observation in all the studies. Moodley et al. (2009) reported wound infection at a rate of 3.8% and 1.9% for controls and cases, respectively (2.8% as a combined cohort). Moodley, Khedun & Devjee (2010) reported 1.3% for participants that booked for antenatal care and 13.9% for those that didn't receive antenatal care (3.9% as a combined cohort). Cebekulu & Buchmann (2006) reported a rate of 7.7% for both cases and controls. Finally, Diarra & Theron (2011) reported wound infection to be 4.7% in the second stage of labour cohort and 5.8% in the first stage of labour cohort (5.2% as a combined cohort).

Table 4.2: Maternal Outcomes of the Included Studies

Ref.	Cohort	N	Maternal Morbidity and Mortality (number and percent of cohort)									
			Mort	**Haem**	**BT**	**Fever**	**Sepsis**	**WI**	**ICU**	**Hyst**	**Lap**	**TE**
Cebekulu et al. (2006)	CD in 1st stage of labour	39	0 (0%)	0 (0%)	0 (0%)	2* (5.1%)	NP	3 (7.7%)	0 (0%)	0 (0%)	1 (2.6%)	NP
	CD in 2nd stage of labour	39	1 (2.6%)	NP	3 (7.7%)	10 (25.6%)	NP	3 (7.7%)	2 (5.1%)	1 (2.6%)	0 (0%)	NP
	Combined	**78**	**1 (1.3%)**	-	**3 (3.8%)**	**12 (15.4%)**	-	**6 (7.7%)**	**2 (2.6%)**	**1 (1.3%)**	**1 (1.3%)**	-
Moodley et al. (2009)	CD in 1st stage of labour	53	NP	4 (7.5%)	5 (9.4%)	1 (1.9%)	NP	2 (3.8%)	NP	NP	NP	NP
	CD in 2nd stage of labour	53	NP	3 (5.7%)	7 (13.2%)	4 (7.5%)	NP	1 (1.9%)	NP	NP	NP	NP
	Combined	**106**	-	**7 (6.6%)**	**12 (11.3%)**	**5 (4.7%)**	-	**3 (2.8%)**	-	-	-	-
Moodley et al. (2010)	Breech booked for antenatal care	303	NP	NP	NP	NP	NP	4 (1.3%)	NP	NP	NP	NP
	Breech unbooked for antenatal care	79	NP	NP	NP	NP	NP	11 (13.9%)	NP	NP	NP	NP
	Combined	**382**	-	**7 (1.8%)**	-	-	-	**15 (3.9%)**	-	-	-	-
Diarra & Theron (2011)	CD in the 1st stage of labour	86	0 (0%)	0 (0%)	6 (7.0%)	NP	9* (10.5%)	5 (5.8%)	1 (1.2%)	1 (1.2%)	NP	0 (0%)
	CD in the 2nd stage of labour	85	0 (0%)	1 (1.2%)	10 (11.8%)	NP	17 (20%)	4 (4.7%)	7* (8.2%)	1 (1.2%)	NP	2 (2.4%)
	Combined	**171**	**0 (0%)**	**1 (0.6%)**	**16 (9.3%)**	-	**26 (15.2%)**	**9 (5.2%)**	**8 (4.7%)**	**2 (1.2%)**	-	**2 (1.2%)**

BT = Blood transfusion; CD = Caesarean delivery; Haem = Haemorrhage; Hyst = Hysterectomy; ICU = admission to ICU; Lap = Laparotomy; Mort = Mortality; NP = Not provided; TE = Thromboembolism; WI = Wound Infection

* = significant difference between groups in the study

Admission to ICU as a post-operative complication was reported in two studies (Cebekulu & Buchmann, 2006; Diarra & Theron, 2011). Cebekulu & Buchmann (2006) reported that 5.1% (2.6% as a combined group) of the women that had CD in the second stage of labour were admitted to the ICU after the surgery. Diarra & Theron (2011) observed a significantly higher rate of ICU admission in the cohort that had CD in the second stage of labour (8.2%) than the cohort that had CD in the first stage of labour (1.2%), and 4.7% with both cohorts combined.

Hysterectomy as a postoperative complication was reported in two studies (Cebekulu & Buchmann, 2006; Diarra & Theron, 2011). In Cebekulu & Buchmann (2006), hysterectomy was performed on only one woman (2.6%) who had CD in the second stage of labour (1.3% as a combined group). Diarra & Theron (2011) reported 1.2% each, in the study group and control group.

Re-laparotomy was reported in one study, it was performed on 2.6% of the participants that had CD in the first stage of labour (1.3% as a combined group) (Cebekulu & Buchmann, 2006).

Thromboembolic events including a case of pulmonary embolism was also reported in one study (Diarra & Theron, 2011), with 2.4% of observations made in the study group and none in the control group (1.2% when both cohorts are combined).

CHAPTER 5: DISCUSSION

This scoping review identified four articles published between 2000 and 2022 that assessed the outcome of CD on maternal morbidity and mortality in pregnant women at term in South African hospitals. The results show that there is a paucity of research studies that have been conducted on the maternal outcomes of CD in South Africa, with only 4 studies meeting the eligibility criteria.

This review found different rates of maternal morbidity and mortality in women who had CD. Haemorrhage and wound infection were common among the participants, and fever occurred at a higher rate in women who had CD in the second stage of labour. Thromboembolism and sepsis were equally observed in one study (Diarra & Theron, 2011). Critical interventions reported were blood transfusion, admission to ICU, hysterectomy and laparotomy.

The frequency of outcomes found in the cohorts in each study was 5.6% (Moodley, Khedun & Devjee, 2010), 25.5% (Moodley et al., 2009), 33.3% Cebekulu & Buchmann (2006) and 37.4% Diarra & Theron (2011). Comparable rates have been found in other countries as well, for example 38.2% in Ethiopia (Wae et al., 2017) and 20.4% in Nigeria (Panti et al., 2012). However, the relatively low rate of the outcomes found in Moodley, Khedun & Devjee, (2010) can be attributed to the fact that most of the outcomes of interest were not reported in the study. Given that the individual studies did not report the rate of the complications, it was calculated as the total number of occurrences of the outcomes in each study divided by the total number of participants in that study. As a result, the rates do not reflect the number of participants that had severe maternal outcome, since it is possible that some of them might have had more than one outcome.

5.1. Maternal Characteristics

5.1.1. Age and Parity of Participants

Cebekulu & Buchmann (2006) reported a mean age of 22.6 ± 4.7 for cohorts that had CD in the first stage of labour and 23.7 ± 6.3 for cohorts that had CD in the second stage of labour. Median parity and range of 0 (0-2) and 0 (0-5) were found for first stage and second stage cohorts respectively. Moodley et al. (2009) reported mean age of 23.8 ± 5.7 for the first stage of labour cohorts and 20.2 ± 4.2 for the second stage of labour cohorts with median parity and

IQR 0 (0-1) for both cohorts. The mean age and median parity found in this review indicate that the participants in the studies were younger aged and mostly nulliparous.

Similar age and parity were found in other studies for women who had CD. A study assessing caesarean morbidity and mortality in a tertiary health institution in Nigeria, found that majority of the patients (67.9%) were less than 30 years of age and most (41.8%) had never given birth before (Panti et al., 2012). Furthermore, they found that this group of women are most likely to give birth through CD due to cephalopelvic disproportion. In an Ethiopian study, majority of the women who had CD were nulliparous (45.4%) with mean age of 25.7 ± 5.2 years (Wae et al., 2017). The study associated age greater than or equal to 30 years with high maternal complication. Another study, assessing the role of maternal age and risk of severe morbidity after CD shows that the association between CD and severe maternal morbidity increased significantly for women aged 35 years or older (Korb et al., 2019). However, the studies in this review did not report any association between the age and parity of the participants and the rate, type or severity of the outcomes found.

5.1.2. Gestational Age

The gestational ages found in this review were mean (SD) 39.3 ± 1.7 and 39.3 ± 1.5 in Cebekulu & Buchmann (2006); median (IQR) 39 (38-40) and 39 (38-40) in Moodley et al. (2009); mean of 39.6 and 39.9 in Diarra & Theron (2011). However, this is not unexpected since pregnancies less than 36 weeks were excluded during the screening stage of the study in order to eliminate maternity outcomes that are as a result of preterm pregnancy.

5.2. Maternal Mortality

Maternal mortality is defined by the WHO as death from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and anatomic site of the pregnancy (WHO, 2011). There are various causes of mortality in women who had CD, the most common direct causes have been identified as haemorrhage and hypertensive disorders of pregnancy (Geleto et al., 2020), and anaesthesia-related deaths (Esteves-Pereira et al., 2016). In South Africa, common causes after CD include those enumerated above, along with pregnancy-related sepsis and embolism (Gebhardt et al., 2015).

In this review, the occurrence of maternal mortality is low in the studies altogether. Only one study reported maternal mortality (Cebekulu & Buchmann, 2006). There were 0% cases of maternal mortality in Diarra & Theron (2011) whereas Moodley et al. (2009) and Moodley, Khedun & Devjee (2010) made no reports on maternal mortality at all. This is unanticipated given the findings from the Saving Mothers Report made by the National Committee for Confidential Enquiries into Maternal Deaths in South Africa, which highlighted the large number of maternal deaths associated with CD (Gebhardt et al., 2015). The report was based on a review conducted from 2011 to 2013 in which 1 243 maternal deaths occurred in 655 686 births by CD. The possible explanation for the low report of maternal death in the studies altogether is that the small sample sizes used in the studies yielded a low number of maternal outcomes, including mortality.

Although only 1 death was reported, the mortality rate for the individual study was 2.6% of the cohort that had CD in the 2nd stage of labour (Cebekulu & Buchmann, 2006). The death occurred as a result of severe intraoperative haemorrhage in one woman. This rate of mortality is high in comparison with findings in other low- and middle-income countries. In a five-year study of CD in a Nigerian tertiary hospital, 6 deaths occurred (0.6%) out of 918 cases of emergency CD, and 1 death (0.1%) occurred among the 62 women that had elective CD (Ugwu et al., 2011). In Ghana, 2 deaths (0.3%) occurred in 645 women that had CD (Prah et al., 2017) and the deaths were due to complications of sickle cell and hypertension in pregnancy. The death rate in Cebekulu & Buchmann (2006) is even higher in comparison with 0.04% and 0.06% found for elective and intrapartum CD in a survey conducted by WHO among 31,821 Latin American women who gave birth by CD (Villar et al., 2007). Again, the relatively small sample size of the study with 1 patient death reported can over-accentuate the percentage reported for this cohort, which could partly explain the high mortality rate reported by Cebekulu & Buchmann (2006).

5.3. Haemorrhage and Blood Transfusion

Haemorrhage is commonly defined as abnormal intra- or post-operation bleeding (1000 ml or more) or any bleeding with hypotension or blood transfusion (Villar et al., 2007; Fawcus & Moodley, 2013; Maswime & Buchmann, 2017a). Two previous studies in South Africa have linked bleeding during and after caesarean section (BDACS) with severe maternal morbidity (near-miss) and mortality (Maswime & Buchmann, 2017a, b). In both studies, maternal near-

miss was defined as a woman who had a caesarean section with a combination of haemorrhage and at least one of the following outcomes: blood transfusion (≥3 units), emergency hysterectomy, repeat laparotomy, admission to ICU, among others.

This scoping review found a rate of 6.6% and 0.6% for haemorrhage in the combined cohorts of Moodley et al. (2009) and Diarra & Theron (2011), respectively. In the women that booked and those that did not book for antenatal care reported in Moodley, Khedun & Devjee (2010), haemorrhage was 1.8% in total. Cebekulu & Buchmann (2006) did not specify the number of women with blood loss above 1000ml in their study. A possible explanation for the variations in the rate of haemorrhage could be from the methods used in blood loss assessment, this factor has been identified to play a vital role in the variation of reported prevalence of PPH in the study by Calvert et al. (2012).

Varying rates of blood transfusion were found in this review as well. Blood transfusion was required in 3.8%, 11.3%, and 9.3% of the combined cohorts in Cebekulu & Buchmann (2006), Moodley et al. (2009) and Diarra & Theron (2011), respectively. Moodley, Khedun & Devjee (2010) made no reports on blood transfusion. An interesting occurrence is the differences in the rates of blood transfusion and haemorrhage reported in the studies. However, this is not uncommon since other countries report a similar trend. In Finland, 8.4% of the women had haemorrhage whereas 6.4% required transfusion (Pallasmaa et al., 2010). In Ethiopia, haemorrhage occurred in 10.8% of the women that had CD, with 7.7% of them requiring blood transfusion (Wae et al., 2017). In USA, haemorrhage was 1.98% among the CD women, with a blood transfusion rate of 1.72% (Moroz et al., 2016). One explanation for the variation of haemorrhage and blood transfusion in this study is the possibility that there was an underestimation the actual blood loss among the women. This could have occurred from the method used for blood loss estimation by the health care providers. Another possible explanation is that the patients that required blood transfusion might have been anaemic from active blood loss or other morbidities that deplete blood cells. The included studies in this review did not specify the women that got transfused as a result of haemorrhage.

5.4. Wound Infection

Wound infection is commonly referred to as surgical site infection (SSI) and is defined by the Centers for Disease Control and Prevention (CDC) as an infection occurring within 30 days from the operative procedure in the part of the body where the surgery took place (Horan et al.,

1992 as cited in (Zuarez-Easton et al., 2017). It is classified according to superficial incisional SSI, deep incisional SSI and organ/space SSI (Opøien et al., 2007).

Wound infection is the most reported postoperative maternal outcome overall in this study with rates of 7.7%, 2.8%, 3.9% and 5.2% in Cebekulu & Buchmann (2006), Moodley et al. (2009), Moodley, Khedun & Devjee (2010) and Diarra & Theron (2011) respectively. These findings are comparable to those found in Nepal (4.4%) (Sharma & Dhakal, 2018) and Egypt (5.34%) (Gomaa et al., 2021). However, they are slightly lower than the rates found in Ethiopia (12%) (Wae et al., 2017) and Kenya (19%) (Koigi-Kamau, Kabare & Wanyoike-Gichuhi, 2005). The findings are also in line with the reported global rate of 3% to 20% (Olsen et al., 2008; Zuarez-Easton et al., 2017). Opøien et al. (2007), reported rates as low as 1.1% to as high as 25% from different studies. These variations occur depending on the methods used to identify infections, the patient population, the use of antibiotic prophylaxis and the time it took to observe the infection (Opøien et al., 2007; Olsen et al., 2008; Zuarez-Easton et al., 2017). Similarly, the variations found in this study can be attributed to non-definition of wound infection or lack of description of methods used in assessment and identification of the infections. These factors make comparison of studies difficult.

The findings for wound infection in this study are lower compared to the finding from a previous study conducted in South Africa on puerperal infection (Johnson & Buchmann, 2012). The study was not included in this review as it failed to meet the eligibility criteria. The authors reported a rate of 11% for possible mild wound infection among discharged women who had CD. However, the identification of wound infection was based on information from self-reports, obtained through follow-up telephone calls made to the participants. This might explain the higher rate found in the study since the women could not have had adequate knowledge to accurately diagnose themselves of wound infection.

Additionally, the findings from Cebekulu & Buchmann (2006) and Moodley et al. (2009) show that there are no differences for wound infection from CD conducted in the first stage of labour compared to the second stage of labour. In Moodley, Khedun & Devjee (2010), there is a higher rate of wound infection in women who did not receive antenatal care compared to those who did. This is in line with evidence in other studies. Killian et al. (2001) identified fewer antenatal visits and absence of antibiotic prophylaxis as significant risk factors for wound infection. Another study on maternal and fetal outcomes found that mothers who did not book for antenatal care were 9.6 times more likely to develop unfavourable maternal outcome after CD

compared to those who had antenatal care follow up during their pregnancy (Mengesha et al., 2019). This implies that adequate antenatal care is a preventive factor for wound infection and possibly other maternal morbidities after CD.

5.5. Sepsis and Fever

There are varied definitions of puerperal sepsis in literature. WHO defined puerperal sepsis as an infection of the genital tract occurring at any time from the time of onset of rupture of membranes or labour and the 42nd day after deliver, in which fever and one or more of the following are present: pelvic pain, abnormal vaginal discharge, abnormal smell/foul odour of discharge and delay in the rate of reduction of the size of the uterus. Alternately, the International Classification of Diseases (ICD-10) defined puerperal sepsis as a rise in body temperature above 38.08C (100.48F) for over 24 hours or is frequent during the period from the end of the first to the end of the 10th day after childbirth or abortion (Maharaj, 2007; van Dillen et al., 2010).

Sepsis was not reported in three of the included studies, it was reported in only one study at a rate of 15.2% (combined cohorts) (Diarra & Theron, 2011). The study observed puerperal sepsis in 17 women who had CD in the second stage of labour (20% of the single cohort) and 9 women who had CD in the first stage of labour (10.5% of the single cohort). These rates are considerably higher than that found in a previous study conducted in South Africa (Johnson & Buchmann, 2012). In the study, 272 women who had CD were followed up and puerperal sepsis was observed in four (1.5%) of them. The significant difference in the studies might be due to the definition of sepsis used in Johnson & Buchmann (2012). In the study, puerperal sepsis was defined as body temperature ≥38°C with vaginal bleeding, malodorous discharge or pain. Additionally, the follow up was for 14 days after delivery instead of 42 days as defined by the World Health Organization. However, Diarra & Theron (2011) did not indicate any criteria for the identification of sepsis and they did not include fever as a postoperative outcome of CD among the women. The variation in the definitions of maternal sepsis makes it difficult to compare studies.

In comparison to this study, a significantly higher rate of sepsis was found in Nigeria. In the study, sepsis ranked higher than other complications at 36.3% and was a major cause of maternal mortality (Panti et al., 2012). However, high rate of sepsis after CD seems to be the

general trend in the country as previous studies reported similar figures (Chama et al., 2000 and Ezechi et al., 2000 as cited in Panti et al. 2012).

Fever (body temperature greater than 38 degrees) was found at the rates of 15.4% in Cebekulu & Buchmann (2006) and 4.7% in Moodley et al. (2009). The variation in the rate of fever observed in both studies might be due to different population characteristics. Both studies did not report the duration of fever or the occurrence of sepsis among their participants.

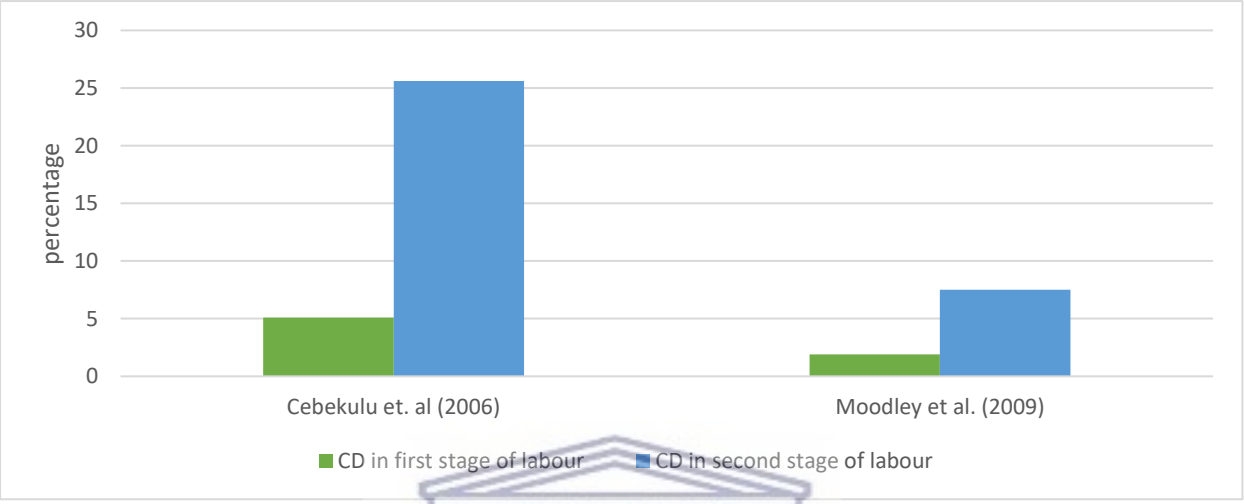

Figure 5.1. Comparison of fever in the first stage and second stage of labour CD

In the two studies, fever was significantly higher among participants with CD performed in the second stage of labour as shown in Figure 5.1. In Cebekulu & Buchmann (2006) 10 women (25.6%) had fever after CD in the second stage of labour compared to 2 women (5.1%) after CD in the first stage of labour. In Moodley et al. (2009), 4 women (7.5%) had fever from CD in the second stage of labour and 1 woman (1.9%) after CD in the first stage of labour. A study in India assessing CD outcome in late first stage versus second stage of labour showed a similar trend (Bhatia & Revankar, 2021). Fever was reported at a rate of 9.1 % for CD performed in the second stage and 7.9% for CD in the first stage of labour. Evidence shows that there is a higher occurrence of maternal morbidity when CD is performed in the second stage of labour (Mengesha et al., 2019). Adequate and thorough assessment of pregnant women during antenatal care is therefore necessary as it will aid early identification of high-risk pregnancies and prompt booking for CD. This will go a long way in reducing unplanned CD at any stage of labour and consequently maternal morbidity associated with CD.

5.6. Thromboembolic Event

A thromboembolic event (TE), also known as a venous thromboembolism (VTE), is defined as deep vein thrombosis (DVT), pulmonary embolism (PE) or both (Beckman et al., 2010), and occurs when a blood clot (thrombus) formed in the veins breaks loose and gets transported by the blood stream to another blood vessel (embolus) where it obstructs the flow of blood (CDC, n.d.). VTE is identified as a leading cause of maternal death during pregnancy and the postpartum period in HICs (Friedman & Ananth, 2016; Schimidt Evangelista et al., 2018). Statistics by WHO show that 2% of all global maternal mortality are caused by VTE, and 14.9% of maternal deaths in developed countries are related to TEs (Friedman & Ananth, 2016).

The rate of TEs found in this study was 2.4% in the study cohorts of Diarra & Theron (2011). In contrast, low rates were found in USA, in a study assessing hospital and patient factors of CD complications (Moroz et al. 2016). The study found a 0.09% rate of TE among the cohorts. In England, after a one-year cohort study of 393 women who had term, singleton, liveborn, cephalic pregnancies requiring CD, no thromboembolic events were found at all (Murphy et al., 2001). In a retrospective one-year analysis of 1377 patients who had CD in Canada, only 0.5% of the patients developed a TE (Lai et al., 2017). These studies were all conducted in HICs that have favourable socioeconomic and political conditions which yield improved health outcomes, this could have played a role in the low rates infection among their women. Contrarily, in Finland, the rate of thromboembolic events was found to be as high as 3% in the patients after CD which is comparable to what was found in this study (Pallasmaa et al., 2010). It is surprising that a higher rate of TEs was not found in this study or reported in all the studies, given that it has been identified as a major complication following CD and a major cause of maternal mortality in South Africa.

5.7. Admission to Intensive Care Units (ICU)

This study found rates of 2.6% (Cebekulu & Buchmann, 2006;) and 4.7% (Diarra & Theron, 2011) in studies that reported admission to ICU with CD. In Diarra & Theron (2011), ICU admission was common in the study cohorts that had CD in the second stage of labour. The authors reported that these women were more likely to have had severe complications such as PPH, thromboembolic event, cardiac arrest, pulmonary oedema and pulmonary embolism and required attentive care immediately after the procedure.

In general, there is not a lot of studies reporting the incidence of ICU admission after CD, however, the few studies that did compared CD with other modes of delivery. Villar et al. (2007), found that women had a double risk of ICU admission in CD than VD. The rate of ICU admission for elective CD (2.72%) in the study was similar to that of Cebekulu & Buchmann (2006). However, the rate of intensive care after emergency CD and VD were 1.42% and 0.54% respectively. Zandvakili et al. (2017), found a rate of 0.24% in women that had CD which is low in comparison with the findings of this review. The study further revealed that the risk of admission to ICU is higher with VD and episiotomy than with CD.

5.8. Laparotomy and Hysterectomy

Laparotomy is defined as a surgical procedure that involves an incision through the abdominal wall to gain access into the abdominal cavity other than CD (Witteveen et al., 2018). WHO (2011), categorized it as one of the critical interventions that is required in the management of life-threatening and potentially life-threatening conditions. A laparotomy performed after CD is generally known as re-laparotomy. Re-laparotomies are defined as abdominal operations performed following the initial surgery, usually within 60 days (Martínez-Casas, 2010 as cited in Shinar et al., 2013). Common indications for re-laparotomies after CD include internal bleeding, hematoma, and PPH (Shinar et al., 2013; Fazari et al., 2015; Khan & Kolasseri, 2017; Huras, Radon-Pokracka & Nowak, 2018). Hysterectomy on the other hand is the surgical removal of the uterus following infection or haemorrhage (WHO, 2011). In patients that had CD, hysterectomy is usually performed through laparotomy (Celle et al., 2015).

There were minimal reports of laparotomy and hysterectomy in this review. Cebekulu & Buchmann (2006) reported re-laparotomy at 1.3% after CD in the first stage of labour. Hysterectomy was found at a similar rate of 1.3% in Cebekulu & Buchmann (2006) and 1.2% in Diarra & Theron (2011). Findings in this study are high in comparison to findings in developed countries. In England, there were no laparotomies and no hysterectomies in a study on maternal and neonatal morbidity in the second stage of CD (Murphy et al., 2001). In USA, Moroz et al. (2016) found a 0.1% rate of hysterectomy. A study in Turkey, investigating maternal complications of CD performed in the first stage versus the second stage of labour, found a rate of 0.6% for hysterectomy for CD in the second stage of labour (Asicioglu et al., 2014). The rate of re-laparotomy in this study is comparable to 1.04% found in Egypt in a prospective study on re-laparotomy performed after CD (Raagab et al., 2014). It is noteworthy

that one case of hysterectomy in this study was performed to control excessive haemorrhage for CD conducted during the second stage of labour (Cebekulu & Buchmann, 2006). Laparotomy and hysterectomy performed as a result of haemorrhage after CD might serve as a useful marker in identifying the severity of bleeding in future studies.

5.9. Validity and Reliability

The strength of this study lies in its research design. To ensure validity, the study followed a written down protocol guided by a PICO framework for formulating the research question and eligibility criteria. The PRISMA-ScR checklist and the methodological framework (Arksey & O'Malley, 2007) for scoping reviews was strictly adhered to for its repeatability. Generalizability was enhanced by the inclusion of both published and grey literature that met the study's eligibility criteria. Preterm pregnancies were excluded from the study due to their confounding nature, in order to minimize complications that are not as a direct result of CD.

5.10. Limitations

One major limitation of this study is the paucity of data used in the review. Research conducted in South Africa on CD and its effect on maternal morbidity and mortality is not extensive, hence, literature for the review only covered a few public hospitals and three out of nine provinces in South Africa. Generalizing the findings of this study to private hospitals and other provinces in the country not included in the study should be carried out with caution. Studies were additionally limited to those published in English language from the year 2000 to 2022. It is plausible that relevant studies published in any of the indigenous languages of the country might have been excluded.

The study did not exclude underlying chronic diseases and medical indications of CD, however preterm pregnancies were excluded. Chronic illnesses (diabetes, hypertension, HIV), medical indications of CD (eclampsia, antepartum haemorrhage) and preterm pregnancies are confounding factors that affect the outcome of delivery in pregnant women. The lack of consideration for these factors yields uncertainty in distinguishing the outcomes that are as a result of CD from those caused by other factors.

Another limitation of this review is posed by the nature of the study design. Data collection for scoping reviews is based exclusively on published literature from previously conducted research which means unavailability of specific clinical detail that might provide insight to the nature of the outcomes and their exact link with CD. Additionally, there was no appraisal of the quality of evidence found in the literature. This is because scoping reviews do not seek to aggregate evidence and consequently cannot determine the accuracy of the findings in the studies.

Finally, the reviewed studies lacked consistency in the outcomes reported. There was also a disuse of standard definitions for the outcomes of interest among the studies. This implies that a misclassification of some of the variables might have occurred.

5.11. Recommendations

Given the low number of studies available on the topic, it would not be feasible to conduct a systematic review. The following recommendations are necessary for future research:

- Well-designed observational studies on the indications and outcomes of CD, with larger sample sizes, covering both public and private hospitals across different provinces in South Africa must be conducted. In order to take reasonable steps in reducing the rate of CD, it is necessary to understand not just the effect of CD on women's health but the driving factors as well.
- Focus should be directed to the outcomes of CD performed without medical indication on healthy women compared with women who had VD. Other factors such as gestational age should be considered as well.
- Outcomes that are to be assessed in the research should be explicitly defined or follow a standard definition before the commencement of the study.

For healthcare workers:

- Unnecessary CD should be avoided whenever possible bearing in mind the possible outcomes that could occur as a result. This especially applies to the private sector where it is believed that majority of CD is performed at the mother's request (Solanki et al., 2020).

- Emphasis should be laid on the outcomes of CD during antenatal care and decision-making process to ensure that pregnant women make a completely informed decision when deciding on the appropriate mode of delivery.
- Early antenatal care and proper monitoring of pregnant women must be encouraged and improved. This is to aid prompt detection of underlying medical conditions which can reduce CD conducted in the late stage of labour where a higher number of complications occur.

5.12. Conclusion

CD has been associated with severe maternal morbidity in South Africa. This is a cause for concern given its increasing rate both in the country and globally, it additionally calls for a better understanding of its effect on the health of women. The increasing rates of CD in South Africa is believed to be driven by the presence of potential life-threatening complications and low rate of vaginal birth after caesarean delivery (VBAC) in the public sector, and possibly due to maternal preference in the private sector (Solanki et. al, 2020).

Severe maternal complications such as PPH, wound infection, sepsis, febrile morbidity, admission to ICU and mortality have been found to occur with CD in this study. However, report of maternal mortality as a result of CD is low in the overall studies when compared to findings from the Saving Mothers Report by Gebhardt et al. (2015). This can possibly be explained by the small sample sizes used in the studies which yielded a low number of maternal outcomes, including mortality. A higher rate of some of the complications occurred in women who had CD in the second stage of labour. Urgent action is needed to reduce the rate of CD especially when not medically necessary in order to reduce the associated maternal morbidity and mortality. The findings in this study can particularly be useful for health care providers during decision making with regards to the appropriate mode of delivery especially when there are no complications. It can also be useful for pregnant women in making informed decision for their preferred mode of delivery.

REFERENCES

Arksey, H. & O'Malley, L. 2007. Scoping studies: towards a methodological framework. *https://doi.org/10.1080/1364557032000119616*. 8(1):19–32. DOI: 10.1080/1364557032000119616.

Asicioglu, O., Güngördük, K., Yildirim, G., Asicioglu, B.B., Güngördük, C., Ark, C., Günay, T. & Yenigül, N. 2014. Second-stage vs first-stage caesarean delivery: comparison of maternal and perinatal outcomes. *Journal of obstetrics and gynaecology : the journal of the Institute of Obstetrics and Gynaecology*. 34(7):598–604. DOI: 10.3109/01443615.2014.920790.

Becher, L., Stokke Supervisors, S., Babill Stray-Pedersen, P. & Msuya, S.E. 2013. Indications For Cesarean Section in St. Joseph Medical Hospital Moshi, Tanzania. Available: https://www.duo.uio.no/bitstream/handle/10852/35663/Prosjektoppgave_medisin.pdf?sequence=2 [2021, December 01].

Beckman, M.G., Hooper, W.C., Critchley, S.E. & Ortel, T.L. 2010. Venous thromboembolism: a public health concern. *American journal of preventive medicine*. 38(4 Suppl). DOI: 10.1016/J.AMEPRE.2009.12.017.

Betran, A., Torloni, M., Zhang, J., Gülmezoglu, A., Section, the W.W.G. on C., Aleem, H., Althabe, F., Bergholt, T., et al. 2016. WHO Statement on Caesarean Section Rates. *Bjog*. 123(5):667. DOI: 10.1111/1471-0528.13526.

Betrán, A.P., Merialdi, M., Lauer, J.A., Bing-Shun, W., Thomas, J., van Look, P. & Wagner, M. 2007. Rates of caesarean section: analysis of global, regional and national estimates. *Paediatric and Perinatal Epidemiology*. 21(2):98–113. DOI: 10.1111/J.1365-3016.2007.00786.X.

Betrán, A.P., Ye, J., Moller, A.B., Zhang, J., Gülmezoglu, A.M. & Torloni, M.R. 2016. The Increasing Trend in Caesarean Section Rates: Global, Regional and National Estimates: 1990-2014. *PLOS ONE*. 11(2):e0148343. DOI: 10.1371/JOURNAL.PONE.0148343.

Betran, A.P., Ye, J., Moller, A.B., Souza, J.P. & Zhang, J. 2021. Trends and projections of caesarean section rates: global and regional estimates. *BMJ Global Health*. 6(6):e005671. DOI: 10.1136/BMJGH-2021-005671.

Bhatia, S. & Revankar, V.M. 2021. Study of maternal and perinatal outcome of caesarean delivery in late first stage and second stage of labour. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 10(4):1503. DOI: 10.18203/2320-1770.IJRCOG20211128.

Bishop, D., Dyer, R.A., Maswime, S., Rodseth, R.N., van Dyk, D., Kluyts, H.L., Tumukunde, J., Madzimbamuto, F.D., et al. 2019. Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. *The Lancet Global Health*. 7(4):e513–e522. DOI: 10.1016/S2214-109X(19)30036-1.

Blondon, M., Casini, A., Hoppe, K.K., Boehlen, F., Righini, M. & Smith, N.L. 2016. Risks of Venous Thromboembolism After Cesarean Sections: A Meta-Analysis. *Chest*. 150(3):572–596. DOI: 10.1016/J.CHEST.2016.05.021.

Boerma, T., Ronsmans, C., Melesse, D.Y., Barros, A.J.D., Barros, F.C., Juan, L., Moller, A.B., Say, L., et al. 2018. Global epidemiology of use of and disparities in caesarean sections. *The Lancet*. 392(10155):1341–1348. DOI: 10.1016/S0140-6736(18)31928-7.

Byamugisha, J. & Adroma, M. 2020. Caesarean Section in Low-, Middle- and High-Income Countries. *Recent Advances in Cesarean Delivery*. (February, 18). DOI: 10.5772/INTECHOPEN.88573.

Calvert, C., Thomas, S.L., Ronsmans, C., Wagner, K.S. & Adler, A.J. 2012. Identifying Regional Variation in the Prevalence of Postpartum Haemorrhage: A Systematic Review and Meta-Analysis. *PLoS ONE*. 7(7):41114. DOI: 10.1371/journal.pone.0041114.

Cebekulu, L. & Buchmann, E.J. 2006. Complications associated with cesarean section in the second stage of labor. *International Journal of Gynecology and Obstetrics*. 95(2):110–114. DOI: 10.1016/J.IJGO.2006.06.026.

Celle, C., Pomés, C., Durruty, G., Zamboni, M. & Cuello, M. 2015. Total laparoscopic hysterectomy with previous cesarean section using a standardized technique: experience of Pontificia Universidad Catolica de Chile. *Gynecological Surgery*. 12(3):149–155. DOI: 10.1007/S10397-015-0896-2/FIGURES/1.

Centers for Disease Control and Prevention. n.d. *What is Venous Thromboembolism? | CDC*. Available: https://www.cdc.gov/ncbddd/dvt/facts.html [2022, November 17].

Daniel, C.N. & Singh, S. 2016. Caesarean delivery: An experience from a tertiary institution in north western Nigeria. *Nigerian Journal of Clinical Practice*. 19(1):18. DOI: 10.4103/1119-3077.164350.

Deneux-Tharaux, C., Carmona, E., Bouvier-Colle, M.H. & Bréart, G. 2006. Postpartum maternal mortality and cesarean delivery. *Obstetrics and Gynecology*. 108(3):541–548. DOI: 10.1097/01.AOG.0000233154.62729.24.

Diarra, A. & Theron, G.B. 2011. Maternal and perinatal morbidity and mortality of caesarean delivery in the late first stage and second stage of labour. *East African Medical Journal*. 88(8):280–284.

Dikete Ekanga, M., Prudence, M., Yves, C., Christine, K., Richard, K., Philippe, S., Yvon, E., Judith, R., et al. 2019. Analysis of caesarean section practices and consequences in Goma, DR Congo: Frequency, indications, maternal and perinatal morbidity and mortality. *Archives of Community Medicine and Public Health*. (December, 26):091–098. DOI: 10.17352/2455-5479.000060.

van Dillen, J., Zwart, J., Schutte, J. & van Roosmalen, J. 2010. Maternal sepsis: epidemiology, etiology and outcome. *Current opinion in infectious diseases*. 23(3):249–254. DOI: 10.1097/QCO.0B013E328339257C.

van Dongen, P.W.J. 2009. Caesarean section – etymology and early history. *South African Journal of Obstetrics and Gynaecology*. 15(2). Available: https://journals.co.za/doi/pdf/10.10520/EJC65901 [2022, February 15].

Esteves-Pereira, A.P., Deneux-Tharaux, C., Nakamura-Pereira, M., Saucedo, M., Bouvier-Colle, M.-H., Do, M. & Leal, C. 2016. Caesarean Delivery and Postpartum Maternal

Mortality: A Population-Based Case Control Study in Brazil. DOI: 10.1371/journal.pone.0153396.

Eyowas, F.A., Negasi, A.K., Aynalem, G.E. & Worku, A.G. 2016. Adverse birth outcome: a comparative analysis between cesarean section and vaginal delivery at Felegehiwot Referral Hospital, Northwest Ethiopia: a retrospective record review. *Pediatric Health, Medicine and Therapeutics*. 7:65–70. DOI: 10.2147/PHMT.S102619.

Fawcus, S. & Moodley, J. 2013. Postpartum haemorrhage associated with caesarean section and caesarean hysterectomy. *Best practice & research. Clinical obstetrics & gynaecology*. 27(2):233–249. DOI: 10.1016/J.BPOBGYN.2012.08.018.

Fazari, A.B., Eldeen, N.S., Mohammed, W., Muror, M., Gailii, E., Fazari, A.B., Eldeen, N.S., Mohammed, W., et al. 2015. Re-Laparotomy after Caesarean Section at Omdurman Maternity Hospital-Khartoum, Sudan. *Open Journal of Obstetrics and Gynecology*. 5(8):448–454. DOI: 10.4236/OJOG.2015.58065.

Forna, F., Miles, A.M. & Jamieson, D.J. 2004. Emergency peripartum hysterectomy: a comparison of cesarean and postpartum hysterectomy. *American Journal of Obstetrics and Gynecology*. 190(5):1440–1444. DOI: 10.1016/J.AJOG.2004.02.021.

Friedman, A.M. & Ananth, C. v. 2016. Obstetrical venous thromboembolism: Epidemiology and strategies for prophylaxis. *Seminars in perinatology*. 40(2):81–86. DOI: 10.1053/J.SEMPERI.2015.11.011.

Gebhardt, G.S., Fawcus, S., Moodley, J. & Farina, Z. 2015. Maternal death and caesarean section in South Africa: Results from the 2011 - 2013 Saving Mothers Report of the National Committee for Confidential Enquiries into Maternal Deaths. *SAMJ: South African Medical Journal*. 105(4):287–291. DOI: 10.7196/SAMJ.9351.

Gebremedhin, S. 2014. Trend and socio-demographic differentials of Caesarean section rate in Addis Ababa, Ethiopia: analysis based on Ethiopia demographic and health surveys data. *Reproductive health*. 11(1). DOI: 10.1186/1742-4755-11-14.

Geleto, A., Chojenta, C., Taddele, T. & Loxton, D. 2020. Association between maternal mortality and caesarean section in Ethiopia: A national cross-sectional study. *BMC Pregnancy and Childbirth*. 20(1):1–11. DOI: 10.1186/S12884-020-03276-1/TABLES/6.

Gomaa, K., Abdelraheim, A.R., el Gelany, S., Khalifa, E.M., Yousef, A.M. & Hassan, H. 2021. Incidence, risk factors and management of post cesarean section surgical site infection (SSI) in a tertiary hospital in Egypt: a five year retrospective study. *BMC Pregnancy and Childbirth*. 21(1):1–9. DOI: 10.1186/S12884-021-04054-3/FIGURES/2.

Govender, I., Steyn, C., Maphasha, O. & Abdulrazak, A.T. 2019. A profile of Caesarean sections performed at a district hospital in Tshwane, South Africa. *https://doi.org/10.1080/20786190.2019.1671655*. 61(6):246–251. DOI: 10.1080/20786190.2019.1671655.

Govuzela, M. 2020. *Epidemiology and trends of caesarean section births in the medical schemes' population, 2015 - 2018*. South Africa.

Guidozzi, D.F., Branch, S. & Chauke, L. 2018. Maternal and fetal outcomes following delivery in a tertiary hospital in Johannesburg, South Africa. *South African Journal of Obstetrics and Gynaecology*. 24(3):28–32. DOI: 10.7196/SAJOG.2018.V24I3.1396.

Gupta, M. & Saini, V. 2018. Cesarean section: Mortality and morbidity. *Journal of Clinical and Diagnostic Research*. 12(9):QE01–QE06. DOI: 10.7860/JCDR/2018/37034.11994.

Heitkamp, A., Aronson, S.L., Van Den Akker, T., Vollmer, L., Gebhardt, S., Van Roosmalen, J., De Vries, J.I. & Theron, G. 2020. Major obstetric haemorrhage in Metro East, Cape Town, South Africa: A population-based cohort study using the maternal near-miss approach. *BMC Pregnancy and Childbirth*. 20(1):1–8. DOI: 10.1186/S12884-019-2668-X/TABLES/6.

Holm, C., Langhoff-Roos, J., Petersen, K.B., Norgaard, A. & Diness, B.R. 2012. Severe postpartum haemorrhage and mode of delivery: a retrospective cohort study. *BJOG: An International Journal of Obstetrics & Gynaecology*. 119(5):596–604. DOI: 10.1111/J.1471-0528.2011.03267.X.

Huras, H., Radon-Pokracka, M. & Nowak, M. 2018. Relaparotomy following cesarean section – a single center study. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 225:185–188. DOI: 10.1016/J.EJOGRB.2018.04.034.

Jamshed, S., Chien, S.C., Tanweer, A., Asdary, R.N., Hardhantyo, M., Greenfield, D., Chien, C.H., Weng, S.F., et al. 2022. Correlation Between Previous Caesarean Section and Adverse Maternal Outcomes Accordingly With Robson Classification: Systematic Review and Meta-Analysis. *Frontiers in Medicine*. 8:2657. DOI: 10.3389/FMED.2021.740000/BIBTEX.

Johnson, A.N. & Buchmann, E.J. 2012. Puerperal infection after caesarean section at Chris Hani Baragwanath academic hospital, Johannesburg. *South African Journal of Obstetrics and Gynaecology*. 18(3):90–91. DOI: 10.7196/SAJOG.559.

Khan, N.B.A. & Kolasseri, S.S. 2017. Relaparotomy after caesarean section: an analysis of the risk factors, indications and outcome. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 4(3):575–580. DOI: 10.18203/2320-1770.IJRCOG20150054.

Killian, C.A., Graffunder, E.M., Vinciguerra, T.J. & Venezia, R.A. 2001. Risk factors for surgical-site infections following cesarean section. *Infection control and hospital epidemiology*. 22(10):613–617. DOI: 10.1086/501831.

Koigi-Kamau, R., Kabare, L.W. & Wanyoike-Gichuhi, J. 2005. Incidence of wound infection after caesarean delivery in a district hospital in Central Kenya. *East African Medical Journal*. 82(7):357–361.

Kongwattanakul, K., Thamprayoch, R., Kietpeerakool, C. & Lumbiganon, P. 2020. Risk of Severe Adverse Maternal and Neonatal Outcomes in Deliveries with Repeated and Primary Cesarean Deliveries versus Vaginal Deliveries: A Cross-Sectional Study. *Journal of Pregnancy*. 2020. DOI: 10.1155/2020/9207431.

Konrad Asghar, A., Nkabinde, T.C. & Naidoo, M. 2022. An analysis of obstetric practices and outcomes in a deep rural district hospital in South Africa. *PLOS ONE*. 17(1):e0262269. DOI: 10.1371/JOURNAL.PONE.0262269.

Korb, D., Goffinet, F., Seco, A., Chevret, S., Deneux-Tharaux, C., Langer, B., Dupont, C., Rudigoz, R.C., et al. 2019. Risk of severe maternal morbidity associated with cesarean delivery and the role of maternal age: A population-based propensity score analysis. *CMAJ*. 191(13):E352–E360. DOI: 10.1503/CMAJ.181067/-/DC1.

Lai, J., Venu, I., Malinowski, A.K., Gandhi, S., McLeod, A., Nisenbaum, R., Zaffar, N. & Shehata, N. 2017. Thromboembolism following cesarean section: a retrospective study. *https://doi.org/10.1080/10245332.2017.1415245*. 23(6):351–356. DOI: 10.1080/10245332.2017.1415245.

Low, J. 2009. Caesarean Section-Past and Present. *Journal of Obstetrics and Gynaecology Canada*. 31:1131–1136. DOI: 10.1016/S1701-2163(16)34373-0.

Maharaj, D. 2007. Puerperal pyrexia: a review. Part I. *Obstetrical & gynecological survey*. 62(6):393–399. DOI: 10.1097/01.OGX.0000265998.40912.5E.

"Management of the second stage of labor". 2012. *International Journal of Gynecology & Obstetrics*. 119(2):111–116. DOI: 10.1016/J.IJGO.2012.08.002.

Mascarello, K.C., Horta, B.L. & Silveira, M.F. 2017. Maternal complications and cesarean section without indication: systematic review and meta-analysis. *Revista de Saúde Pública*. 51:105. DOI: 10.11606/S1518-8787.2017051000389.

Massyn, N., Peer, N., English, R., Padarath, A., Barron, P. & Day, C. 2016. *District Health Barometer 2015/16*. Durban. Available: https://www.hst.org.za/publications/District%20Health%20Barometers/District%20Health%20Barometer%202015_16.pdf [2022, February 18].

Maswime, T.S. & Buchmann, E.J. 2017a. Why women bleed and how they are saved: a cross-sectional study of caesarean section near-miss morbidity. *BMC pregnancy and childbirth*. 17(1). DOI: 10.1186/S12884-016-1182-7.

Maswime, T.S. & Buchmann, E.J. 2017b. Near-miss maternal morbidity from severe haemorrhage at caesarean section: A process and structure audit of system deficiencies in South Africa. *South African Medical Journal*. 107(11):1005–1009. DOI: 10.7196/SAMJ.2017.V107I11.12340.

Mengesha, M.B., Adhanu, H.H., Weldegeorges, D.A., Assefa, N.E., Werid, W.M., Weldemariam, M.G., Welay, F.T., Hidru, H.D., et al. 2019. Maternal and fetal outcomes of cesarean delivery and factors associated with its unfavorable management outcomes; In Ayder Specialized Comprehensive Hospital, Mekelle, Tigray, Ethiopia, 2017. *BMC Research Notes*. 12(1):1–6. DOI: 10.1186/S13104-019-4690-5/TABLES/1.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., Altman, D., Antes, G., Atkins, D., Barbour, V., et al. 2009. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLOS Medicine*. 6(7):e1000097. DOI: 10.1371/JOURNAL.PMED.1000097.

Molina, G., Weiser, T.G., Lipsitz, S.R., Esquivel, M.M., Uribe-Leitz, T., Azad, T., Shah, N., Semrau, K., et al. 2015. Relationship Between Cesarean Delivery Rate and Maternal and Neonatal Mortality Original Investigation. *JAMA*. 314(21):2263–2270. DOI: 10.1001/jama.2015.15553.

Moodley, J., Devjee, J., Khedun, S.M. & Esterhuizen, T. 2009. Second-stage primary Caesarean deliveries: Are maternal complications increased? *South African Family Practice*. 51(4):328–331. DOI: 10.1080/20786204.2009.10873873.

Moodley, J., Khedun, S.M. & Devjee, J. 2010. Breech presentation at a district level hospital in South Africa. *South African Family Practice*. 52(1):64–68. DOI: 10.1080/20786204.2010.10873938.

Moroz, L.A., Wright, J.D., Ananth, C. v. & Friedman, A.M. 2016. Hospital variation in maternal complications following caesarean delivery in the United States: 2006-2012. *BJOG : an international journal of obstetrics and gynaecology*. 123(7):1115–1120. DOI: 10.1111/1471-0528.13523.

Murphy, D.J., Liebling, R.E., Verity, L., Swingler, R. & Patel, R. 2001. Early maternal and neonatal morbidity associated with operative delivery in second stage of labour: a cohort study. *Lancet (London, England)*. 358(9289):1203–1207. DOI: 10.1016/S0140-6736(01)06341-3.

National Department of Health. 2013. *Saving Mothers: Caesarean Section Monograph*. J. Moodley, Ed. Durban: National Department of Health, South Africa. Available: http://www.kznhealth.gov.za/family/Caesarean-monograph-2013.pdf [2021, December 01].

National Department of Health (NDOH), Statistics South Africa (Stats SA), South African Medical Research Council (SAMRC) & ICF. 2019. *South Africa Demographic and Health Survey 2016*. Pretoria. Available: https://dhsprogram.com/pubs/pdf/FR337/FR337.pdf [2022, February 18].

Olsen, M.A., Butler, A.M., Willers, D.M., Devkota, P., Gross, G.A. & Fraser, V.J. 2008. Risk factors for surgical site infection after low transverse cesarean section. *Infection control and hospital epidemiology*. 29(6):477–484. DOI: 10.1086/587810.

Omona, K. 2021. Vaginal Delivery. *Empowering Midwives and Obstetric Nurses*. (March, 3). DOI: 10.5772/INTECHOPEN.96097.

Opøien, H.K., Valbø, A., Grinde-Andersen, A. & Walberg, M. 2007. Post-cesarean surgical site infections according to CDC standards: rates and risk factors. A prospective cohort study. *Acta Obstetricia et Gynecologica Scandinavica*. 86(9):1097–1102. DOI: 10.1080/00016340701515225.

Otkjær, A.M., Jørgensen, H.L., Clausen, T.D. & Krebs, L. 2019. Maternal short-term complications after planned cesarean delivery without medical indication: A registry-based study. *Acta Obstetricia et Gynecologica Scandinavica*. 98(7):905–912. DOI: 10.1111/AOGS.13549.

Pallasmaa, N., Ekblad, U., Aitokallio-Tallberg, A., Uotila, J., Raudaskoski, T., Ulander, V.M. & Hurme, S. 2010. Cesarean delivery in Finland: maternal complications and obstetric risk factors. *Acta obstetricia et gynecologica Scandinavica*. 89(7):896–902. DOI: 10.3109/00016349.2010.487893.

Panti, A., Karima, T., Nwobodo, E., Yakubu, A., Airede, L. & Egondu, S. 2012. Caesarean morbidity and mortality in a tertiary health institution in Sokoto, North-West Nigeria. *Orient Journal of Medicine*. 24(1–2):7–12. DOI: 10.4314/ojm.v24i1-2.

Prah, J., Kudom, A., Afrifa, A., Abdulai, M., Sirikyi, I. & Abu, E. 2017. Caesarean section in a primary health facility in Ghana: Clinical indications and feto-maternal outcomes. *Journal of Public Health in Africa*. 8(2):155–159. DOI: 10.4081/JPHIA.2017.704.

Raagab, A.E., Mesbah, Y.H., Brakat, R.I., Zayed, A.A. & Alsaammani, M.A. 2014. Re-laparotomy after cesarean section: risk, indications and management options. *Medicinski arhiv*. 68(1):41–43. DOI: 10.5455/MEDARH.2014.68.41-43.

Robertson, S. & White, S. 2021. Cesarean Section. *National Library of Medicine*. (December, 12):267–280. DOI: 10.1002/9781119646006.ch13.

Rubgega, F.D., Soma-Pillay, P. & Becker, P. 2021. Caesarean section indications and outcomes at a tertiary level hospital in South Africa. 31:8–11. DOI: 10.10520/EJC-MEDOG_V31_N3_A3.

Schimidt Evangelista, M., Slompo, K., Rufino, J. & Timi, R. 2018. Venous Thromboembolism and Route of Delivery-Review of the Literature Tromboembolismo venoso e via de parto-revisão da literatura. *Rev Bras Ginecol Obstet*. 40:156–162. DOI: 10.1055/s-0037-1621742.

Sewell, J.E. 1993. *Caesarean Section - A Brief History*. Washington: American College of Obstetricians and Gynaecologists. Available: http://www.neonatology.org/pdf/cesarean.pdf [2022, February 13].

Sharma, S. & Dhakal, I. 2018. Cesarean vs Vaginal Delivery : An Institutional Experience. *JNMA: Journal of the Nepal Medical Association*. 56(209):535. DOI: 10.31729/jnma.3467.

Shinar, S., Hareuveni, M., Ben-Tal, O. & Many, A. 2013. Relaparotomies after cesarean sections: risk factors, indications, and management. *Journal of perinatal medicine*. 41(5):567–572. DOI: 10.1515/JPM-2012-0280.

Solanki, G., Fawcus, S. & Daviaud, E. 2019. A cross sectional analytic study of modes of delivery and caesarean section rates in a private health insured South African population. *PLOS ONE*. 14(6):e0219020. DOI: 10.1371/JOURNAL.PONE.0219020.

Solanki, G.C., Cornell, J.E., Daviaud, E. & Fawcus, S. 2020. Caesarean section rates in South Africa: A case study of the health systems challenges for the proposed National Health Insurance. *SAMJ: South African Medical Journal*. 110(8):747–750. DOI: 10.7196/SAMJ.2020.V110I8.14699.

Souza, J.P., Gülmezoglu, A.M., Lumbiganon, P., Laopaiboon, M., Carroli, G., Fawole, B. & Ruyan, P. 2010. Caesarean section without medical indications is associated with an increased risk of adverse short-term maternal outcomes: The 2004-2008 WHO Global Survey on Maternal and Perinatal Health. *BMC Medicine*. 8. DOI: 10.1186/1741-7015-8-71.

Stivanello, E., Knight, M., Dallolio, L., Frammartino, B., Rizzo, N. & Fantini, M.P. 2010. Peripartum hysterectomy and cesarean delivery: A population-based study. *Acta Obstetricia et Gynecologica Scandinavica*. 89(3):321–327. DOI: 10.3109/00016340903508627.

Sun, G., Lin, Y., Lu, H., He, W., Li, R., Yang, L., Liu, X., Wang, H., et al. 2020. Trends in cesarean delivery rates in primipara and the associated factors. *BMC Pregnancy and Childbirth*. 20(1):1–9. DOI: 10.1186/S12884-020-03398-6/TABLES/2.

Todman, D. 2007. A history of caesarean section: From ancient world to the modern era. *Australian and New Zealand Journal of Obstetrics and Gynaecology*. 47(5):357–361.

Tricco, A.C., Lillie, E., Zarin, W., O'Brien, K.K., Colquhoun, H., Levac, D., Moher, D., Peters, M.D.J., et al. 2018. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*. 169(7):467–473. DOI: 10.7326/M18-0850.

Ugwu, E., Obioha, K., Okezie, O. & Ugwu, A. 2011. A Five-year Survey of Caesarean Delivery at a Nigerian Tertiary Hospital. *Annals of Medical and Health Sciences Research*. 1(1):77. DOI: 10.4103/tjog.tjog_59_17.

Uzuncakmak, C. & Ozcam, H. 2016. Association between Maternal Mortality and Cesarean Section: Turkey Experience. *PLOS ONE*. 11(11):e0166622. DOI: 10.1371/JOURNAL.PONE.0166622.

Villar, J., Carroli, G., Zavaleta, N., Donner, A., Wojdyla, D., Faundes, A., Velazco, A., Bataglia, V., et al. 2007. Maternal and neonatal individual risks and benefits associated with caesarean delivery: multicentre prospective study. *BMJ*. 335(7628):1025. DOI: 10.1136/BMJ.39363.706956.55.

Wae, M.B., Belayneh, F., Mekonnen, N. & Hailemicheal, F. 2017. Magnitude of maternal complications and associated obstetric factors among women who gave birth by cesarean section at Arba-Minich General Hospital, Southern Ethiopia: Retrospective cohort. *undefined*. 9(5):133–144. DOI: 10.5897/JPHE2016.0898.

WHO. 1985. APPROPRIATE TECHNOLOGY FOR BIRTH. *The Lancet*. 326(8452):436–437. DOI: 10.1016/S0140-6736(85)92750-3.

WHO. 2011. *Evaluating the quality of care for severe pregnancy complications The WHO near-miss approach for maternal health*. Available: www.who.int/reproductivehealthISBN9789241502221 [2022, April 07].

WHO. 2015. *WHO Statement on Caesarean Section Rates*. Geneva. Available: http://apps.who.int/iris/bitstream/handle/10665/161442/WHO_RHR_15.02_eng.pdf?sequence=1 [2021, November 17].

WHO. 2018. *WHO recommendations non-clinical interventions to reduce unnecessary caesarean sections*. Available: http://apps.who.int/iris/bitstream/handle/10665/275377/9789241550338-eng.pdf?ua=1 [2021, November 11].

Witteveen, T., Kallianidis, A., Zwart, J.J., Bloemenkamp, K.W., van Roosmalen, J. & van den Akker, T. 2018. Laparotomy in women with severe acute maternal morbidity: Secondary analysis of a nationwide cohort study. *BMC Pregnancy and Childbirth*. 18(1):1–7. DOI: 10.1186/S12884-018-1688-2/TABLES/3.

Zandvakili, F., Rezaie, M., Shahoei, R. & Roshani, D. 2017. Maternal Outcomes Associated with Caesarean versus Vaginal Delivery. *Journal of Clinical and Diagnostic Research : JCDR*. 11(7):QC01. DOI: 10.7860/JCDR/2017/24891.10239.

Zuarez-Easton, S., Zafran, N., Garmi, G. & Salim, R. 2017. Postcesarean wound infection: prevalence, impact, prevention, and management challenges. *International Journal of Women's Health*. 9:81. DOI: 10.2147/IJWH.S98876.

ANNEXURE

7.1. Ethics Approval Letter, UWC

UNIVERSITY of the WESTERN CAPE

60 YEARS of hope, action & knowledge

12 August 2022

Ms C Ezenwamma
School of Public Health
Faculty of Dentistry

Ethics Reference Number:	BM22/6/24
Project Title:	Severe maternal outcomes of Caesarean delivery in South Africa: a scoping review
Approval Period:	**29 July 2022 – 29 July 2025**

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above-mentioned research project and the requested amendment to the project.

Any further amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report annually by 30 November for the duration of the project.

For permission to conduct research using student and/or staff data or to distribute research surveys/questionnaires please apply via:
https://sites.google.com/uwc.ac.za/permissionresearch/home

The permission letter must then be submitted to BMREC for record keeping purposes.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

NHREC Registration Number: BMREC-130416-050

FROM HOPE TO ACTION THROUGH KNOWLEDGE.