Pre-natal risk factors for postpartum haemorrhage in a district in Zimbabwe: A case-control study

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KEY WORDS

Childbirth

Complication

Post-partum haemorrhage

Pregnant

Pre-natal

Risk factors

Vaginal delivery

Zimbabwe

ABSTRACT

Background: Post-partum haemorrhage (PPH), a common complication of childbirth, is a global public health concern which is responsible for the majority of global maternal deaths. Causes of PPH include uterine atony, over-distended uterus, multiple pregnancies, infection and hypertension. Risk factors to develop PPH include a previous history of PPH, maternal age and anaemia. The risk factors for PPH have been studied extensively and the majority of these studies have been conducted in high income countries. The risk factors for PPH have not been extensively studied in Zimbabwe. This study aimed to determine the pre-natal risk factors for PPH for women who underwent vaginal delivery at Beitbridge District Hospital from January 2018 to December 2019.

Methods: A case-control study design was used, where cases were women who developed PPH after vaginal delivery. The study sample was obtained from the population of women who underwent vaginal delivery at the district hospital from January 2018 to December 2019. The study sample consisted of a total of 63 participants, with 16 cases and 47 controls. Three control subjects were included per case. Data was collected from maternity ward delivery registers. The collected data was consolidated using MS Excel and exported into IBM SPSS STATISTICS software package version 28 for Windows (IBM Inc., Chicago IL, USA) for data analysis.

Results: Among a total of 5100 deliveries occurring between 2018 and 2019, the frequency of PPH was 1.5%. The strongest risk factors were a history of PPH (OR 10.615, 95% CI 1.017-110.799, p=0.019), anaemia (OR 10.615, 95% CI 1.017-110.799, p=0.019), and Multiple pregnancy (OR 4.357, 95% CI 2.751-6.901, p=0.014.

Conclusions: Women with a history of previous PPH or anaemia are at highest risk for developing PPH after delivery. Having a multiple pregnancy should be included as a risk factor in the development of appropriate preventative interventions.

DECLARATION:

I declare *that Pre-natal risk factors for postpartum haemorrhage in a district in Zimbabwe: A case-control study* is my work, has not been submitted for any degree or examination at any other university, and that all the sources I have used have been indicated in text and acknowledged in the references section.

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Date:

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I would like to dedicate this mini-thesis to my late mother, Tombizodwa Masawi, her light has guided me throughout this work.

Abbreviations and operational terms

Abbreviations:

MMR	Maternal mortality rate
PPH	Post-partum haemorrhage
SDG	Strategic Development Goal
SSA	Sub-Saharan Africa

Operational Terms:

Gestational hypertension:	High blood pressure in pregnancy in a woman who did not have hypertension prior getting pregnant
Placenta retention:	When the placenta is not delivered within 30 minutes of the baby's birth
Maternal mortality:	The death of a woman while pregnant or within 42 days of the termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental causes
Maternal mortality rate:	The number of maternal deaths per 100000 live births
Post-partum haemorrhage:	A loss of 500mls of blood or more within 24 hours of vaginal delivery and 1000mls or more after caesarean section delivery
Pre-natal:	Occurring or existing before a pregnant woman gives birth.
Risk factor:	Something that increases a person's chances of developing a disease or an outcome
Uterine atony:	A serious condition that can occur after childbirth when the uterus fails to contract after the delivery of the baby

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CHAPTER 1 INTRODUCTION

1.1 Background

According to the World Health Organisation (WHO, 2021c), 810 women died every day in 2017 from preventable pregnancy-related causes, and 94% of these deaths occurred in low-resource settings. WHO defines maternal death as *"...a 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 site of the pregnancy"* (WHO, 2021a, p1).

In 2015 the United Nations (UN) adopted 17 Sustainable Development Goals (SDGs) as a call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. SDG 3 is concerned with good health and well-being and one of the targets under this goal is to reduce the global maternal mortality rate (MMR) to less than 70 deaths per 100000 live births by 2030 (UNDP, 2016).

Globally the MMR declined from 342 deaths per 100000 live births in 2000 to 211 deaths per 100000 live births in 2017. In the last decade, the MMR for Southern Asia has declined from 278 to 163 deaths per 100000 live births, while for sub-Saharan Africa, the MMR declined from 685 to 533 deaths per 100000 births (UNICEF, 2021).

Maternal deaths occur due to complications which arise during and following pregnancy and childbirth (WHO, 2022c). The main causes of maternal deaths globally are severe bleeding, infections, high blood pressure during pregnancy, complications during delivery and unsafe abortions (WHO, 2022c). Obstetric haemorrhage accounts for 27% of global maternal deaths and 66% of obstetric haemorrhage is due to PPH (UNICEF, 2022).

Causes of maternal mortality may be direct or indirect. Direct causes are as a result of obstetric conditions and indirect causes result from pre-existing or newly developed diseases during pregnancy. Direct causes of maternal mortality include haemorrhage, hypertensive disorders and sepsis. There has been a reduction in eclampsia maternal mortality in developed countries over the past 50 years, however, this mortality remains high in developing countries (Ghulmiyyah & Sibai, 2012). Africa has the highest risk of maternal deaths from unsafe abortions and nearly 50% of all abortions occur in unsafe conditions (WHO, 2022a). Puerperal sepsis was revealed to be one of the leading causes of maternal death in Harare public health institutions accounting for 19% and 30% of maternal deaths for the years 2010 and 2014 respectively, from being the fourth nationwide cause at 12.3% in the year 2007 (Majangara, 2016). Infections such as HIV and Malaria are examples of indirect causes of maternal mortality and in 2008, 53% of maternal deaths in Zimbabwe were HIV related (WHO, 2022c).

Underlying causes of maternal mortality include poor water and sanitation and hygiene and inadequate basic health care, insufficient access to food and micronutrients, inadequate maternal health practices and care seeking, insufficient access to maternity services and lack of education. 20% of maternal deaths in LMICs can be attributed to maternal malnutrition (Salam et al., 2014).

Delays in seeking healthcare and opting for traditional methods may result in complications such as haemorrhage, or refusal to receive a blood transfusion after haemorrhaging due to religious beliefs. Women who do not have antenatal care, or a skilled birth attendant during delivery, or those who give birth at home are more likely to have pregnancy related complications or to die during delivery.

Zimbabwe has a high burden of maternal mortality and in 2007, the MMR in Zimbabwe was 617 deaths per 100000 live births, while in 2017 it was 458 deaths per 100000 live births

(WHO, 2017b). In 2020 Zimbabwe had one of the highest MMR worldwide which was 614 deaths per 100000 live births (UNFPA, 2021). The problem of maternal mortality appears to be increasing in Zimbabwe. Though the MMR for Zimbabwe decreased from 2000 to 2017, there was an increase in 2020 (UNFPA, 2021). The loss of skilled workers to other countries, and the poor supplies of life saving products such as oxytocin and blood products have contributed to the increase in maternal mortality in Zimbabwe (Musarandega et al., 2022). No woman should die in pregnancy, during or after childbirth, and all pregnant women must have access to healthcare services in order to prevent any pregnancy or childbirth complications that may arise.

Zimbabwe follows an eight-visit model recommended by WHO for pregnant women in low-income regions (WHO, 2018). This model requires that every pregnant woman attends at least eight pre-natal visits to a healthcare facility for pre-natal checks. In 2007 Zimbabwe developed a National Maternal and Neonatal Roadmap as a framework to improve maternal and new-born health services (WHO, 2007). Despite having this framework in place, pregnancy-related complications continue to occur, and a study by Makate and Makate, (2017) concluded that public health policy makers in Zimbabwe needed to focus on ensuring high quality pre-natal care. In 2013 an investigation into the major causes of maternal mortality in Zimbabwe revealed PPH as the predominant cause (Mlambo et al., 2013). The most common cause of PPH is uterine atony resulting from poor contraction of the uterus following childbirth (Ngwenya, 2016). Other causes include incomplete removal of placental remains, uterine tears and poor clotting (Bienstock et al., 2021).

In 2012 the MMR for Beitbridge District was 456 deaths per 100000 live births (ZIMSTAT, 2012). Pregnant women in Beitbridge follow the recommended eight-visit model and undergo pre-natal screening at every visit.

Problem statement

Despite being a preventable and treatable condition, PPH was identified as the number one cause of maternal deaths globally in a global review of obstetric haemorrhage (Goffman et al., 2016). A systematic review concluded that women in low-income countries and lower-middle income countries have an increased chance of developing severe PPH (Maswime & Buchmann, 2017).

Zimbabwe follows the WHO recommended eight-visit model for pregnant women, and during these visits, pregnant women are screened for risk factors for pregnancy-related diseases. At the district level these screening activities are conducted by nurses and midwives at health facilities. Despite these activities, women continue to develop this complication after childbirth and in order to address this problem more information is required.

There have been some studies conducted in Zimbabwe on the risks associated with developing PPH (Tsu, 1993; Zvandasara et al., 2015; Ngwenya, 2020), however, there have been a dearth of literature on this topic conducted at district level. This study will assist in closing the gap in literature on risk factors associated with PPH in Beitbridge district and in Zimbabwe. This research is necessary because PPH is an outcome of childbirth in Zimbabwe. The results from this study will provide information that will allow recommendations and policies to be made for sexual and reproductive health services.

1.3 Study Aim and Objectives

The aim of the study was to determine the pre-natal risk factors for developing PPH for women who underwent vaginal delivery at Beitbridge District Hospital between January 2018 and December 2019.

The specific objectives of the study were:

- To describe the demographic characteristics of women who underwent vaginal delivery at Beitbridge District Hospital between January 2018 and December 2019.
- To determine the pre-natal risk factors for developing PPH among women who underwent vaginal delivery at Beitbridge District Hospital between January 2018 and December 2019.
- To determine the association between pre-natal risk factors and developing PPH among women who underwent vaginal delivery at Beitbridge District Hospital between January 2018 and December 2019.

1.4 Outline of the thesis

This thesis is structured in six chapters beginning with an introduction to the study in chapter 1 above.

Chapter 1 provides an overview of the global trends in maternal mortality and narrows down to maternal mortality in Zimbabwe and the predominant cause of maternal mortality which is PPH. The activities which are conducted in Zimbabwe in order to mitigate this outcome are outlined in this chapter as well as the aim and objectives of the study.

Chapter 2 looks at the literature, from both the global north and south, that has been published (some unpublished) on PPH focusing on the causes and risk factors for developing PPH and the interventions that are in place in order to prevent pregnant women from developing this outcome.

Chapter 3 gives an outline of the study methodologies including the study design, study population and sampling, data collection processes, data management and data analysis, as well

as the validity and reliability of the study observations. The chapter is concluded by the ethical considerations for the study.

The results of the study are outlined in chapter 4 with particular focus on a comparison of the odds of developing PPH after delivery between the case participants and the control participants in the study.

A discussion based on these results in chapter 5 is followed by conclusions and recommendations in chapter 6.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This literature review will look at the global, regional and country specific trends in the prevalence and incidence of maternal mortality and PPH; the causes and risk factors associated with developing PPH and the interventions that have been put in place to prevent pregnant women from developing PPH.

Approximately 1% to 6% of all deliveries are complicated by PPH and it is the leading cause of morbidity and mortality in childbirth (Wormer et al., 2021). PPH is a loss of 500mls or more of blood within 24 hours of childbirth following a vaginal delivery or 1000mls following a caesarean section (WHO, 2017c). Primary PPH occurs within 24 hours of delivery while secondary PPH occurs from 24 hours to 12 weeks after delivery (Wormer et al., 2021). According to the Royal College of Obstetricians and Gynaecologists (RCOG), PPH can be minor (500mls-1000mls) or major (more than 1000mls) (RCOG, 2021b). The American College of Obstetricians and Gynaecologists (ACOG) defines PPH as a loss of 1000mls of blood or more accompanied by signs of hypovolaemia within 24 hours of delivery (ACOG, 2021).

2.2 Prevalence of PPH

Approximately 14 million women develop PPH globally each year and this risk is higher in developing countries (WHO, 2017a). Between 2003 and 2009, 41% of the PPH-related maternal deaths occurred in sub-Saharan Africa (Say et al., 2014a). An estimated 295000 maternal deaths occurred globally in 2017 (WHO, 2021c), and the majority of these deaths were in sub-Saharan Africa (SSA) and Southern Asia. About 99% of maternal deaths occur in developing countries where there are more pregnancies compared to developed countries (WHO, 2021b).

Goffman, Nathan and Chazotte (2016) conducted a review of obstetric haemorrhage which revealed Africa as having the highest prevalence of PPH, which was 25%, while the lowest was 7.2% in countries of Oceania. The prevalence of PPH increased globally from 6.5% in 2000 to 11% in 2016 (Mvandal & Coletha, 2021). In a systematic analysis of the causes of maternal deaths (Say et al., 2014b) identified PPH as the leading cause of maternal deaths globally, and 83% of maternal deaths due to PPH occurred in SSA and Southern Asia. PPH-associated maternal deaths are three times more common in Africa than in other regions of the world (Borovac-Pinheiro et al., 2021).

2.2.1 PPH in HIC

Some studies have shown an increase in the incidence of PPH in developed countries. van Stralen *et al.* (2016) conducted a retrospective study on the incidence of PPH in the Netherlands from 2000 to 2013, and data collected showed an increase in the incidence of PPH during the study period. The incidence of PPH rose from 4.1% in 2000 to 6.4% in 2013 and the researchers concluded that a change in the management of reporting of PPH could be responsible for their findings. Fukami et al., (2019) conducted a prospective cohort study in Japan from June 2013 to July 2016 using a questionnaire administered to women recruited at 22 weeks gestation or greater. In this study, PPH was defined as a blood loss of 1000mls or more and the results revealed an incidence of PPH of 8.7%.

Vendittelli *et al.* (2016) conducted a prospective observation study in French maternity wards from 1 February 2011 to 31 July 2011 using data collected from 182 maternity units. Data of women who gave birth at 22 weeks or more were included in this study and the incidence of PPH after vaginal delivery was 3.36%. Nyfløt et al., (2017) conducted a case control study in Norway using data collected from a cohort of women who delivered at one of three hospitals

between 2008 and 2011. Out of a total of 45105 deliveries, 1064 cases and 2059 random controls were identified with the results revealing a frequency of PPH of 2.5%.

In a systematic analysis conducted in Australia, Flood et al., (2018) collected perinatal data from 2006 to 2014 from all Australian states and territories and the results revealed a range of PPH prevalence of 3.3% to 26.5%. This study also found that the states and territories used different definitions for PPH as well as different data collection and reporting approaches. It is noteworthy that what may be considered as PPH in one state or territory may not be considered so in another which may make it difficult to come up with national statistics. If possible, the measures, data collection and reporting methods should be standardised in all states and territories to ensure uniformity and accuracy of all data. Flood et al., (2019) conducted a cross-sectional study using perinatal data from the state of Victoria, Australia from January 2003 to December 2013 which revealed an increase in the incidence of PPH from 9%in 2003 to 13.5% in 2013.

Agten et al., (2017) conducted a retrospective cohort study to investigate changes in the incidence of PPH in Switzerland from 1993 to 2014 using data from the national Swiss Hospital database and the study revealed an increase in the incidence of PPH from 2.5% in 1993 to 4.5% in 2014 from a total of 739444 deliveries over the 22 year period. In Sweden, Ladfors et al., (2021) conducted a study to assess the trends in PPH between 1 January 2000 and 31 December 2016 using a cohort of 1 590 178 deliveries which revealed an increase in PPH incidence from 5.4% to 7.3% in 2016. This increase could not be attributed to changes in maternal, obstetric practice or risk factors and the researchers suggested the further study was needed to establish whether the increase could be attributed to other factors such as duration of labour, oxytocin augmentation or changes in the quantification of blood loss.

Emeka Madu, (2016) conducted a study at a hospital in the UK, to investigate the incidence of PPH between 2007 and 2008 using data collected from the birth registers which revealed that from a total of 4132 deliveries, 390 women developed PPH. Jardine et al., (2021) conducted a study in the UK between 1 April 2015 and 31 March 2017 using data collected from a national database and the results revealed that from the 981801 births recorded during that period, 28268 births were complicated by PPH. In a global review of obstetric haemorrhage, Goffman et al., (2016) highlighted PPH as the cause of 12% of maternal deaths in the USA. This review showed an increase in the incidence of PPH of approximately 8.9% per year from 1994 to 2006.

2.2.2 PPH in LMIC

In developing countries, post-partum haemorrhage accounts for 20% of maternal deaths while in developed countries, it accounts for 8% of maternal deaths (Bienstock et al., 2021). Nathan (2019) wrote an overview of obstetric haemorrhage in which Africa was shown to have the highest prevalence of PPH. Ntuli *et al.* (2017) conducted a retrospective descriptive study in South Africa by reviewing maternal mortality data from a hospital in Limpopo from 2011 to 2015, and the results revealed PPH to be one of the main causes of death.

Ononge *et al.* (2016) conducted a prospective cohort study in Uganda from March 2013 to March 2014 using data collected from a study population of 1188 pregnant women who were 28 weeks pregnant or more, and the incidence of PPH in the study was 10.2% which was within the same range as that reported by (Calvert et al., 2012).

In a case-control study conducted in Cameroon between 1 January 2009 and 31 December 2018, (Nana et al., 2021) collected data from birth registers and hospital records which comprised of 152 cases and 456 controls from a total of 12240 deliveries. The prevalence of PPH for this period was 1.33% which was lower than what has been reported by other authors

in Africa (Ntuli et al., 2017, Ononge et al., 2016).

Sotunsa et al., (2019) conducted a cross-sectional study in Nigeria between 1 June 2012 and 14 August 2013 suing data collected from 42 tertiary hospitals with a total of 94835 deliveries for this period. 2087 women were diagnosed with PPH with a prevalence of PPH of 2.2% for the study period. In another study conducted in Nigeria, Ifeadike et al., (2018b) collected data from labour and delivery records from 1 January 2006 to 31 December 2015, and from a total of 10502 deliveries, 119 women were diagnosed with PPH with a prevalence of 1.13%. In contrast to the low incidences in these studies, a 10 year review of PPH was conducted at a teaching hospital in Nigeria using data collected from 1 January 2001 and 31 December 2010 which identified 272 cases of PPH from a total of 5929 deliveries with an incidence of 25.6% (Lamina et al., 2015).

A number of studies have been conducted in Ethiopia which have revealed a high prevalence of PPH in that country and it has been identified as one of the leading causes of maternal morbidity and mortality (Nigussie et al., 2021). In a cross-sectional study conducted by Kebede et al., (2019) the prevalence of PPH was found to be 16.6% and similarly Dagne & Zewude, (2021) and Mesfin et al., (2021) revealed a prevalence of 13.6% and 12.9% respectively. In a cross-sectional study conducted in Ethiopia using data collected from a national database between December 2018 and May 2019, the results revealed an incidence of PPH of 9% (Tiruneh et al., 2020). The magnitude of PPH in Ethiopia was highlighted in a systematic review and meta-analysis which included all articles up to 10 October 2021 in which the pooled magnitude of PPH was revealed to be 8.18% (Nigussie et al., 2021).

Legesse et al., (2017) conducted a case-control study in Ethiopia using data collected from January 2010 to December 2014 using 120 cases and 480 controls and in this study, PPH was

revealed to have been the cause of 56% of the maternal deaths. Similarly, PPH was found to be the cause of 46% of the maternal deaths in an analysis conducted using data collected from a national database between 2008 and 2014 (Tesfaye et al., 2018).

Kodan et al., (2020) conducted a retrospective descriptive study of all hospital deliveries in Suriname between 1 January and 31 December 2017 and the collected data revealed a prevalence of PPH of 9.2% from a total of 8747 deliveries in that period. Firmin et al., (2019) conducted a case-control study in French Guiana from September 2014 to September 2015 with a study sample of 154 cases and 308 controls selected from a total of 2496 deliveries, and the results revealed and incidence of PPH of 6.7%. In Thailand, Thepampan et al., (2021) conducted a case-control study using data collected from a hospital from 2014 to 2018 and from a total of 4774 births, 265 cases of PPH were identified with an incidence of 5.5%.

In Zimbabwe, a retrospective cohort study using 4567 deliveries at one institution from January to June 2016 using case notes identified 74 cases of PPH and the results revealed an incidence of 1.6% (Ngwenya, 2016). In a Multiple Indicator Cluster Survey (MICS) conducted in Zimbabwe in 2019, it was reported that 462 women died per 100000 births with PPH accounting for 26% of these deaths (CHAI, 2020). In a study conducted in Zimbabwe from 1 January to 31 December 2014 to identify common obstetric complications requiring blood transfusion at a tertiary hospital, the majority of the women who received blood transfusion were those diagnosed with PPH (Scheuer et al., 2015).

Compared to HIC, LMIC have a higher burden of PPH. Studies conducted in HIC have revealed a lower prevalence of PPH in Switzerland (4.5%), Netherlands (6.4%) and Norway (2.5%), while in countries LMIC such as Nigeria (25.6%), Ethiopia (13.6&) and Uganda

(10.2%) the prevalence is much higher. Although some studies have revealed an increase in the prevalence of PPH in some HIC like USA, Sweden and Australia, the prevalence of PPH is still much higher in LMIC than it is in those countries.

2.3 Causes of PPH

PPH results from excessive bleeding after childbirth and this bleeding may have many causes including uterine atony, over-distended uterus, multiple pregnancies, infection, gestational hypertension, and instrument assisted delivery (CHOP, 2021b). The most common causes of PPH are known as "The Four Ts". These are tone (uterine atony), tissues (retained placenta, invasive placenta), trauma (to any part of the genital tract) and thrombin (coagulopathy) (Evensen et al., 2017).

2.3.1 Tone (uterine atony)

Uterine atony is defined as failure of the uterus to contract adequately in response to endogenous oxytocin which releases during delivery (Khan et al., 2021). After delivery, if the uterus does not contract sufficiently to result in stopping of bleeding at the placenta site, PPH will occur (Sebghati & Chandraharan, 2017). Contraction of the uterus after the placenta has been delivered helps to compress the bleeding vessels at the site where the placenta was attached and failure of the uterus to contract will result in free bleeding and haemorrhage from these blood vessels (CHOP, 2021b).

According to Bienstock et al., (2021), uterine atony accounts for approximately 70% of the cases of PPH and these cases are often preceded by conditions such as chorioamnionitis, the use of magnesium sulphate, prolonged labour, uterine fibroids, foetal macrosomia, over distended uterus or polyhydramnios. Firmin *et al.* (2019) conducted a case-control study in

Guiana from September 2014 to September 2015 in which uterine atony was cited as the primary cause of PPH. Nana *et al.* (2021) found one of the main causes of PPH to be uterine atony in a descriptive and case-control study conducted in Cameroon from January 2009 to December 2018.

2.3.2 Tissues (retained placenta, invasive placenta)

Placental retention occurs when there is failure to deliver the placenta within 30 minutes of delivering the baby (Evensen et al., 2017), and this complication occurs in 1%-3% of deliveries (Perlman & Carusi, 2019). Placental retention commonly occurs in the setting of uterine atony, abnormally attached placenta or closure of the cervix before delivery of the placenta (Perlman & Carusi, 2019).

Placental retention was identified as the leading cause of PPH by Ifeadike et al., (2018a) in a retrospective cohort study conducted in Nigeria from January 2016 to December 2015. Firmin *et al.* (2019) and Nana et al., (2021) also cited placental retention as a cause for PPH in their studies. Favilli et al., (2021) conducted a systematic review which revealed the prevalence of placental retention to be between 0.5% and 4.8%, and the researchers also highlighted that placental retention was most likely under-reported. Similarly, Greenbaum et al., (2017) conducted a retrospective cohort study in Israel using data collected from a hospital database between 1989 and 2014 and the results revealed that 4.8% of the 205522 deliveries for that time period were complicated with placental retention.

2.3.3 Trauma

PPH due to trauma can occur due to episiotomy extension, perineal tears and vaginal lacerations (Podder & Seshadri, 2020). Trauma to any part of the genital tract may lead to loss

of a large volume of blood and result in haemorrhage (Sebghati & Chandraharan, 2017). Bienstock, Eke and Hueppchen (2021) identified trauma from lacerations and uterine rupture as a cause of PPH and in the study by Ifeadike et al., (2018a) genital trauma was identified as the commonest cause of PPH.

2.3.4 Thrombin

Coagulopathies are disorders in blood clotting which can lead to PPH alone or in combination with other factors (Sebghati & Chandraharan, 2017). Most coagulopathies are identified before delivery although pregnant women can develop HELLP (haemolysis, elevated liver enzyme levels and low platelets) syndrome or disseminated intravascular coagulation (Evensen et al., 2017).

2.4 Antenatal risk factors for developing PPH

The antenatal risk factors for developing PPH include a previous history of PPH, maternal age, anaemia, ethnicity, parity, multiple pregnancy, previous abortion and hypertension.

2.4.1 Previous history of PPH

Once a pregnant woman develops PPH, she is at risk of developing PPH in the next pregnancy because PPH has a negative effect on muscular contraction (Habitamu et al., 2019). Women with a previous history of PPH were found to be more likely to develop PPH in the current pregnancy in a study conducted in Australia (Ford et al., 2015). Oberg et al., (2014) conducted a study in Sweden using data collected from the medical birth register between 1997 and 2009 and results revealed that women with a previous history of PPH were three times more likely to develop PPH in their next pregnancy compared to women without a previous history of PPH.

In a case-control study conducted in Norway from 2008 to 2011, the results revealed a nine fold increase in the risk of developing PPH in women with a previous history of PPH (Nyfløt et al., 2017). Similarly, Firmin et al., (2019) revealed an increased risk of developing PPH in women with a previous history of PPH in a study conducted in French Guiana.

2.4.2 Maternal age

Advanced maternal age was found to increase the risk of developing PPH in a study conducted at a hospital in Poland using data collected from 1 January to 30 June 2018 (Radoń-Pokracka et al., 2019). Increasing maternal age was found to be associated with PPH in a study conducted at a maternity unit in the UK using data from 51225 deliveries collected between 2004 and 2012 (Oakley et al., 2016). Varghese *et al.* (2021) identified age as a risk factor for PPH in a case-control study conducted in Bahrain from January 2015 to December 2016, this was also revealed by Liu et al., (2021) in a retrospective cohort study conducted in China from January 2015 to August 2019. Lancaster *et al.* (2020) also revealed age as a risk factor in a retrospective cross-section study conducted in Mozambique between January and June 2018.

2.4.3 Multiple pregnancy

A multiple pregnancy is a pregnancy with more than one baby at the same time (RCOG, 2021a). Having a multiple pregnancy results in a large placental area and an over-distended uterus which in turn increases the risk of bleeding after delivery and developing PPH (CHOP, 2021a). Ononge et al., (2016b) conducted a prospective cohort study in Uganda between March 2013 and March 2014 and in this study, having a multiple pregnancy was identified as a risk factor for developing PPH. Nyfløt et al., (2017) conducted a case-control study in Norway using data collected from a hospital between 1 January 2008 and 31 December 2011 and from this study

it was revealed that the presence of a twin or triplet pregnancy was associated with a higher risk of developing PPH.

2.4.4 Ethnicity

Ethnicity was identified as a risk factor by Kodan et al., (2020) in a retrospective descriptive study conducted in Suriname from January to December 2017, as well as in a case-control study by Thepampan et al., (2021) conducted in Thailand from 2014 to 2018. In a study conducted in England using data collected from 981801 birth records between 1 April 2015 and 31 March 2017, 2.9% of the births were complicated by PPH and the risk of PPH was found to be higher in women from black and other ethnic backgrounds (Jardine, Gurol-Urganci, et al., 2021).

2.4.5 Anaemia

According to Young, (2018), anaemia can result in circulatory decompensation and an increases risk of haemorrhage leading to circulatory shock and death. Kodan *et al.* (2020) conducted a study in Suriname in which anaemia was identified as a risk factor for developing PPH and this was also identified by Nyfløt et al., (2017). Having anaemia in the third trimester of pregnancy was revealed to increase the risk of developing PPH in a prospective cohort study conducted in India (Nair et al., 2021). The outcome of PPH was found to be more frequent in women with anaemia in a study conducted in Ghana (Owiredu et al., 2016).

2.4.6 Parity

Parity refers to the number of times that a woman has given birth to a foetus of 24 weeks gestational age or more (Tidy, 2019). According to Dewi et al., (2018), women with high parity have a higher risk of developing PPH. This is consistent with a study conducted by Marshall et al., (2017) in which it was revealed that high parity was associated with an increased risk of developing PPH.

2.4.7 Hypertension

If a pregnant woman has a systolic blood pressure measurement of 140 mmHg or more, or a diastolic blood pressure measurement of 90 mmHg or more on two separate occasions, she is diagnosed with hypertension in pregnancy (Cífková et al., 2020). Women with hypertension in pregnancy were found to have higher rates of PPH compared to women without hypertension in a study conducted in the Gaza Strip between August 2016 and May 2017 (Jamil El-Qatrawi & Health, 2021). In a meta-analysis to determine antenatal risk factors for PPH conducted using literature from nine databases of studies published between 2000 and 2012, maternal hypertension was identified as a risk factor for developing PPH (Durmaz & Komurcu, 2018).

2.5 Prevention of PPH

Global efforts to reduce maternal mortality have seen a decline in maternal deaths over the past decade (UNICEF, 2021). The burden of PPH is apparent both in developed and in developing countries, and in order to prevent this outcome, health care workers (HCWs) must possess adequate skills and knowledge (Bazirete et al., 2021). WHO has various recommendations and guidelines which assist HCWs prevent and manage PPH (WHO, 2021d).

PPH can be prevented if HCWs are well trained and able to identify the risks of PPH, and are able to implement strategies for detection of these risk factors (Bazirete et al., 2021). Strategies to prevent PPH must be put in place in the antenatal period and these should include an assessment of every pregnant woman in order to screen them for any risk factors. It is recommended that every maternity unit have a haemorrhage cart which contains the required medications such as uterotonic drugs which are used to increase the tone of contractions in the uterus and in turn, reduce bleeding (Evensen et al., 2017). A well trained response team should always be prepared for emergencies and every unit should receive regular education as well as conduct unit drills (Evensen et al., 2017).

Active management of the third stage of labour (AMTSL) is the most effective strategy to prevent PPH and this includes administering uterotonics, controlled cord traction and uterine massage (Shadap, 2018).

2.6 Summary

The available literature from studies conducted globally reveals a higher prevalence of PPH in LMIC than in HIC. The most common causes of PPH have been identified as uterine atony which accounts for most of the cases of PPH, trauma, placental retention and coagulation disorders. Some of the risk factors for a pregnant woman to develop PPH after delivery include a previous history of PPH, maternal age, anaemia, multiple pregnancy, a previous abortion and hypertension. The World Health Organization has introduced recommendations and guidelines to assist in the prevention and management of PPH and the most effective strategy to prevent the development of PPH has been cited to be the active management of the third stage of labour.

CHAPTER 3: METHODOLOGY

3.1 Study Setting

The study setting was Beitbridge District Hospital within Beitbridge District, Matebeleland South Province, Zimbabwe. The district is situated at the border between Zimbabwe and South Africa and has a transient population of migrants travelling across the border. Beitbridge District Hospital has a bed capacity of 140 and serves as the referral hospital for the rural and urban clinics and health facilities within the district.

3.2 Study Design

For this study, a case-control study design was used to determine if an exposure was associated with an outcome, the study was conducted retrospectively since the outcome had already occurred, and the researcher traced back to investigate the exposure (Lewallen & Courtright, 1998). The design of a case-control study was used because PPH is a rare outcome and a case-control study design is an appropriate study design to study rare outcomes (Harvey, 2019). Rare outcomes are usually fewer in number, which is suitable for a case-control study since it is a study design which requires a small sample size. Case-control studies make it possible to look at multiple risk factors at once (Tenney Steven, Kerndt Connor, 2020) and it is efficient for this study because it takes less time to conduct and it is cost effective (Dey et al., 2020).

3.3 Study Population

The study population consisted of women who delivered at Beitbridge District Hospital between the period 1 January 2018 and 31 December 2019.

Cases were defined as women who delivered at the hospital and developed PPH 24 hours after childbirth, having been booked for delivery and undergone pre-natal screening at the hospital.

Controls were defined as women who delivered at the hospital and did not develop PPH after childbirth, having been booked for delivery and undergone pre-natal screening at the hospital.

The inclusion criteria were:

- Pregnant women who were booked at the hospital for delivery, underwent pre-natal screening, delivered at the facility and did not develop PPH
- Pregnant women who were booked at the hospital for delivery, underwent prenatal screening, delivered at the facility and developed PPH

The exclusion criteria were:

- Pregnant women who were booked and underwent pre-natal screening at other facilities and were referred for delivery at the district hospital
- Pregnant women who delivered at other facilities and were referred to the district hospital after developing PPH
- Pregnant women who received augmented labour management with oxytocin
- Pregnant women who underwent caesarean section, forceps or vacuum delivery
- Pregnant women who delivered at the hospital and were not booked for delivery at the hospital or any other health facility and did not undergo pre-natal screening

The cases and controls were selected from the hospital maternity delivery registers.

3.4 Study sample

The sampling method that was used for selecting cases for this study was convenience sampling which involved including all the cases that were found in the study population until the required number of cases for the sample was reached. The controls were selected using systematic probability sampling. The starting point was randomly chosen from the first ten controls in the population after which every third control was selected until the number of controls required

for the study was attained.

The required sample size was determined by CDC *Epi-Info* statistical calculator version 7.2.5 using an Odds Ratio (OR) of 0.03, a prevalence of PPH of 2%, a ratio of one case to three controls, confidence level of 95% and a statistical power of 80%. After inputting these parameters into the statistical calculator the sample size was determined to be a total of 63 participants, with 16 cases and 47 controls. In this study an estimate of the prevalence of PPH of 2% was selected since the known prevalence of PPH is 0.3%- 5.1% and varies according to geographic location (Lill Trine Nyfløt et al., 2017; Kramer et al., 2013; Al-Zirqi et al., 2008).

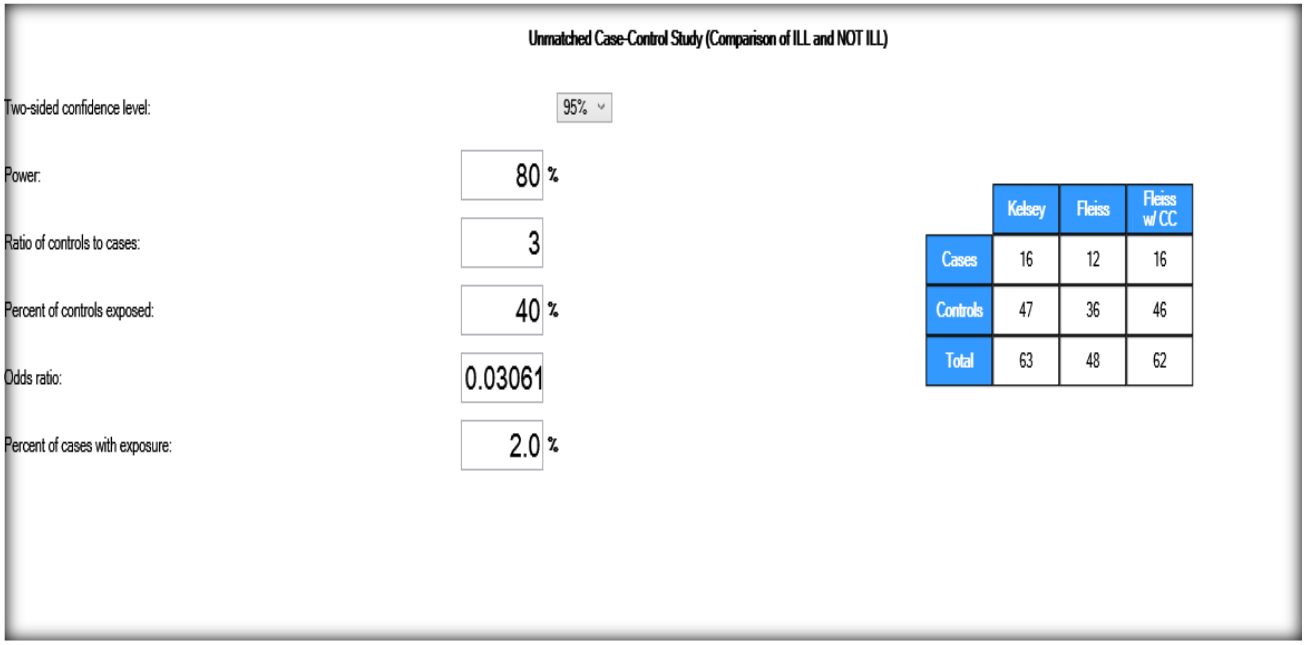


Figure 1: Output from Epi-Info sample size calculation

The sampling frame for this study was the hospital patient registers which provided a list of the data elements of the population of pregnant women who delivered at the hospital. The district hospital had approximately 7000 deliveries between 1 January 2018 and 31 December 2019.

3.5 Data collection

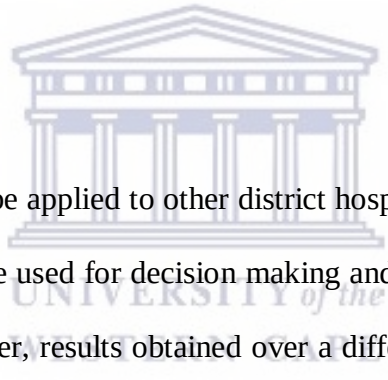
Data extrapolation from the hospital maternity delivery registers was conducted by two research assistants who are trained midwives working at the hospital. The researcher trained the assistants on how to use the form to extract data from the maternity registers. During data collection, Covid 19 protocols were adhered to and the data collectors were supplied with hand sanitizers, face shields and N95 face masks. The researcher used a self-developed data extrapolation form (Appendix 5). The form consisted of three sections for demographic variable data, risk factor variable data and outcome variable data with a total of 12 variables. The researcher captured the data from the extrapolation forms in MS Excel 2013 and checked for errors and missing data. The completeness of the data for all variables was 100%. All the data was collected from registers stored at central data centre. However, there is need to adopt electronic data entry processes as the registers are vulnerable to the elements, may be misplaced and the data entered by hand may fade with time.

3.6 Data Analysis

The MS Excel data sheet was exported into IBM SPSS STATISTICS software package version 28 for Windows (IBM Inc., Chicago IL, USA) for data analysis. The descriptive analysis for each variable was summarized into proportions looking at the characteristics of distribution, central tendency and dispersion. The epidemiological analysis involved calculating the Odds Ratio (OR) which was used to determine if the odds of developing PPH were the same in those exposed to the risk factor and those who were not exposed. The Chi-square analysis was used to determine the degree of association between risk factors and developing PPH. Logistic regression analysis was used to identify risk factors associated with development of PPH.

3.7 Validity

Case control study designs are prone to bias and in order to ensure validity and reliability of this study there is a need to eliminate or minimise bias which can occur at any phase of research (Pannucci & Wilkins, 2010). In order to eliminate measurement bias in this study, data from cases and controls was collected in the same manner. Selection bias was minimized in this study by selecting cases and controls from the same population. Information bias resulting from misclassification of exposure and outcome data was minimized since the midwives who recorded the data were not aware of this research. Pre-testing the data extrapolation form was done using a small fraction of the data in order to test the feasibility of the form and identify any errors that needed correcting and reduce measurement bias. Selecting the best study design, research methodology and data analysis for this study ensured scientific validity.



3.8 Generalizability

The results from this study can be applied to other district hospitals in Zimbabwe which have similar characteristics and can be used for decision making and targeted interventions on pre-natal screening services. However, results obtained over a different time period from the one used in the study may differ and not be generalizable.

3.9 Ethical considerations

Ethical clearance was obtained from the Biomedical Research Ethics Committee BMREC of the University of Western Cape in South Africa. In Zimbabwe, ethical clearance was obtained from the Medical Research Council of Zimbabwe. Letters of permission were sent to the Director of the National Institute of Health Research in the Ministry of Health and Child Care, Zimbabwe and the District Medical Officer for Beitbridge District Hospital. Data collection was only conducted once all clearances and permissions had been obtained. Since the study made use of secondary data informed consent was not sought from the study participants, no

names or identifying data were used, and each participant was assigned a number. Extrapolated data files were password-protected and stored on a secure password-protected laptop and will be destroyed after five years.

CHAPTER 4: RESULTS

4.1 Introduction

In this chapter the results of the study will be reported. It will include sections outlining the realization of the sample and the description of the baseline socio-demographic characteristics and the baseline risk factor characteristics of the women in the study. It will also include the bivariate analysis of PPH and the risk factors. The final section will include a description of the multiple variable logistic regression for PPH.

4.2 Baseline socio-demographic characteristics

The demographic characteristics analysed were age, marital status, education level and employment status. They are presented in table 4.1 below. Although there were no meaningful differences in demographic characteristics between cases and controls, education levels were higher in controls compared to cases.

Table 4.1: Demographic characteristics of cases and controls

Characteristics	**Cases (%) n=16**	**Controls (%) n=47**	**p-value**
Age group			
<18 18-25 26-39 >39	2 (12.5) 6 (38.0) 8 (50.0) 0 (0)	5 (10.6) 15 (32.0) 25 (53.2) 2 (4.2)	
Marital status			
Single Married	6 (37.5) 10 (62.5)	16 (34.0) 31 (66.0)	.802
Employment status			
Employed Not employed	5 (31.3) 11 (68.7)	15 (32.0) 32 (68.0)	.961
Education level			

Primary	1 (6.3)	2 (4.2)	
Secondary	11 (68.7)	16 (34.0)	
High School	3 (18.7)	14 (29.8)	
College	1 (6.3)	12 (25.6)	
University	0	3 (6.4)	

4.2.1 Age

The average age of the study participants was 26 years with a range of 26 ranging from a minimum of 14 years to a maximum of 40 years. The mode for the study participants was 27 years which consisted of 11% of the study participants. The age range for cases was 16 years to 39 years, while for controls the range was 14 years to 40 years.

4.2.2 Marital status

The categories for marital status were married and single. Of the 63 women in the study group 41 were married (65%), while 22 were single (35%). There was a similar proportion of married and single women amongst cases and controls. For the cases, 37.5% were single and 62.5% were married, while for the controls, 34% were single and 66% were married.

4.2.3 Employment

There was a small difference in the employment status of cases and controls. For the cases, 31.3% were employed and 68.7% were not employed, while for the controls, 32% were employed while 68% were not employed. No statistical significance was found between the cases and controls ($p>0.05$). Both cases and controls had more unemployed participants than employed participants.

4.2.4 Education

The study sample did not have any participants who had not received any education. For the cases, the highest number of participants had secondary level education (68.7%), followed by high school level (18.7%), while both primary and college levels had 6.3%. None of the cases

in the study sample had university level education. For the controls, the highest number of participants had secondary level education, followed by high school level (29.8%), college level (25.6%), university level (6.4%) and primary level (4.2%). There were more controls than cases for all of the categories for education level, however, these differences were not of any statistical significance.

4.3 Risk factor characteristics

An analysis of the risk factor characteristics parity, multiple pregnancy, previous abortion, anaemia, pregnancy induced hypertension, pre-existing hypertension and previous history of PPH was conducted. The risk factor characteristics for the cases and controls in the study sample are presented in Table 4.2 below.

Table 4.2: Risk factor characteristics of cases and controls

		Cases (%) N=16	Controls (%) N=47	Bivariate Crude OR [CI 95%]	p-value
Parity	Primigravid Multigravid	5 (31.3) 11 (68.7)	12 (25.5) 35 (74.5)	1.33 [0.38-4.60]	.656
Multiple pregnancy	Present Absent	2 (12.5) 14 (87.5)	0 (0.0) 47 (100.0)	4.36 [2.75-6.90]	.014
Previous abortion	Present Absent	2 (12.5) 14 (87.5)	4 (8.5) 43 (91.5)	1.54 [0.25-9.30]	.639
Anaemia	Present Absent	3 (18.8) 13 (81.2)	1 (2.1) 46 (97.9)	10.62 [1.02-110.80]	.019
Pregnancy induced hypertension	Present Absent	2 (12.5) 14 (87.5)	4 (8.5) 43 (91.5)	1.54 [0.25-9.30]	.639

Pre-existing hypertension	Present Absent	0 (0.0) 16 (100.0)	1 (2.1) 46 (97.9)	1.35 [1.16-1.56]	.556
Previous post-partum haemorrhage	Present Absent	3 (18.8) 13 (81.2)	1 (2.1) 46 (97.9)	10.62 [1.02-110.80]	.019

The results from the analysis did not reveal any statistical significance association between developing PPH after delivery and the risk factors parity, previous abortion, pre-existing hypertension and pregnancy induced hypertension.

There was statistical significance association between women who developed PPH and having a multiple pregnancy (p=0.014). The OR of 4.357 indicates a greater risk of exposure for controls compared to cases. The magnitude of the OR indicates a strong association between multiple pregnancy and developing PPH after delivery. There was statistical significance association between women who developed PPH and having anaemia (p=0.019). The OR of 10.615 indicates a greater risk of exposure for controls compared to cases. The magnitude of the OR indicates a strong association between anaemia and developing PPH after delivery. There was statistical significance association between women who developed PPH and having a previous history of PPH (p=0.019). The OR of 10.615 indicates a greater risk of exposure for controls compared to cases. The magnitude of the OR indicates a strong association between a previous history of PPH and developing PPH after delivery.

CHAPTER 5: DISCUSSION

5.1 Main findings

In this study, pregnant women with anaemia or multiple pregnancy or a previous history of PPH were found to be at highest risk of developing PPH after delivery. Post-partum haemorrhage is a complication that can develop after a woman gives birth, and if not managed correctly and efficiently, it can lead to hypovolemic shock and death. There have been numerous studies conducted on PPH worldwide, however, very few studies have been conducted in Zimbabwe and no studies on PPH have been conducted in Beitbridge District. The incidence of PPH found in this study was 1.5% during the study period which is similar to a study conducted at Mpilo Central Hospital, Bulawayo Zimbabwe from 1 January 2016 to June 2016 where the incidence of PPH was 1.6% (Ngwenya, 2016).

5.2 Socio-demographic characteristics

The study included analysis of the socio-demographic characteristics age, marital status, employment status and education level. The average age of the study participants was 26 years and the ages ranged from 14 years to 40 years. The ages for cases and controls ranged from 16 years to 39 years, and 14 years to 40 years respectively. The majority of the cases and controls were in the age range 26 years to 39 years. Similar age ranges have been reported in other studies on PPH and this age range corresponds to the reproductive age for women. In a study conducted in Cameroon, the majority of the study participants were found to be in the 19 years to 35 years age range (Nana et al., 2021), while the study by Ononge et al., (2016b) in Uganda reported most of the participants in the age range 20 years to 34 years. Similarly, in a study by Bazirete et al., (2022) conducted in Rwanda, the authors found that age was not a risk factor for developing PPH.

The majority of the study participants (65%) were married while 35% were single. Marital status was not associated with developing PPH in this study and similar studies such as the study by Ononge et al., (2016a) conducted in Uganda where marital status was not identified as a risk factor for developing PPH. In a study conducted in Ethiopia, 98.4% of the study participants were married and the remainder were single (Degno et al., 2022), and though their study had more married participants compared to this study.

Zimbabwe had an unemployment rate of 11% in 2015 (Index Mundi, 2021b) and a female unemployment rate of 5.2% in the same year which went up to 5.9% in 2020 (Trading Economics, 2022). 32% of the study participants were employed while 68% were not employed. 31% of the cases were not employed and 32% of the controls were not employed. The study setting is in an area which has a transient population and most of the inhabitants are not formally employed. The response to employment status is subjective as one may view themselves as employed as a cross border trader, while others may not view this as employment it is not a formal form of employment.

In 2015 the female literacy rate for Zimbabwe was 84.6% (Index Mundi, 2021a). The education system in Zimbabwe consists of primary, secondary, high school, vocational and tertiary education levels (Scholaro, 2021). The study participants consisted of 5% women with primary education, 43% with secondary education, 26% with high school education, 21% with college education and 5% with university level education. In both cases and controls, the most common level of education was secondary level.

5.3 Risk factor characteristics

The study included the analysis of parity, multiple pregnancy, previous abortion, anaemia, pregnancy induced hypertension, pre-existing hypertension and a history of previous PPH as the risk factors for developing PPH.

The most common parity for both cases and controls was having between 2 and 4 children. This is consistent with the fertility rate for Zimbabwe which was 3.6 births per woman in 2018 and 3.5 births per woman in 2019 (Macrotrends, 2020). Parity was not found to be significantly associated with developing PPH in this study and this is similar to findings in a study conducted by (Firmin et al., 2019) in French Guiana. In a study conducted in Suriname, the majority of the study participants had between 1 and 4 children, and in this study parity was not found to be associated with developing PPH after delivery. However, findings from studies conducted in Norway (Lill Trine Nyfløt et al., 2017) and China (Liu et al., 2021) suggest that PPH is more likely in primiparous and multiparous women respectively. The variations of findings between studies conducted in LMIC and those conducted in HIC suggests that parity may be a risk factor in more developed countries than in developing countries. There is no consensus on whether parity is a risk factor for developing PPH as evidenced by the varying degree of findings in numerous studies.

Having a multiple pregnancy increases the risk of complications in pregnancy. In a study conducted in Ethiopia, Degno et al., (2022) revealed women with a multiple pregnancy to be 5 times more likely to have adverse birth outcomes than women with singleton pregnancies (AOR=4.74, p=0.0006). According to CHOP, (2021a), the placenta in a twin pregnancy occupies a larger area compared to a singleton pregnancy and this increases the risk of bleeding after delivery. In a multiple pregnancy, the uterus is over-distended which may result in uterine atony after delivery which is the most common cause of PPH, and the uterus may contract after delivery of the first twin thus separating the placenta resulting in bleeding for a longer period during the delivery of the second twin (MSD, 2022). From the 63 participants in this study 2 had a multiple pregnancy and in both cases the participants developed PPH after delivery. This study revealed a significant association between multiple pregnancy and PPH, women with a

multiple pregnancy were found to be 4.36 times more likely to develop PPH after delivery than women without a multiple pregnancy (p=0.014). Similar findings have been reported in literature, Nana et al., (2021) reported an OR of 9.21 (p=0.035). In a study conducted in Suriname, Kodan et al., (2020) identified having a multiple pregnancy as a risk factor for developing PPH. It is clear from the findings obtained from various studies that having a multiple pregnancy increases the risk for developing PPH after delivery.

From the results of this study, 12.5% of the cases had a history of a previous abortion while in the controls the prevalence was 8.9%. In this study, having a previous history of abortion was not found to be associated with developing PPH. However, the majority of literature is contrary to these findings. Nana et al., (2021) and Pubu et al., (2021) found a significant association between a history of a previous abortion and developing PPH. Halle-Ekane et al., (2015) found that a history of previous abortion resulted in an increased likelihood of developing PPH of 3.18 in a study conducted in Cameroon. The term abortion and miscarriage may be used interchangeably in literature and they both mean a pregnancy that is that is not carried to term and results in a non-viable foetus. In layman's language the term abortion means intentionally terminating a pregnancy. It would be problematic for a woman to admit to having a previous abortion in Zimbabwe because abortion is illegal and is only permitted under limited legal circumstances. Therefore, the findings in this study on this particular variable may correspond to the non-acceptance of the word abortion, resulting in reluctance to give the proper information.

Anaemia is a condition in which there is a condition in which there is a lower than normal concentration of red blood cells or haemoglobin, and it estimated that 33% of all women of reproductive age have anaemia (WHO, 2022b). The prevalence of anaemia in pregnant women in Zimbabwe was 31.8% in 2018 and 31.7% in 2019 (WHO, 2022d). In this study, anaemia was found to be significantly associated with developing PPH with an OR of 10.62 (p=0.019).

This finding corresponds to other studies conducted where anaemia was identified as a significant risk factor for developing PPH. In the study by Lill Trine Nyfløt et al., (2017), the authors identified anaemia as a strong independent risk factor for developing PPH (AOR=4.27, p<0.001), and similar findings were made by Ononge et al., (2016b) and Liu et al., (2021). There also exists contradictory findings on the association of anaemia with developing PPH after delivery. In a study conducted in Tibet, Pubu et al., (2021) found no significant association between having anaemia and developing PPH (OR 0.52, p=0.471), and similarly, Varghese et al., (2021) conducted a study in Bahrain and the results showed no link between anaemia and developing PPH. The prevalence of anaemia in pregnancy is higher in developing countries such as Togo (53%), Uganda (38%) and Tanzania (48%), while in developed countries it is lower (USA 11%, Norway 16%, Netherlands 17%) (WHO, 2022d). Since anaemia in pregnancy is more prevalent in LMICs than in HICs, it is justified that findings in studies conducted in LMIC would show and association between anaemia and PPH, while in HICs where it is less prevalent, studies conducted there would have contrary findings.

According to CDC, (2022), having hypertension in pregnancy puts the mother and the foetus at risk. There are some studies which demonstrated a significant association between pregnancy induced hypertension and developing PPH. Ford et al., (2015) conducted a study in New South Wales, Australia and the results revealed that women with pregnancy induced hypertension had a high risk of developing PPH. The results from a meta-analysis conducted by Durmaz & Komurcu, (2018) revealed that there was a relationship between pregnancy induced hypertension and developing PPH. However, having pregnancy induced hypertension was not associated with developing PPH in this study. A similar finding was made by Varghese et al., (2021) in a study conducted in Bahrain, and by Thepampan et al., (2021) in a study conducted in a Thai and Myanmar border community.

Having a history of previous PPH was significantly associated with developing PPH in this study with an OR of 10.615 (p=0.019) which means that in this study women with a previous history of PPH were 10 times as likely to develop PPH after delivery as women without a history of PPH. From the results, 3 (75%) of the women who developed PPH in this study, had a history of previous PPH. A significant association between a previous history of PPH and developing PPH was reported in the study conducted in the Thai and Myanmar border community where women with a previous history of PPH were 22.77 times as likely to develop PPH and women without a history of previous PPH (Thepampan et al., 2021). Ford et al., (2015) reported that PPH in the currently pregnancy was a more likely outcome if the woman had a previous history of PPH. In the study by Lill Trine Nyfløt et al., (2017) the authors reported that PPH was more likely in women with a previous history of PPH (OR 6.42, p<0.001) which means that women in the study population with a previous history of PPH were 6 times more likely to develop PPH than women without a history of PPH.

5.5 Strengths and limitations

This study is the basis for reference as it is the 1st study of PPH to be conducted in Beitbridge District. However, there were some limitations. Assessing the risk factors in retrospect is a limitation as some cases may have been misclassified. Retrospective case-control studies are associated with selection bias, measurement bias and confounding. Measurement bias may occur since the diagnosis of PPH was based on the estimation of blood loss rather than measured blood loss resulting in observer variations. Collecting data from maternity registers may introduce selection bias and the results may not be generalizable to the population. Confounding may occur from other risk factors that are not measured in the study. The small sample size resulted in some comparisons containing small numbers. The sample was based on a prevalence of 2%, however, the results of the study revealed a prevalence of 1.5% which

reduced the power to detect some associations. The confidence intervals for the odds ratios are broad and this may signify inadequate sample size. Only a few variables were investigated in this study, however, there are many other risk factors such as body mass index and caesarean delivery which are usually documented in the maternity case note/record that can be investigated.

6. CONCLUSION AND RECOMMENDATIONS

In this chapter conclusions are drawn based on the discussion and the results of this study and some recommendations for research and interventions are made.

6.1 Conclusion

The analysis of the risk factors for PPH showed that having anaemia, a multiple pregnancy or a previous history of PPH are significant risk factors for a woman to develop PPH after delivery. Most of the women with a multiple pregnancy in this study developed PPH after delivery. Additionally, a significant proportion of the women with anaemia developed PPH after delivery. Furthermore, most of the women with a previous history of PPH developed PPH after delivery. Despite the findings obtained from this study being similar to studies conducted in other countries, they are specific for this particular settings and therefore any response or intervention plans must be relevant to this particular setting.

6.2 Recommendations

The findings from this studies highlight areas where improvement can be made and strategic interventions may be implemented to reduce the outcome of PPH in Beitbridge District, Zimbabwe.

6.2.1 Health worker competency

Active management of the third stage of labour (AMTSL) is the most effective strategy to prevent PPH, and as such, all health workers working at health facilities which provide maternity services must receive adequate training in AMTSL with refresher courses according to changes in policies and guidelines.

6.2.2 Health facility staffing

All health facilities providing maternity services must be adequately staffed with competent health workers who are able to recognise that a pregnant woman is at risk.

6.2.3 Identification of risk factors

Since having anaemia, a multiple pregnancy and a previous history of PPH have been identified as significant risk factors for developing PPH after pregnancy, pregnant women who are identified as having these risk factors must be referred for secondary care where their pregnancy can be carefully monitored and may be referred for specialist management if deemed necessary.

6.2.4 Additional research

Since PPH is a prevalent outcome and the leading cause of maternal deaths in Zimbabwe, more research should be done on this topic in various settings in order to come up with national policies and interventions that are effective in reducing the prevalence of PPH and maternal deaths in Zimbabwe. Data collection for these studies should be prospectively to ensure that the data collected is complete and accurate as this study revealed that data collected retrospectively may be incomplete and not accurate.

REFERENCES

ACOG. (2021). *Postpartum Hemorrhage | ACOG*. https://www.acog.org/clinical/clinical-guidance/practice-bulletin/articles/2017/10/postpartum-hemorrhage

Agten, A. K., Passweg, D., Orelli, S. von, Ringel, N., Tschudi, R., & Tutschek, B. (2017). Temporal trends of postpartum haemorrhage in Switzerland: a 22-year retrospective population-based cohort study. *Swiss Medical Weekly 2017 :45*, *45*. https://doi.org/10.4414/SMW.2017.14551

Al-Zirqi, I., Vangen, S., Forsen, L., & Stray-Pedersen, B. (2008). Prevalence and risk factors of severe obstetric haemorrhage. *BJOG: An International Journal of Obstetrics & Gynaecology*, *115*(10), 1265–1272. https://doi.org/10.1111/J.1471-0528.2008.01859.X

Bazirete, O., Chantal, U. M., & Umubyeyi, A. (2021). Factors affecting the prevention of postpartum hemorrhage in Low-and Middle-Income Countries: A scoping review of the literature School of Public Health View project Clinical features, precipitating factors and outcomes of patients with stroke admitted to tertiary hospitals in Rwanda: A retrospective three-year study View project. *Article in Journal of Nursing Education and Practice*. https://doi.org/10.5430/jnep.v11n1p66

Bazirete, O., Nzayirambaho, M., Umubyeyi, A., Karangwa, I., & Evans, M. (2022). Risk factors for postpartum haemorrhage in the Northern Province of Rwanda: A case control study. *PLOS ONE*, *17*(2), e0263731. https://doi.org/10.1371/JOURNAL.PONE.0263731

Bienstock, J. L., Eke, A. C., & Hueppchen, N. A. (2021). Postpartum Hemorrhage. *New England Journal of Medicine*, *384*(17), 1635–1645. https://doi.org/10.1056/NEJMra1513247

Borovac-Pinheiro, A., Priyadarshani, P., & Burke, T. F. (2021). A review of postpartum hemorrhage in low-income countries and implications for strengthening health systems.

International Journal of Gynecology & Obstetrics, *154*(3), 393–399. https://doi.org/10.1002/IJGO.13618

Calvert, C., Thomas, S. L., Ronsmans, C., Wagner, K. S., Adler, A. J., & Filippi, V. (2012). Identifying Regional Variation in the Prevalence of Postpartum Haemorrhage: A Systematic Review and Meta-Analysis. *PLOS ONE*, *7*(7), e41114. https://doi.org/10.1371/JOURNAL.PONE.0041114

CDC. (2022). *High Blood Pressure During Pregnancy | cdc.gov*. https://www.cdc.gov/bloodpressure/pregnancy.htm

CHAI. (2020). *Anti-shock garment prevents maternal deaths in rural Zimbabwe - Clinton Health Access Initiative*. https://www.clintonhealthaccess.org/anti-shock-garment-prevents-maternal-deaths-in-rural-zimbabwe/

Chiang, I.-C. A., Jhangiani, R. S., & Price, P. C. (2015). *Reliability and Validity of Measurement*. BCcampus.

CHOP. (2021a). *Complications of Multiple Pregnancy | Children's Hospital of Philadelphia*. https://www.chop.edu/conditions-diseases/complications-multiple-pregnancy

CHOP. (2021b). *Postpartum Hemorrhage | Children's Hospital of Philadelphia*. https://www.chop.edu/conditions-diseases/postpartum-hemorrhage

Cífková, R., Johnson, M. R., Kahan, T., Brguljan, J., Williams, B., Coca, A., Manolis, A., Thomopoulos, C., Borghi, C., Tsioufis, C., Parati, G., Sudano, I., Mcmanus, R. J., Van Den Born, B. J. H., Regitz-Zagrosek, V., & De Simone, G. (2020). Peripartum management of hypertension: a position paper of the ESC Council on Hypertension and the European Society of Hypertension. *European Heart Journal - Cardiovascular Pharmacotherapy*, *6*(6), 384–393. https://doi.org/10.1093/EHJCVP/PVZ082

Dagne, A. H., & Zewude, S. B. (2021). Postpartum haemorrhage and associated factors among mothers who gave birth in South Gondar Zone public health facilities, Ethiopia: a cross-sectional study. *Postgraduate Medical Journal*, postgradmedj-2020-139382. https://doi.org/10.1136/POSTGRADMEDJ-2020-139382

Degno, S., Lencha, B., Aman, R., Atlaw, D., Mekonnen, A., Woldeyohannes, D., Tekalegn, Y., Hailu, S., Woldemichael, B., & Nigussie, A. (2022). Adverse birth outcomes and associated factors among mothers who delivered in Bale zone hospitals, Oromia Region, Southeast Ethiopia. *Journal of International Medical Research*, *49*(5), 1–12. https://doi.org/10.1177/03000605211013209

Dey, T., Mukherjee, A., & Chakraborty, S. (2020). A Practical Overview of Case-Control Studies in Clinical Practice. *Chest*, *158*, S57–S64. https://doi.org/10.1016/j.chest.2020.03.009

Durmaz, A., & Komurcu, N. (2018). Relationship between Maternal Characteristics and Postpartum Hemorrhage: A Meta-Analysis Study. *Journal of Nursing Research*, *26*(5), 362–372. https://doi.org/10.1097/JNR.0000000000000245

Emeka Madu, A. (2016). *Primary Post-Partum Haemorrhage; the Pilgrim Hospital's Experience, Boston, Lincolnshire, United Kingdom*. https://doi.org/10.15406/ogij.2016.04.00125

Evensen, A., Anderson, J. M., & Fontaine, P. (2017). Postpartum Hemorrhage: Prevention and Treatment. *American Family Physician*, *95*(7), 442–449.

Favilli, A., Tosto, V., Ceccobelli, M., Parazzini, F., Franchi, M., Bini, V., & Gerli, S. (2021). Risk factors for non-adherent retained placenta after vaginal delivery: a systematic review. *BMC Pregnancy and Childbirth*, *21*(1), 1–13. https://doi.org/10.1186/S12884-021-03721-9/TABLES/2

Firmin, M., Carles, G., Mence, B., Madhusudan, N., Faurous, E., & Jolivet, A. (2019). Postpartum hemorrhage: incidence, risk factors, and causes in Western French Guiana. *Journal of Gynecology Obstetrics and Human Reproduction*, *48*(1), 55–60. https://doi.org/10.1016/j.jogoh.2018.11.006

Flood, M. M., Pollock, W. E., McDonald, S. J., & Davey, M. A. (2018). Monitoring postpartum haemorrhage in Australia: Opportunities to improve reporting. *Women and Birth*, *31*(2), 89–95. https://doi.org/10.1016/J.WOMBI.2017.07.012

Flood, M., McDonald, S. J., Pollock, W., Cullinane, F., & Davey, M. A. (2019). Incidence, trends and severity of primary postpartum haemorrhage in Australia: A population-based study using Victorian Perinatal Data Collection data for 764 244 births. *Australian and New Zealand Journal of Obstetrics and Gynaecology*, *59*(2), 228–234. https://doi.org/10.1111/AJO.12826

Ford, J. B., Patterson, J. A., Seeho, S. K. M., & Roberts, C. L. (2015). Trends and outcomes of postpartum haemorrhage, 2003-2011. *BMC Pregnancy and Childbirth*, *15*(1), 1–10. https://doi.org/10.1186/S12884-015-0788-5/TABLES/3

Fukami, T., Koga, H., Goto, M., Ando, M., Matsuoka, S., Tohyama, A., Yamamoto, H., Nakamura, S., Koyanagi, T., To, Y., Kondo, H., Eguchi, F., & Tsujioka, H. (2019). Incidence and risk factors for postpartum hemorrhage among transvaginal deliveries at a tertiary perinatal medical facility in Japan. *PLoS ONE*, *14*(1). https://doi.org/10.1371/journal.pone.0208873

Ghulmiyyah, L., & Sibai, B. (2012). Maternal Mortality From Preeclampsia/Eclampsia. *Seminars in Perinatology*, *36*(1), 56–59. https://doi.org/10.1053/J.SEMPERI.2011.09.011

Goffman, D., Nathan, L., & Chazotte, C. (2016). *Obstetric hemorrhage: A global review.*

https://doi.org/10.1053/j.semperi.2015.11.014

Greenbaum, S., Wainstock, T., Dukler, D., Leron, E., & Erez, O. (2017). Underlying mechanisms of retained placenta: Evidence from a population based cohort study. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *216*, 12–17. https://doi.org/10.1016/J.EJOGRB.2017.06.035

Habitamu, D., Goshu, Y. A., & Zeleke, L. B. (2019). The magnitude and associated factors of postpartum hemorrhage among mothers who delivered at Debre Tabor general hospital 2018. *BMC Research Notes*, *12*(1), 1–6. https://doi.org/10.1186/S13104-019-4646-9/TABLES/3

Halle-Ekane, G. E., Ketchem Emade, F., Bechem, N. N., Palle, J. N., Fongaing, D., Essome, H., Fomulu, N., & Halder, A. (2015). Cameroon Article in International Journal of TROPICAL DISEASE & Health ·. *International Journal of TROPICAL DISEASE & Health*, *13*(2), 23078. https://doi.org/10.9734/IJTDH/2016/23078

Harvey, L. A. (2019). Case-control studies: an efficient study design. In *Spinal Cord* (Vol. 57, Issue 1, pp. 1–2). Nature Publishing Group. https://doi.org/10.1038/s41393-018-0234-4

Ifeadike, C., Eleje, G., Umeh, U. S., Ozoemena Ifeadike, C., Uchenna Eleje, G., & Okaforcha, E. I. (2018a). *Emerging trend in the etiology of postpartum hemorrhage in a low resource setting Antimicrobial Activities of Different Honeys Sold in Ado-Ekiti on Bacteria Associated with Upper Respiratory Tract Infections View project Influence of Malaria Parasitemia o*. https://doi.org/10.35841/neonatal-medicine.2.2.34-39

Ifeadike, C., Eleje, G., Umeh, U. S., Ozoemena Ifeadike, C., Uchenna Eleje, G., & Okaforcha, E. I. (2018b). *Emerging trend in the etiology of postpartum hemorrhage in a low resource setting Edu-maternal project View project Emerging trend in the etiology*

of postpartum hemorrhage in a low resource setting. https://doi.org/10.35841/neonatal-medicine.2.2.34-39

Index Mundi. (2021a). *Zimbabwe Literacy - Demographics*. https://www.indexmundi.com/zimbabwe/literacy.html

Index Mundi. (2021b). *Zimbabwe Unemployment rate - Economy*. https://www.indexmundi.com/zimbabwe/unemployment_rate.html

Jamil El-Qatrawi, K., & Health, D.-B. (2021). *Effect of hypertension on pregnancy outcomes at UNRWA health centres in Gaza governorates: a comparative study*. https://doi.org/10.1016/S0140-6736(21)01512-9

Jardine, J., Gurol-Urganci, I., Harris, T., Hawdon, J., Pasupathy, D., Meulen, J. van der, & Walker, K. (2021). Risk of postpartum haemorrhage is associated with ethnicity: a cohort study of 981 801 births in England. *BJOG: An International Journal of Obstetrics & Gynaecology*. https://doi.org/10.1111/1471-0528.17051

Jardine, J., Gurol-Urganci, I., Harris, T., Hawdon, J., Pasupathy, D., van der Meulen, J., & Walker, K. (2021). Risk of postpartum haemorrhage is associated with ethnicity: a cohort study of 981 801 births in England. *BJOG: An International Journal of Obstetrics & Gynaecology*. https://doi.org/10.1111/1471-0528.17051

Kartika Dewi, R., Retno Budihastuti, U., & Poncorini Pamungkasari, E. (2018). *Dewi et al./ Biopsychosocial Factors Associated with Postpartum Haemorrhage Biopsychosocial Factors Associated with Postpartum Haemorrhage in Surakarta, Central Java*. https://doi.org/10.26911/thejmch.2018.03.03.05

Kebede, B. A., Abdo, R. A., Anshebo, A. A., & Gebremariam, B. M. (2019). Prevalence and predictors of primary postpartum hemorrhage: An implication for designing effective

intervention at selected hospitals, Southern Ethiopia. *PLOS ONE*, *14*(10), e0224579. https://doi.org/10.1371/JOURNAL.PONE.0224579

Khan, S. M., Saeed, M., Mustafa, G., & Durrani, H. D. (2021). Uterine Atony. *The Professional Medical Journal*, *21*(06), 1117–1121. https://doi.org/10.29309/tpmj/2014.21.06.2672

Kodan, L. R., Verschueren, K. J. C., Prüst, Z. D., Zuithoff, N. P. A., Rijken, M. J., Browne, J. L., Klipstein-Grobusch, K., Bloemenkamp, K. W. M., & Grunberg, A. W. (2020). Postpartum hemorrhage in Suriname: A national descriptive study of hospital births and an audit of case management. *PLoS ONE*, *15*(12 December), e0244087. https://doi.org/10.1371/journal.pone.0244087

Kramer, M. S., Berg, C., Abenhaim, H., Dahhou, M., Rouleau, J., Mehrabadi, A., & Joseph, K. S. (2013). Incidence, risk factors, and temporal trends in severe postpartum hemorrhage. *American Journal of Obstetrics & Gynecology*, *209*(5), 449.e1-449.e7. https://doi.org/10.1016/J.AJOG.2013.07.007

Ladfors, L. V., Muraca, G. M., Zetterqvist, J., Butwick, A. J., & Stephansson, O. (2021). Postpartum haemorrhage trends in Sweden using the Robson ten group classification system: a population-based cohort study. *BJOG: An International Journal of Obstetrics & Gynaecology*. https://doi.org/10.1111/1471-0528.16931

Lamina, M. A., Ikhile, M., Lamina, M. A., & Ikhile, M. (2015). A Ten-Year Review of Primary Postpartum Haemrrhage at a University Teaching Hospital, Sagamu, Nigeria: A Case-Control Study. *Open Journal of Obstetrics and Gynecology*, *5*(3), 142–150. https://doi.org/10.4236/OJOG.2015.53019

Lancaster, L., Barnes, R. F. W., Correia, M., Luis, E., Boaventura, I., Silva, P., & von Drygalski, A. (2020). Maternal death and postpartum hemorrhage in sub-Saharan Africa

– A pilot study in metropolitan Mozambique. *Research and Practice in Thrombosis and Haemostasis*, *4*(3), 402–412. https://doi.org/10.1002/rth2.12311

Legesse, T., Abdulahi, M., & Dirar, A. (2017). Trends and causes of maternal mortality in Jimma University Specialized Hospital, southwest Ethiopia: a matched case-control study. *International Journal of Women's Health*, *9*, 307–313. https://doi.org/10.2147/IJWH.S123455

Lewallen, S., & Courtright, P. (1998). Epidemiology in Practice: Case-Control Studies. *Community Eye Health*, *11*(28), 57. /pmc/articles/PMC1706071/

Liu, C. ning, Yu, F. bing, Xu, Y. zhe, Li, J. sheng, Guan, Z. hong, Sun, M. na, Liu, C. an, He, F., & Chen, D. jin. (2021). Prevalence and risk factors of severe postpartum hemorrhage: a retrospective cohort study. *BMC Pregnancy and Childbirth*, *21*(1), 1–8. https://doi.org/10.1186/s12884-021-03818-1

Macrotrends. (2020). *Zimbabwe Fertility Rate 1950-2022 | MacroTrends*. https://www.macrotrends.net/countries/ZWE/zimbabwe/fertility-rate

Majangara, R. (2016). *MICROBIOLOGY OF PUERPERAL SEPSIS AND ITS CLINICAL IMPLICATIONS AMONG HIV-INFECTED AND HIV-UNINFECTED WOMEN IN A HOSPITAL SAMPLE IN ZIMBABWE*.

Makate, M., & Makate, C. (2017). The impact of prenatal care quality on neonatal, infant and child mortality in Zimbabwe: Evidence from the demographic and health surveys. *Health Policy and Planning*, *32*(3), 395–404. https://doi.org/10.1093/heapol/czw154

Marshall, A. L., Durani, U., Bartley, A., Hagen, C. E., Ashrani, A., Rose, C., Go, R. S., & Pruthi, R. K. (2017). The impact of postpartum hemorrhage on hospital length of stay and inpatient mortality: a National Inpatient Sample-based analysis. *American Journal*

of Obstetrics and Gynecology, *217*(3), 344.e1-344.e6. https://doi.org/10.1016/J.AJOG.2017.05.004

Maswime, S., & Buchmann, E. (2017). A systematic review of maternal near miss and mortality due to postpartum hemorrhage. In *International Journal of Gynecology and Obstetrics* (Vol. 137, Issue 1, pp. 1–7). Wiley Blackwell. https://doi.org/10.1002/ijgo.12096

Mesfin, S., Dheresa, M., Fage, S. G., & Tura, A. K. (2021). Assessment of Postpartum Hemorrhage in a University Hospital in Eastern Ethiopia: A Cross-Sectional Study. *International Journal of Women's Health*, *13*, 663. https://doi.org/10.2147/IJWH.S300143

Mlambo, C., Chinamo, C., & Zingwe, T. (2013). An investigation of the causes of maternal mortality in Zimbabwe. *Mediterranean Journal of Social Sciences*, *4*(14), 615–620. https://doi.org/10.5901/MJSS.2013.V4N14P615

MSD. (2022). *Multifetal Pregnancy - Gynecology and Obstetrics - MSD Manual Professional Edition*. https://www.msdmanuals.com/professional/gynecology-and-obstetrics/abnormalities-and-complications-of-labor-and-delivery/multifetal-pregnancy

Musarandega, R., Ngwenya, S., Murewanhema, G., Machekano, R., Magwali, T., Nystrom, L., Pattinson, R., & Munjanja, S. (2022). Changes in causes of pregnancy-related and maternal mortality in Zimbabwe 2007-08 to 2018-19: findings from two reproductive age mortality surveys. *BMC Public Health*, *22*(1), 923. https://doi.org/10.1186/S12889-022-13321-7/TABLES/4

Mvandal, S. P., & Coletha, K. (2021). *Prevalence, Causes and Associated Factors for Postpartum Haemorrhage (Pph) At St. Joseph Referral Hospital Peramiho-Songea, Tanzania; A Hospital-Based Retrospective Cross-Sectional Study.*

https://doi.org/10.20944/PREPRINTS202109.0417.V1

Nair, M., Chhabra, S., Choudhury, S. S., Deka, Di., Deka, G., Kakoty, S. D., Kumar, P., Mahanta, P., Medhi, R., Rani, A., Rao, S., Roy, I., Solomi V, C., Talukdar, R. K., Zahir, F., Kansal, N., Arora, A., Opondo, C., Armitage, J., … Kurinczuk, J. J. (2021). Relationship between anaemia, coagulation parameters during pregnancy and postpartum haemorrhage at childbirth: a prospective cohort study. *BMJ Open*, *11*(10), e050815. https://doi.org/10.1136/BMJOPEN-2021-050815

Nana, T. N., Tchounzou, R., Mangala, F. N., Essome, H., Demgne, J. T., Kobenge, F. M., Adamo, B., Egbe, T. O., Nguefack, C. T., & Halle, G. E. (2021). Primary Post-Partum Haemorrhage Following Vaginal Deliveries at the Douala General Hospital: Prevalence, Causes and Risk Factors. *Open Journal of Obstetrics and Gynecology*, *11*(06), 742–752. https://doi.org/10.4236/ojog.2021.116069

Nathan, L. M. (2019). An overview of obstetric hemorrhage. In *Seminars in Perinatology* (Vol. 43, Issue 1, pp. 2–4). W.B. Saunders. https://doi.org/10.1053/j.semperi.2018.11.001

Ngwenya, S. (2016). Postpartum hemorrhage: Incidence, risk factors, and outcomes in a low-resource setting. *International Journal of Women's Health*, *8*, 647–650. https://doi.org/10.2147/IJWH.S119232

Ngwenya, S. (2020). Risk factors for composite adverse outcomes of postpartum haemorrhage in a low-resource setting: a single-centre cross-sectional study in Mpilo Central Hospital, Bulawayo, Zimbabwe. *F1000Research*, *9*, 211. https://doi.org/10.12688/f1000research.22769.1

Nigussie, J., Girma, B., Molla, A., Tamir, T., & Tilahun, R. (2021). *Magnitude of Postpartum Hemorrhage and Its Associated Factors in Ethiopia: Systematic Review and Meta-*

analysis. https://doi.org/10.21203/rs.3.rs-993345/v1

Ntuli, S. T., Mogale, M., Hyera, F. L., & Naidoo, S. (2017). An investigation of maternal mortality at a tertiary hospital of the Limpopo province of South Africa. *Southern African Journal of Infectious Diseases*, *32*(2), 73–76. https://doi.org/10.1080/23120053.2017.1293902

Nyfløt, L. T., Sandven, I., Oldereid, N. B., Stray-Pedersen, B., & Vangen, S. (2017). Assisted reproductive technology and severe postpartum haemorrhage: a case–control study. *BJOG: An International Journal of Obstetrics & Gynaecology*, *124*(8), 1198–1205. https://doi.org/10.1111/1471-0528.14471

Nyfløt, Lill Trine, Sandven, I., Stray-Pedersen, B., Pettersen, S., Al-Zirqi, I., Rosenberg, M., Jacobsen, A. F., & Vangen, S. (2017). Risk factors for severe postpartum hemorrhage: A case-control study. *BMC Pregnancy and Childbirth*, *17*(1), 1–9. https://doi.org/10.1186/s12884-016-1217-0

Oakley, L., Penn, N., Pipi, M., Oteng-Ntim, E., & Doyle, P. (2016). Risk of Adverse Obstetric and Neonatal Outcomes by Maternal Age: Quantifying Individual and Population Level Risk Using Routine UK Maternity Data. *PLOS ONE*, *11*(10), e0164462. https://doi.org/10.1371/JOURNAL.PONE.0164462

Oberg, A. S., Hernandez-Diaz, S., Palmsten, K., Almqvist, C., & Bateman, B. T. (2014). Patterns of Recurrence of Postpartum Hemorrhage in a Large, Population-Based Cohort. *American Journal of Obstetrics and Gynecology*, *210*(3), 229.e1. https://doi.org/10.1016/J.AJOG.2013.10.872

Ononge, S., Mirembe, F., Wandabwa, J., & Campbell, O. M. R. (2016a). Incidence and risk factors for postpartum hemorrhage in Uganda. *Reproductive Health*, *13*(1), 1–7. https://doi.org/10.1186/s12978-016-0154-8

Ononge, S., Mirembe, F., Wandabwa, J., & Campbell, O. M. R. (2016b). Incidence and risk factors for postpartum hemorrhage in Uganda. *Reproductive Health*, *13*(1), 1–7. https://doi.org/10.1186/S12978-016-0154-8/TABLES/2

Owiredu, W. K. B. A., Osakunor, D. N. M., Turpin, C. A., & Owusu-Afriyie, O. (2016). Laboratory prediction of primary postpartum haemorrhage: A comparative cohort study. *BMC Pregnancy and Childbirth*, *16*(1), 1–8. https://doi.org/10.1186/S12884-016-0805-3/TABLES/4

Pannucci, C. J., & Wilkins, E. G. (2010). Identifying and avoiding bias in research. *Plastic and Reconstructive Surgery*, *126*(2), 619–625. https://doi.org/10.1097/PRS.0b013e3181de24bc

Perlman, N. C., & Carusi, D. A. (2019). Retained placenta after vaginal delivery: risk factors and management. *International Journal of Women's Health*, *11*, 527. https://doi.org/10.2147/IJWH.S218933

Podder, A. R., & Seshadri, J. G. (2020). Traumatic Postpartum Hemorrhage: <Emphasis Type="Italic">How to Avoid and How to Manage</Emphasis>. *Atlas of Difficult Gynecological Surgery*, 169–193. https://doi.org/10.1007/978-981-13-8173-7_10

Pubu, Z. M., Bianba, Z. M., Yang, G., CyRen, L. M., Pubu, D. J., Lang, K. Z. S., Bian, Z., Qu-Zong, Z., & Nyma, Z. G. (2021). Factors Affecting the Risk of Postpartum Hemorrhage in Pregnant Women in Tibet Health Facilities. *Medical Science Monitor : International Medical Journal of Experimental and Clinical Research*, *27*, e928568-1. https://doi.org/10.12659/MSM.928568

Radoń-Pokracka, M., Adrianowicz, B., Płonka, M., Danił, P., Nowak, M., & Huras, H. (2019). Evaluation of Pregnancy Outcomes at Advanced Maternal Age. *Open Access Macedonian Journal of Medical Sciences*, *7*(12), 1951.

https://doi.org/10.3889/OAMJMS.2019.587

RCOG. (2021a). *Multiple pregnancy: having more than one baby*. https://www.rcog.org.uk/en/patients/patient-leaflets/multiple-pregnancy-having-more-than-one-baby/

RCOG. (2021b). *Postpartum Haemorrhage, Prevention and Management (Green-top Guideline No. 52)*. https://www.rcog.org.uk/en/guidelines-research-services/guidelines/gtg52/

Salam, R. A., Das, J. K., & Bhutta, Z. A. (2014). Multiple Micronutrient Supplementation during Pregnancy and Lactation in Low-to-Middle-Income Developing Country Settings: Impact on Pregnancy Outcomes. *Annals of Nutrition and Metabolism*, *65*(1), 4–12. https://doi.org/10.1159/000365792

Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A. B., Daniels, J., Gülmezoglu, A. M., Temmerman, M., & Alkema, L. (2014a). Global causes of maternal death: a WHO systematic analysis. *The Lancet. Global Health*, *2*(6). https://doi.org/10.1016/S2214-109X(14)70227-X

Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A. B., Daniels, J., Gülmezoglu, A. M., Temmerman, M., & Alkema, L. (2014b). Global causes of maternal death: A WHO systematic analysis. *The Lancet Global Health*, *2*(6), e323–e333. https://doi.org/10.1016/S2214-109X(14)70227-X

Scheuer, C., Boot, E., Carse, N., Clardy, A., Gallagher, J., Heck, S., Marron, S., Martinez-Alvarez, L., Masarykova, D., Mcmillan, P., Murphy, F., Steel, E., Ekdom, H. Van, & Vecchione, H. (2015). Blood transfusion practices in obstetric care at a tertiary referral hospital in Zimbabwe. *Vox Sanguinis*, *109*, 100. https://doi.org/10.2/JQUERY.MIN.JS

Scholaro. (2021). *Zimbabwe Education System*. https://www.scholaro.com/pro/Countries/Zimbabwe/Education-System

Sebghati, M., & Chandraharan, E. (2017). An update on the risk factors for and management of obstetric haemorrhage. *Women's Health*, *13*(2), 34. https://doi.org/10.1177/1745505717716860

Shadap, A. (2018). 59-66 Peer Reviewed & Open Access Journal Research Article Copyright (c). *International Journal of Nursing & Midwifery Research*, *5*, 2455–9318. https://doi.org/10.24321/2455.9318.201849

Sotunsa, J. O., Adeniyi, A. A., Imaralu, J. O., Fawole, B., Adegbola, O., Aimakhu, C. O., Adeyemi, A. S., Hunyinbo, K., Dada, O. A., Adetoro, O. O., & Oladapo, O. T. (2019). Maternal near-miss and death among women with postpartum haemorrhage: a secondary analysis of the Nigeria Near-miss and Maternal Death Survey. *BJOG: An International Journal of Obstetrics & Gynaecology*, *126*(S3), 19–25. https://doi.org/10.1111/1471-0528.15624

Tenney Steven, Kerndt Connor, H. M. (2020). *Case Control Studies - PubMed*. https://pubmed.ncbi.nlm.nih.gov/28846237/

Tesfaye, G., Loxton, D., Chojenta, C., Assefa, N., & Smith, R. (2018). Magnitude, trends and causes of maternal mortality among reproductive aged women in Kersa health and demographic surveillance system, eastern Ethiopia 11 Medical and Health Sciences 1117 Public Health and Health Services 11 Medical and Health Sciences 1114 Paediatrics and Reproductive Medicine. *BMC Women's Health*, *18*(1), 1–10. https://doi.org/10.1186/S12905-018-0690-1/FIGURES/6

Thepampan, W., Eungapithum, N., Tanasombatkul, K., & Phinyo, P. (2021). Risk factors for postpartum hemorrhage in a thai–myanmar border community hospital: A nested case-

control study. *International Journal of Environmental Research and Public Health*, *18*(9), 4633. https://doi.org/10.3390/ijerph18094633

Tidy. (2019). *Gravidity and Parity Definitions (Implications in Risk Assessment) | Patient*. https://patient.info/doctor/gravidity-and-parity-definitions-and-their-implications-in-risk-assessment

Tiruneh, B., McLelland, G., & Plummer, V. (2020). Incidence and Mortality Associated with Primary Postpartum Haemorrhage Following In-Hospital Births in Northwest Ethiopia. *SSRN Electronic Journal*. https://doi.org/10.2139/SSRN.3566174

Trading Economics. (2022). *Zimbabwe - Unemployment, Female - 2022 Data 2023 Forecast 1991-2020 Historical*. https://tradingeconomics.com/zimbabwe/unemployment-female-percent-of-female-labor-force-wb-data.html

Tsu, V. D. (1993). Postpartum haemorrhage in Zimbabwe: a risk factor analysis. *BJOG: An International Journal of Obstetrics & Gynaecology*, *100*(4), 327–333. https://doi.org/10.1111/j.1471-0528.1993.tb12974.x

UNDP. (2016). *Sustainable Development Goals | United Nations Development Programme*. https://www.undp.org/sustainable-development-goals#good-health

UNFPA. (2021). *UNFPA Zimbabwe | Sexual & reproductive health*. https://zimbabwe.unfpa.org/en/topics/sexual-reproductive-health-5

UNICEF. (2021). *Maternal mortality rates and statistics - UNICEF DATA*. https://data.unicef.org/topic/maternal-health/maternal-mortality/

UNICEF. (2022). *Maternal mortality rates and statistics - UNICEF DATA*. https://data.unicef.org/topic/maternal-health/maternal-mortality/

van Stralen, G., von Schmidt auf Altenstadt, J. F., Bloemenkamp, K. W. M., van Roosmalen,

J., & Hukkelhoven, C. W. P. M. (2016). Increasing incidence of postpartum hemorrhage: the Dutch piece of the puzzle. *Acta Obstetricia et Gynecologica Scandinavica*, *95*(10), 1104–1110. https://doi.org/10.1111/aogs.12950

Varghese, B., Jain Sunder, A., Nayak, M., & Dayoub, N. (2021). Identifying Risk Factors of Severe Primary Post-Partum Hemorrhage ** Senior Resident OBG *** Senior Resident OBG **** Obstetrics/Gynaecology and IVF consultant BACKGROUND and OBJECTIVES. In *Bahrain Medical Bulletin* (Vol. 43, Issue 1).

Vendittelli, F., Barasinski, C., Pereira, B., & Lémery, D. (2016). Incidence of immediate postpartum hemorrhages in French maternity units: A prospective observational study (HERA study). *BMC Pregnancy and Childbirth*, *16*(1), 1–9. https://doi.org/10.1186/s12884-016-1008-7

WHO. (2007). *The Zimbabwe National Maternal and Neonatal Health Road Map 2007-2015*.

WHO. (2017a). *6. Priority diseases and reasons for inclusion 6.16 Postpartum haemorrhage*. http://www.pphprevention.org/pph.php.

WHO. (2017b). *Maternal mortality in 2000-2017*. www.who.int/reproductivehealth/publications/maternal-mortality-2017/en/

WHO. (2017c). *WHO | WHO Recommendations on Prevention and Treatment of Postpartum Haemorrhage and the WOMAN Trial*. https://www.who.int/reproductivehealth/topics/maternal_perinatal/pph-woman-trial/en/

WHO. (2018). *WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience 1 WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience: Summary*. https://doi.org/10.1016/S0140-6736(15)00838-7

WHO. (2021a). *Maternal deaths*. https://www.who.int/data/gho/indicator-metadata-registry/imr-details/4622

WHO. (2021b). *Maternal Health | WHO | Regional Office for Africa*. https://www.afro.who.int/health-topics/maternal-health

WHO. (2021c). *Maternal mortality*. https://www.who.int/news-room/fact-sheets/detail/maternal-mortality

WHO. (2021d). *WHO | Maternal and perinatal health*. https://www.who.int/reproductivehealth/publications/maternal_perinatal_health/en/

WHO. (2022a). *Abortion*. https://www.who.int/health-topics/abortion#tab=tab_1

WHO. (2022b). *Anaemia*. https://www.who.int/health-topics/anaemia#tab=tab_1

WHO. (2022c). *Maternal mortality*. https://www.who.int/news-room/fact-sheets/detail/maternal-mortality

WHO. (2022d). *Prevalence of anaemia in pregnant women (aged 15-49) (%)*. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/prevalence-of-anaemia-in-pregnant-women-(-)

Wormer, K. C., Jamil, R. T., & Bryant, S. B. (2021). Acute Postpartum Hemorrhage. *StatPearls*. https://www.ncbi.nlm.nih.gov/books/NBK499988/

Young, M. F. (2018). Maternal anaemia and risk of mortality: a call for action. *The Lancet Global Health*, *6*(5), e479–e480. https://doi.org/10.1016/S2214-109X(18)30185-2

ZIMSTAT. (2012). *QUALITY CONTROL MANUAL Provincial Report*.

Zvandasara, P., Chipato, T., Mawere, E., Rivelt, K., & McNally, T. (2015). Introducing misoprostol for the management of postpartum hemorrhage in Zimbabwe: final report

on operational research. *Central African Journal of Medicine*, *61*(9–12), 76–83. https://doi.org/10.4314/cajm.v61i9-12.

APPENDICES

Appendix 1: Ethical clearance – University of the Western Cape

UNIVERSITY of the WESTERN CAPE

60 YEARS of hope, action & knowledge

27 September 2021

Dr P Musonza
School of Public Health
Faculty of Community and Health Sciences

Ethics Reference Number: BM21/8/2

Project Title: Pre-natal risk factors for post-partum haemorrhage in a district in Zimbabwe: A case control study

Approval Period: 17 September 2021 – 17 September 2024

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.

Any 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.

Permission to conduct the study must be submitted to BMREC for record-keeping.

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

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: BMREC-130416-050

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

Appendix 2: Permission letter – National Institute of Health Research, Zimbabwe

Telephone: +263-4-798537-70
All correspondences to be addressed to the **Secretary for Health and Child Care**

ZIMBABWE

Ministry of Health and Child Care
P O Box CY1122
Causeway
HARARE

22 October 2021

Dr Poshia Musonza
University of the Western Cape
Private Bag X 17
Bellville 7535
South Africa

Dear Dr Musonza

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT BEITBRIDGE DISTRICT HOSPITAL (MASTERS IN PUBLIC HEALTH)

Your letter dated the 27th of August 2021 refers.

It is noted that you requested for permission to conduct research titled "Pre-natal risk factors for postpartum haemorrhage in a district in Zimbabwe" as part of your Masters in Public Health (MPH) studies at the University of Western Cape in Cape Town, South Africa. The retrospective study involves determining the pre-natal risk factors for women to develop post-partum haemorrhage following vaginal delivery at Beitbridge District Hospital from January 2018 to December 2019.

It is further noted that your studies have been approved by the University of Western Cape Bio-medical Research and Ethical Committee (BMREC).

Your application is approved on condition that you obtain Medical Research Council of Zimbabwe (MRCZ) ethical approval before the implementation of the study. As indicated in your letter you will be requested by the Secretary for Health and Child Care to share your findings with MoHCC in the form of presentation or written report during the course or on completion of your study

Kindly submit a copy of the MRCZ ethical approval for this project to the Ministry of Health and Child Care. Address your communication to Prof. Nicholas Midzi (Director National Institute of Health Research) at nmidzi@mohcc.org.zw, Cell No. 0785023912.

MIN. OF HEALTH &CHILD CARE
DIRECTOR NAT. INSTITUTE OF HEALTH RESEARCH (FORMERLY BLAIR RES.)
25 OCT 2021
P.O. BOX CY 573, CAUSEWAY
ZIMBABWE

Prof N Midzi
DIRECTOR: NATIONAL INSTITUTE OF HEALTH RESEARCH
FOR: SECRETARY FOR HEALTH AND CHILD CARE

cc Air Commodore Dr J Chimedza - Secretary for Health and Child Care

Appendix 3: Permission letter – DMO Beitbridge District

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa

Tel: +27 21-959 2809, Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

27 August 2021

The District Medical Officer

Beitbridge District Hospital

4527 Main Street

Beitbridge

Zimbabwe

Tel No: +263 852 322112

For Attention: Dr L Samhere

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT BEITBRIDGE DISTRICT HOSPITAL

Dear Dr Samhere

My name is Dr Poshia Musonza, I am a Public Health student at the University of Western Cape in Cape Town. The research I wish to conduct for my Master's dissertation involves determining the pre-natal risk factors for women to develop post-partum haemorrhage following vaginal delivery at Beitbridge District Hospital. The project will be conducted under the supervision of Dr Verona Mathews University Western Cape, South Africa.

I am hereby seeking your consent to conduct this research using data that will be collected from maternity registers.

I have provided you with a copy of my dissertation proposal which includes a copy of the data extrapolation form, as well as a copy of the approval letter which I received from the University of Western Cape Bio-medical Research and Ethical Committee (BMREC). The Protection of Personal Information Act will be adhered to and no names or identification information will be collected.

Upon completion of the study, I undertake to provide you with a bound copy of the full research report. If you require any further information, please do not hesitate to contact me on 0777326343 and 4001437@myuwc.ac.za. Thank you for your time and consideration in this matter.

Yours sincerely,

Dr Poshia Musonza (MD-Russia)
University Western Cape

Biomedical Research Ethics Committee
University of the Western Cape
Private Bag X17
Bellville
7535
Tel: 021 959 4111
E-mail: research-ethics@uwc.ac.za

Permission granted

Appendix 4: Ethical Clearance – Medical Research Council of Zimbabwe

Telephone: 08644073772/791193
E-mail: mrcz@mrcz.org.zw
Website: http://www.mrcz.org.zw

Medical Research Council of Zimbabwe
Josiah Tongogara / Mazowe Street
P. O. Box CY 573
Causeway
Harare

APPROVAL

MRCZ/B/2196 **21 October, 2021**

Dr Poshin Musonzo
97 Parklane
Beitbridge
Zimbabwe

RE: - Pre-Natal Risk Factors for Postpartum Haemorrhage in a District in Zimbabwe: A Case Control Study

Thank you for the application for review of Research Activity that you submitted to the Medical Research Council of Zimbabwe (MRCZ). Please be advised that the Medical Research Council of Zimbabwe has **reviewed** and **approved** your application to conduct the above titled study.

This approval is based on the review and approval of the following documents that were submitted to MRCZ for review: -

1. Full protocol
2. Informed Consent Form
3. Data Collection Tools

- **APPROVAL NUMBER** : **MRCZ/B/2196**

This number should be used on all correspondence, consent forms and documents as appropriate.

- **TYPE OF MEETING** : **EXPEDITED**
- **APPROVAL DATE** : **21 October, 2021**
- **EXPIRATION DATE** : **20 October, 2022**

After this date, this project may only continue upon renewal. For purposes of renewal, a progress report on a standard form obtainable from the MRCZ offices should be submitted three months before the expiration date for continuing review.

- **SERIOUS ADVERSE EVENT REPORTING**: All serious problems having to do with subject safety must be reported to the Institutional Ethical Review Committee (IERC) as well as the MRCZ within 3 working days using standard forms obtainable from the MRCZ Offices or website.
- **MODIFICATIONS**: Prior MRCZ and IERC approval using standard forms obtainable from the MRCZ Offices is required before implementing any changes in the Protocol (including changes in the consent documents).
- **TERMINATION OF STUDY**: On termination of a study, a report has to be submitted to the MRCZ using standard forms obtainable from the MRCZ Offices or website.
- **QUESTIONS**: Please contact the MRCZ on Telephone No. (0242) 791193, 0864407377203 or by e-mail on mrcz@mrcz.org.zw

Other

- Please be reminded to send in copies of your research results for our records as well as for Health Research Database.
- You're also encouraged to submit electronic copies of your publications in peer-reviewed journals that may emanate from this study.
- In addition to this approval, all clinical trials involving drugs, devices and biologics (including other studies focusing on registered drugs) require approval of Medicines Control Authority of Zimbabwe (MCAZ) before commencement

Yours Faithfully

.....

MRCZ SECRETARIAT
FOR CHAIRPERSON
MEDICAL RESEARCH COUNCIL OF ZIMBABWE

MEDICAL RESEARCH COUNCIL OF ZIMBABWE
2021 -10- 21
APPROVED
P.O. BOX HG 573 HIGHFIELD, HARARE

PROMOTING THE ETHICAL CONDUCT OF HEALTH RESEARCH

Appendix 5: Data extrapolation tool

Participant number		☐		
Section 1: Demographic variable data (tick √ appropriate box)				
Age (fill in)		☐		
Marital status	single	☐	married	☐
	divorced	☐		
Education	none	☐	primary	☐
	secondary	☐	high school	☐
	college	☐	university	☐
Employment	employed	☐	not employed	☐
Section 2: Risk factor variable data (tick √ appropriate box)				
Parity	P0	☐	P1	☐
	P2-4	☐	≥P5	☐
Anaemia	present	☐	absent	☐
PIH	present	☐	absent	☐
Hypertension	present	☐	absent	☐
Multiple pregnancy	present	☐	absent	☐
Previous abortion	yes	☐	no	☐
Previous PPH	yes	☐	no	☐
Section 3: Outcome variable data (tick √ appropriate box)				
PPH	yes	☐	no	☐