HYPERTENSIVE DISORDERS IN PREGNANCY AT PIETERSBURG TERTIARY HOSPITAL IN LIMPOPO PROVINCE, SOUTH AFRICA

by

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DISSERTATION

Submitted in fulfilment of the requirements for the degree of

Master of Medicine

In

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Faculty of Health Sciences

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at the

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DEDICATION

The current research is dedicated to my wife and daughters for the support and understanding and love they gave me during the training.

DECLARATION

I, **Malebana Thabo Harmonean**, here declare that "**Hypertensive disorders in pregnancy at Pietersburg tertiary hospital in Limpopo Province, South Africa"** is my work and that all quoted or used sources have been indicated and acknowledged through complete referencing. Furthermore, this work has never been submitted for any other degree at any institution.

Thabo Harmonean Malebana (Dr)

23 February 2024
Date

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ABSTRACT

Background: Rates of maternal hypertensive disorders during pregnancy are increasing among women in South Africa. However, overall prevalence of complications, demographic characteristics, and subtypes of hypertension in pregnancy are still unknown at Pietersburg Hospital.

Objectives: To determine the prevalence of hypertensive disorders in pregnancy in the Department of Obstetrics and Gynaecology at Pietersburg Hospital, Limpopo Province.

Method: A retrospective descriptive study was conducted to examine the medical files of patients who were admitted with hypertensive disorders in pregnancy and also singleton deliveries over a six-month period. The researcher also reviewed medical archives of mothers to find the perinatal outcome indicators of interest for the study. A pre-tested structured questionnaire was used to capture data. Data was then analysed using the Statistical Package for Social Sciences (v-28) through descriptive statistics (percentages, mean, and standard deviations [±SD]). A probability value (*p*) of ≤ 0.05 was a criterion for significance among variables.

Results: The mean age for hypertensive pregnant women presenting with preeclampsia was 26.01 (±7.13) years, of whom 15.8% had singleton deliveries. Preeclampsia is the most common subtype of hypertensive disorder (63.4%), followed by gestational hypertension (15.0%), chronic hypertension (7.3%), and chronic hypertension with superimposed preeclampsia (11.2%). Maternal complications occurred in more than 80% of the hypertensive women. There were 4 (1.95%) maternal deaths. Adverse perinatal outcomes included 42 (20.5%) stillbirths, 1 (0.5%) early neonatal death, 18 (8.8%) cases of intrauterine growth restriction, and 101 (49.3%) low birth weight babies, with a 209 per 1000 births perinatal mortality rate. Comparisons between age, laboratory and clinical parameters were made. There was significant association when comparing age and AST (P value = 0.01); age and platelets (P value = 0.02); age at booking of pregnant mothers and diastolic blood pressure (P value = 0.00); age and systolic blood pressure (P value = 0.00); and age and birth weight (P value = 0.00). No comparisons were made (P value > 0.05) when age is compared to Hb, urea and creatinine. Age had a significant risk of developing preeclampsia (P value < 0.001) and younger age had a higher risk of having preeclampsia than with other maternal hypertensive disorders. Preeclampsia is also found more commonly in primigravidae and women with low parity (P value = 0.03). Pregnant mothers with previous complications of hypertensive disorders had less preeclampsia compared to those without such complications (P value = 0.09).

Conclusion: There is a substantial burden of maternal and perinatal morbidity and mortality associated with maternal hypertensive disorders at Pietersburg Hospital, Limpopo Province, South Africa. Preeclampsia had more predominant adverse outcomes compared to other classes of maternal hypertensive disorders identified in the study.

Keywords: Hypertensive disorders, pregnancy, women, preeclampsia

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Abbreviations

ACOG	American College of Obstetricians and Gynaecologists
ALT	Alanine transaminase
AOR	Adjusted Odd Ratio
AST	Aspartate aminotransferase
BMI	Body mass index
BP	Blood pressure
CI	Confidence interval
CVA	Cardiovascular accident
DBP	Diastolic blood pressure
HDP	Hypertensive disorders in pregnancy
HELLP	Haemolysis, elevated liver enzymes and low platelets
HIV	Human immunodeficiency virus
HT	Hypertension
ISSHP	International Society for the Study of Hypertension in Pregnancy
IUFD	Intrauterine foetal death
IUGR	Intrauterine growth restriction
LDH	Lactic acid dehydrogenase
N	Total number of individuals or observations in the sample study
PET	Preeclampsia
PIH	Pregnancy-induced hypertension
SA	South Africa
SBP	Systolic blood pressure
SD	Standard deviation
SSA	sub-Saharan Africa
WHO	World Health Organization

DEFINITION OF TERMS

Hypertension: Systolic blood pressure (SBP) of 140 mmHg or more or a diastolic blood pressure (DBP) of 90 mmHg or more, or both (Brown, Magee, Karumanchi, McCarthy & Saito *et al.,* 2018). In this study, a similar context applied.

Hypertensive disorders in pregnancy: This is the most common medical problem encountered during pregnancy, with significant percentage complications of pregnancies classified according to timing, onset and severity. In addition, one of the commonest causes of maternal deaths worldwide is hypertensive disorders (Nyflot, Ellingsen, Yli, Qian & Vangen, 2018). In this study, a similar context applied.

During pregnancy, chronic hypertension: High blood pressure (BP) before 20 weeks of gestation (Brown *et al.,* 2018). In this study, a similar context applied.

Gestational hypertension: This is a development of hypertension (HT) after 20 weeks of gestation (Brown *et al.,* 2018). In this study, a similar context was used. Two categories of HT are the mild and severe categories. Mild hypertension is defined as systolic blood pressure between 140 and 159 mmHg and/or diastolic blood pressure between 90 and 109 mmHg. Severe HT is SBP equal to or more than 160mmHg and/or DBP equal to or more than 110mmHg.

Preeclampsia: This is the new onset of hypertension with the presence of protein in the urine (protein to creatinine ratio equal to or above 3.0 mg/dL) or signs of multi-system involvement after 20 weeks of gestation. Without proteinuria, preeclampsia (PET) is explained by the development of HT with end-organ complications of having one or more of the following: thrombocytopenia, renal insufficiency, liver involvement, pulmonary oedema, or visual or cerebral disturbances (Brown *et al.,* 2018; Tranquilli *et al*., 2014). In this study, a similar context applied.

Superimposed preeclampsia: This is PET that occurs after 20 weeks in pregnant mothers with chronic hypertension. PET can be either mild or severe according to the blood pressure measurement (Brown *et al.,* 2018). In this study, a similar context applied.

Eclampsia: This involves convulsions or fits related to hypertensive disorders in pregnancy that occurs in gestation of more than 20 weeks, with the presence of more

than 2+ protein in urine and features of severe preeclampsia (Brown *et al.,* 2018; Tranquilli, Dekker, Magee, Roberts, Sibai *et al.,* 2014). In this study, a similar context applied.

HELLP syndrome (hemolysis, elevated liver enzymes, and low platelets) means kidney involvement with creatinine ≥ 90 micromol/L, neurological involvement (e.g., eclampsia), and/or uteroplacental dysfunction (e.g., fetal growth restriction, abnormal umbilical artery dopplers) (ACOG, 2013). In this study, the HELLP syndrome is defined by hemolysis or low hemoglobin levels, elevated liver enzymes, and low platelets.

Primary outcome: This is described as the degree of occurrence of maternal hypertensive disorders in pregnancy where there was delivery at the current study site (Pietersburg Hospital, Limpopo Province) during the study period.

Secondary outcome: This is described as the degree of occurrence of maternal and foetal complications and its outcomes among those with maternal hypertensive disorders in pregnancy that are admitted to Pietersburg Hospital (Limpopo Province) during the study period.

CHAPTER ONE: INTRODUCTION AND BACKGROUND

This chapter introduces the topic on hypertensive disorders in pregnancy and further gives background which is contextualised in relation to the area researched.

1.1. Introduction and background

Hypertension is among the commonest comorbidities found during pregnancy (Sharma, Sidhu & Kaur, 2016). The effect of hypertensive disorders during pregnancy is significant on foetal and maternal well-being during pregnancy and postpartum. Hypertensive disorders in pregnancy (HDP) are among the commonest causes of adverse outcomes related to increased rates of preterm birth, small for gestational age babies, maternal mortality, neonatal mortality and stillbirth (Jeena, Asharam, Mitku, Naidoo & Naidoo, 2020). Demographic characteristics among the childbearing population in South Africa (SA) suggest that women have increased high-risk pregnancies, and that includes those with advanced maternal age and chronic medical conditions such as diabetes mellitus, hypertension and asthma (Jeena *et al.*, 2020). Surveillance of maternal health and morbidity, both antenatal and postpartum, are critical to improve the health of those women at high risk. Evidence suggests that HDP may have long-term neurodevelopmental consequences for the foetus (Maher, O'Keeffe, Kearney, Kenny & Dinan *et al.,* 2018). As a result of the suboptimal placental perfusion in HDP-complicated pregnancies, insufficient oxygen and nutrient supply can be associated with alterations in foetal brain development and subsequent poorer behavioural and cognitive development (Pinereiho, Brunetto, Ramos, Bernardi & Goldani, 2016; Walker, Krakowiak, Baker, Hansen & Ozonoff *et al.,* 2015).

The rates of HDP appear to be rising in some parts of the world including, but not limited to, the United State of America. According to the World Health Organization (WHO), 303 000 women die worldwide during pregnancy and childbirth each year. The weighted stillbirth rate is 21.9 per 1000 births in women with hypertensive disorder during pregnancy and live births of 8.4 per 1000 in China (Xiong, Mu, Liang, Zhu & Li *et al.,* 2018). In Ethiopia, the incidence of HDP is around 5% with most having severe preeclampsia (Berhe, Kassa, Fekadu & Muche, 2018). Although incidences of HDP are low in Saudi Arabia, frequent maternal and perinatal complications were still reported (Subki, Algethami, Baabdullah, Alnefaie, Alzanbagi *et al.,* 2018). In India, hypertensive disorders complicate around 5% to 10% of all pregnancies forming the fatal triad (Sengodan & Sreeparthi, 2020).

In South Africa (SA), HDP have contributed to 19–21% of maternal deaths (Moodley, 2018; Berhe *et al.,* 2018). According to the 'Saving Mothers Reports' on confidential inquiries in SA, eclampsia and proteinuric hypertension accounted for most of the deaths (83%) in the second triennial reports (Saving Mothers Report, 2002). About 50% of deaths related to eclampsia resulted from cerebral haemorrhage in under-resourced countries (Maurice *et al.,* 2008). On the other hand, 18% and 12.5% of all admissions at King Edward VIII Hospital and KwaMashu Hospital (Durban) consisted of HDP, respectively, while 12% of admissions in the Durban Metropolitan Area were associated with hypertension (Moodley, 2007; Panday *et al.,* 2004). Hypertension and its related complications account for a significant percentage of maternal and neonatal morbidity and mortality globally, including in SA. It is possible, therefore, that in Limpopo Province, HDP-related complications are common. It is important to investigate HDP among pregnant women in this province in order to minimise the health and other related risks associated with this condition.

1.2. Problem statement

During the clinical practice of the researcher at Pietersburg Tertiary Hospital, an average of 250 deliveries by pregnant women, per month, were done. These pregnant women came as referrals from various clinics and hospitals in Limpopo Province as the hospital serves as a tertiary referral institution for many conditions, including complicated pregnancies. The hospital further serves as a training institution for medical students from the University of Limpopo and is a central hospital with multiple departments or disciplines. However, the incidence related to HDP in this institution from the referred pregnant women in the maternity ward remains unreported. Generally, chronic metabolic condition rates and hypertensive disorders among pregnant women are increasing in SA (Moodley, 2018). It is possible that these disorders have a high prevalence so contributing to some of the preventable deaths among the pregnant women giving birth in the Pietersburg Hospital labor ward. Therefore, the researcher aimed to investigat3 the HDP among pregnant women referred to the Pietersburg Hospital, in order to improve the general outcomes during birth.

1.3. Rationale

Maternal hypertension and its related complications could be responsible for maternal and neonatal morbidity and mortality at Pietersburg Hospital. These cases of HDP and its related complications are often admitted daily to high care units. In spite of this problem, the overall

prevalence related to complications, various forms of presentations, and demographic characteristics remain unknown. This therefore drove the need for the current study to be undertaken at Pietersburg Tertiary Hospital.

1.4. Aim

This study aimed to determine the prevalence of hypertensive disorders in pregnancy, associations and outcomes at Pietersburg Tertiary Hospital, Limpopo Province, South Africa.

1.5. Objectives

The objectives of this study at Pietersburg Hospital, Limpopo Province, South Africa were to:

1.5.1. Determine the demographic profile of patients with hypertensive disorders in pregnancy.
1.5.2. Classify hypertensive disorders (timing, onset and severity) in pregnancy.
1.5.3. Determine the relationship between the demographic profile and hypertensive disorders in pregnancy.

1.6. Research question

What is the spectrum, and what are the outcomes and association of hypertensive disorders in pregnancy at Pietersburg Hospital, Limpopo Province, South Africa?

1.7. Structure of the dissertation

This dissertation consists of five chapters. In Chapter One, the researcher introduces the reader to the background of the study and includes the problem statement, aims, objectives and research question. In Chapter Two, a literature review on hypertensive disorders in pregnancy is presented. Chapter Three cites the methodology followed during this research, which includes study design, study population, techniques for the sample, and collection of data including analysis. The results are presented in Chapter Four. In Chapter Five, the conclusion and recommendations are presented.

CHAPTER TWO: LITERATURE REVIEW

This chapter reviews the literature on hypertensive disorders in pregnancy. Different scientific search engines such as Pub-Med, Science Direct and Google Scholar were used to source articles.

2.1. Introduction

The pregnant woman is considered to have hypertension when her blood pressure is ≥ 140/90 mmHg on two consecutive measurements (Braunthal & Brateanu, 2019). Hypertensive disorders in pregnancy generally refer to an increased blood pressure during pregnancy (Gemechu *et al.,* 2020). The subtypes of HDP include gestational hypertension, chronic hypertension, preeclampsia (with protein in urine) and chronic hypertension with superimposed preeclampsia (Gemechu *et al.,* 2020).

Factors contributing to hypertensive disorders in pregnancy were found to be obesity, weight gain, and smoking (Macdonald-Wallies, Tiling, Fraser, Nelson & Lawlor, 2013). The common complications include pulmonary oedema, renal failure/impairment, and disseminated intravascular coagulation (Nisa, Shaikh & Kumar, 2019). Obesity is a high-risk factor for gestational hypertension and diabetes mellitus. Women who are excessively gaining weight during their pregnancy are probably predisposed to PET (Nisa *et al.,* 2019).

2.2. Diagnosis of HDP

The International Society for the Study of Hypertension in Pregnancy (ISSHP) has classified the diagnosis of HDP as described below (Brown *et al.,* 2018). Chronic hypertension (HT) is HT which is diagnosed pre-conception or is developed before 20 weeks of gestation. White coat hypertension, defined as patient's blood pressure readings that are taken at consultation room and which are higher and different from ones taken at different location (home) may be due to a patient anxious about a previous experience in consultation (Brown *et al*., 2018). Masked HT is defined as normal BP readings taken at the clinic level but with higher readings outside the clinic setting. This can be diagnosed with 24-hour ambulatory or automated BP monitoring at home. Clinicians can use different strategies to identify, monitor, and manage those hypertensive disorders in pregnancy to prevent severe complications and deaths. For example, BP monitored at home after pregnancy (Brown *et al*., 2018). Gestational HT is defined as HT that develops after 20 weeks without protein in the urine, and/or is not in

relation to foetal growth restriction or poor pregnancy outcome. Preeclampsia is defined by development of HT after 20 weeks of gestation and with presence of protein in the urine or maternal evidence of end-organ involvement, such as maternal acute renal injury, neurological features, liver dysfunction, thrombocytopenia or hemolysis, or foetal growth restriction (Brown *et al*., 2018). Preeclampsia (PET) may result or be diagnosed during labor or postpartum. HELLP syndrome is a serious feature of PET.

2.3. Hypertensive disorders in pregnancy in South Africa

Hypertensive disorders in pregnancy (HDP) account for 18% of all maternal deaths and are the most common cause of maternal mortality (Moodley, 2004). Twelve per cent (12%) and 18% incidences of HDP cases were found during community- and tertiary facility-based studies, respectively, in SA (Moodley, 2004). The Saving Mothers report published by the National Committee for Confidential Enquiry focuses on maternal deaths and in South Africa it identified several problems in the management of HDP and recommended interventions (Naidoo & Pattison, 2020). Even though most of the emergencies originated from primary healthcare and/or the district hospital levels, maternal deaths (78%) occur at the regional or tertiary level of care (Moodley *et al.,* 2019). The guidelines further indicated that 75% of potentially preventable maternal deaths have been increasing over the last decade due to HDP (Moodley, Soma-Pillay, Buchman & Pattinson, 2019). Forty-eight per cent of cases at the Community Health Centre and 60% of cases at the District Hospital level with avoidable factors of HDP deaths were identified (Moodley *et al.,* 2019). The factors identified included incomplete assessment, delays in or failure to refer to regional or tertiary level of care, errors in diagnosis, failure to adhere to protocols, failure to monitor, and failure to respond to abnormal monitoring. The incidence of hypertensive disorders in pregnancy in SA was 12% and it is the commonest cause of maternal death – contributing to 21% of maternal deaths (Moodley, 2004). The recent management of HDP derived from the National Guidelines addresses the approach to the diagnosis, assessment and management of HDP (Moodley *et al.,* 2019).

2.4. Incidences of HDP

Globally, pregnancy and childbirth results in half a million of women dying yearly. Of these deaths, 50% and 42% were reported in Africa and Asia, respectively, 4% in Latin America and the Caribbean and < 1% in developed countries (WHO, 2019). Worldwide, about 2.7%

mothers have HDP, with a 0.2% incidence of chronic hypertension, while preeclampsia is 2.1%, and eclampsia is 0.28% (Gemechu, Assefa & Meninstie, 2020). Of all pregnancies globally, 5–10% are affected by hypertensive disorders in pregnancy (HDP) and this is the commonest cause of maternal and perinatal morbidity and mortality (Braunthal & Brateanu, 2019). In developing countries, its believed that 10–15% of maternal deaths are due to HDP (Girum & Wasie, 2017).

However, in sub-Saharan Africa (SSA), a relatively higher prevalence of 1 in 10 pregnant women are reported to have HDP (Gemechu *et al.,* 2020). Furthermore, it is concerning that SSA populations are underrepresented in recent information on the worldwide burden of HDP, therefore showing the need for further research in addressing HDP among women (Gemechu *et al.,* 2020). Over the last few decades, the burden of hypertension has increased in SSA. However, most of the population diagnosed with hypertension remains untreated, so leading to increased cardiovascular disorders in the region (Gemechu *et al.,* 2020). There is little knowledge of the incidence of HDP in SSA despite a widespread investigation in developed countries (Berhe *et al.,* 2018; Gemechu *et al.,* 2020). According to WHO, it is estimated that one woman dies every seven minutes from complications of hypertensive disorders in pregnancy (Xiong *et al.,* 2018). Therefore, it is important to measure the overall prevalence and types of HDP and related pregnancy outcomes in the Limpopo Province setting, in order to inform policymakers and to guide strategies for early detection, management, and prevention of these disorders.

In Ethiopia, hypertensive disorders in pregnancy are reported to be the leading cause of poor perinatal outcomes in older pregnant women (> 35 years old) (Berhe *et al.,* 2018; Gemechu *et al.,* 2020). The most prevalent subtype of HDP was preeclampsia followed by gestational hypertension and eclampsia (Gemechu *et al.,* 2020). A statistically significant association of hypertensive disorders in pregnancy with increasing age was determined (Berhe *et al.,* 2018). A study in Saudi Arabia further showed that 30.3% of primigravidae and 46% of grand multipara presented with pregnancy disorders (Al-Shaikh, Ibrahim, Fayed & Al-Mandeel, 2017). Another study at Umtata General Hospital (UGH) reported a 27.3% and 18.3% incident of hypertensive patients among teenage mothers and mothers over the age of 35 years, respectively (Kilembe, 2004). However, the prevalence of HDP was lower (2.4%) in Saudi Arabia. Screening for HDP was recommended early in pregnancy to prevent the detrimental effects of the condition on both the mother and the foetus (Berhe *et al.,* 2018).

In India, the prevalence of HDP was low among multigravidae (46%) compared to primigravidae (54%) (Prakash, Pandey, Singh & Kar, 2006). Hypertensive disorders are reported to be highest among the 18–22 year-olds and especially in women over 30 years old (Berhe *et al.,* 2018; Gemechu *et al.,* 2020).

In other countries such as India, a commonly reported maternal complication was HELLP syndrome (Magee, Sharma, Nathan, Adetoro, Bellad *et al.,* 2019). Intracranial haemorrhage was the major final cause of death (Gemechu *et al.,* 2020). In developed countries, eclampsia occurs in 1.5 to 10 cases per 10 000 deliveries and 19.6–140 in low- to middle-resource countries (WHO, 2019). The contributing causes include disseminated intravascular coagulation, pulmonary oedema, and renal failure/impairment. The deaths resulting from eclampsia can occur in any healthcare facility irrespective of level of care (Vousden, Lawley, Seed, Gidiri, Goudar, Sandall, Chappell & Shennan, 2019). HDP is regarded as a risk to the foetus and mother when not diagnosed early. It is important to screen pregnant women for HDP and if HT is present, close and regular monitoring is needed (Kattah & Garovic, 2013). Early diagnosis and timely intervention may reduce maternal complications (Berhe *et al.,* 2018). Failure to follow clinical protocols or lack of management protocols of care has resulted in avoidable medical factors (Gemechu *et al*., 2020). Foetal growth restriction is more common in hypertensive disorders in pregnancy with low birth weight (Berhe *et al.,* 2018).

The prevalence of perinatal mortality in hypertensive pregnant mothers was found to be higher in sub-Saharan countries. Hypertensive disorders in pregnant women remain a challenge globally. Accordingly, this study seeks to assess the prevalence of hypertensive disorders in pregnancy at the Obstetrics and Gynaecology Department, Pietersburg Tertiary Hospital, in Limpopo Province. Failure to diagnose early and initiate early treatment of hypertensive disorders in pregnancy may result in severely adverse maternal and perinatal outcomes. Therefore, it is important to identify the magnitude of the problem at Pietersburg Tertiary Hospital and to determine risk or predisposing factors in order to prevent some cause of HDP.

CHAPTER THREE: RESEARCH METHODOLOGY

This chapter describes the methodology and procedures adhered to during data analysis. Statistical tests for data analysis are also included.

3.1. Research design

This study was cross-sectional with a descriptive design. It also adopts a retrospective design. A cross-sectional study design is a collection of data at a specific point in time using the same participants (Brink, Van der Walt & Van Rensburg, 2018). A descriptive study refers to one that is intended to describe a phenomenon (Brink *et al.,* 2018). In the current study, the descriptive study design aims to describe the prevalence of hypertensive disorders in pregnant women in the Pietersburg Tertiary Hospital in Limpopo Province.

3.2. Study population

The study population for this research was the hypertensive pregnant women in Pietersburg Tertiary Hospital that gave birth in the maternity ward between 01 January and 30 June 2022. The hospital in Limpopo Province receives referrals from district and regional hospitals for complicated cases, including obstetric patients. Therefore, the population expected for this study over a period of six (6) months was 1500.

3.3. Study site

The study took place in the maternity (labor ward) of Pietersburg Hospital (see above). This hospital in Limpopo Province is a training site for University of Limpopo Health Science students. It is a central hospital with multiple departments or disciplines. Limpopo had an estimated population of 5 852 553 in 2020, according to Statistics South Africa. The geographical location of the hospital is shown in Figure 3.1 below:

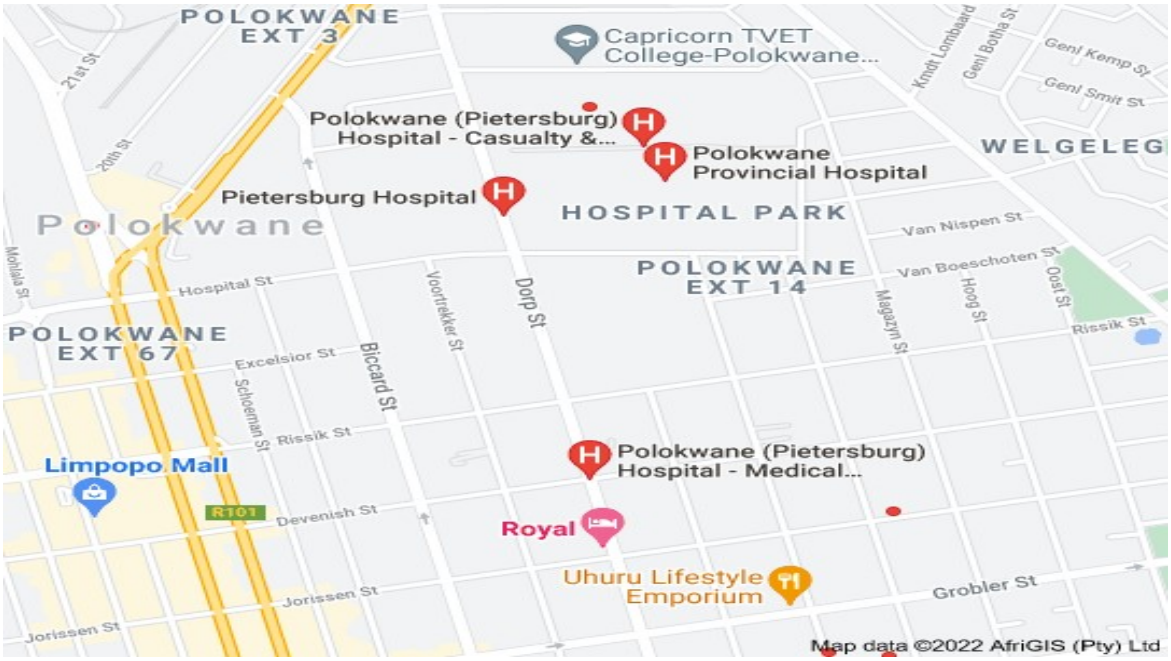

Figure 3.1. Geographical location of Pietersburg Hospital (*Google Maps*)

3.4. Sample size and procedure

The sample size for this research was 123 records drawn from 180 patient files from 1 January to 30 June 2022. These were stored in the Registry Department. The sample size was representative of the population obtained using the Morgan and Krejcie Table (1970). The first 123 records of patients treated for hypertension disorders that were received according to the registry list were used to answer the research question of this study.

3.4.1. Inclusion criteria

All patients who were admitted at Pietersburg Tertiary Hospital maternity ward from 1 January to 30 June 2022 and have delivered and were diagnosed with hypertension in pregnancy were included in the study.

3.4.2. Exclusion criteria

All patients admitted to Pietersburg Tertiary Hospital maternity ward who delivered and were diagnosed with hypertension in pregnancy with co-morbidity or already known other diseases (e.g., diabetes mellitus, heart disease, kidney disease). Patients with multiple pregnancies (twins) or late spontaneous abortions were also excluded from this study as they may bring extreme variation to the data.

3.5. Exposure variable

Hypertensive disorders in pregnancy were the variable of interest, which was explained as a diagnosis of the following complications during pregnancy: gestational hypertension defined as elevated BP on at least two occasions, four hours apart, and systolic blood pressure (SBP) of ≥ 140 mmHg or diastolic blood pressure (DBP) of ≥ 90 mmHg with more than 20 weeks of gestation without proteinuria (Braunthal *et al*., 2019). Preeclampsia is defined as SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg at more than 20 weeks (on two occasions, four or more hours apart) with proteinuria of ≥ 300 mg/24 hours from at least two urine specimens collected within or more than 6 hours apart (Moodley *et al.,* 2019). Eclampsia was described as HT with SBP ≥ 140 mmHg or DBP ≥ 90 mmHg, the presence of seizures, and proteinuria (Moodley *et al.,* 2019).

3.6. Data collection

Since this study was retrospective, the administrative databases and medical records of patients who were already known to have a disease or condition were used. During data collection, the master list" containing real patient names and record numbers were utilised to request hospital folders from Records Department of Pietersburg hospital. The demographic profile and incidences of HDP were gathered from these medical records by the researcher. Information pertaining to HDP was gathered from patient files and will help answer the research question as in Annexure 3. The researcher collected data mostly in the afternoon when patient ward rounds and flow at the registry were low. Files were requested in batches of 10 each day after the identification of patients in the registry list. Data collection was done in a private office by the researcher in order to ensure quality. Every set of files was returned to the registry once data collection had been completed.

3.7. Data analysis

The collected data was analysed using Statistical Package for Social Sciences (SPSS) software (IBM) v-28. Descriptive stats which included percentages (%), mean and standard deviation values were used to describe the population. Paired t-tests were used to compare the mean values within the groups for more than three or more than two variables, respectively. The Chi-square and One-way ANOVA test was used to associate the

demographic data with the maternal and perinatal outcomes. All significant thresholds were set at a p-value < 0.05 using a 95% confidence interval (CI).

3.8. Measures of rigour

3.8.1. Reliability

Reliability is the dependability and uniformity of a research tool used to analyse a variable (Brink, 1996). Reliability was ensured in this study as data collection was conducted by the researcher, who obtained training in standards and procedures applied for the management of pregnant women. The tool used in this study was also assessed for reliability through the pilot study and moderation by medical experts in gynaecology and obstetrics.

3.8.2. Validity

Brink, Van der Walt and Van Rensburg (2018) define validity as the capability of an instrument to measure the variables that it intended to measure. The instruments used in this study were modified after the pilot study. Content validity was ensured by reviewing the literature and ensuring that questions asked in the current study questionnaire are in line with questions asked in previous studies. Content validity was also ensured by taking questionnaires to the experts in the field for review.

3.9. Bias

Bias refers to any act of deviation from the truth during data collection, analysis and publication (Šimundić, 2013). In this study, the following indicated that bias parameters were minimised:

3.9.1. Selection bias

According to Šimundić (2013), the sample studied must be representative of the total population. In this study, this was achieved as all 120 files were drawn from records of patients in the registry.

3.9.2. Content bias

This was minimised by the inclusion of extensive literature searches and updated recent articles (as much as possible).

3.9.3. Data analysis bias

This was minimised by using parametric methods (such as descriptive statistics) to analyse the data. This measure of central tendencies translates the sample mean as an unbiased estimator of the population mean. The assumed value of the sample mean is equivalent to the population mean μ. Therefore, the sample mean was an unbiased estimator of the population mean. Therefore, this study managed bias by applying parametric methods for quantitative analysis.

3.10. Ethical considerations

Ethics compliance requires autonomy and the protection of those with lessened autonomy when performing research. This also covers such items as justice and non-maleficence; beneficence; informed consent; confidentiality; protection of data; and integrity. Since the current study was retrospective, confidentiality and data protection and integrity were considered by not using patients' true personal details but by creating a code of identification for the sake of the study. To ensure confidentiality, files were allocated numbers and the identity of patients is not published in the results. The ward register was used to identify patients with HDP, and the list was done using patients' hospital numbers. This list was used to collect files from records where the administrator and researcher signs when collecting and returning files.

3.11. Ethical approval

The proposal was presented at the departmental level and then was submitted to the Faculty Research Office. Approval to collect data was obtained from the Turfloop Research and Ethics Committee (TREC) (TREC/19/2023 PG) at the University of Limpopo. Permission for data collection from the Pietersburg Hospital was sought from the Department of Health (Limpopo Province) and the Hospital Ethical Committees.

3.12. Permission

Permission for collection of data was sought first from the Department of Health, Limpopo Province, and then from the Chief Executive officer at Pietersburg Tertiary Hospital before the data was collected.

3.13. Consent

The study involved the collection of data using patient records/files. Therefore, the researcher received a waiver of consent to participate in the research given that the sample involves the records of participants. It was granted by the ethics committee (TREC) and the Department of Health Limpopo on behalf of Pietersburg Hospital.

3.14. Privacy

Privacy was ensured by keeping the completed questionnaire in locked shelves and the keys were accessed only by researchers.

3.15. Anonymity

Anonymity was ensured by assigning specific codes for each participant, and the codes appeared in the questionnaires instead of the participants names.

3.16. Implications for public health practice

This study will contribute to the pool of knowledge in obstetrics. Furthermore, this study has significant implications for public health practice. Hypertensive disorders in pregnancy, associated with morbidity and mortality, are preventable with proper implementation of quality improvement initiatives to recognise and promptly treat HDP and to increase urgent maternal warning signs' awareness.

3.17. Timeframe

Item	Jan 2023	Feb 2023	March2023	April2023	May 2023	June2023	July 2023	August 2023
Proposal development								
Ethical approval								
Data collection process								
Data capturing								
Data analysis								
Discussion of results								
Compilation of research report								
Editing of document								
Submission for examination								

3.18. Budget

Item	Price
Stationery	R500
Travel	R1500
Data capturing	R1500
Data analysis	R6000
Editing	R3500
Total	**R13000**

CHAPTER FOUR: RESULTS AND DISCUSSION

The chapter presents the results of the study and further discusses them in comparison with the literature and other related studies.

4.1. Results

During the six-month study period, 1650 singleton births occurred at Pietersburg Hospital. Of these, 260 women had pregnancies complicated by HDP – an incidence of 15.8%. Medical records of 205 cases were obtainable for analysis and 55 were excluded because 12 had multiple gestations, there were 5 cases of cardiac disease (severe mitral regurgitation with pulmonary hypertension, rheumatic heart disease with severe mitral regurgitation, peripartum cardiomyopathy, Tetralogy of Fallot, and pulmonary hypertension), spontaneous miscarriage (n=1), gestational diabetes mellitus (n=1), and 36 files were untraceable (Figure 4.1).

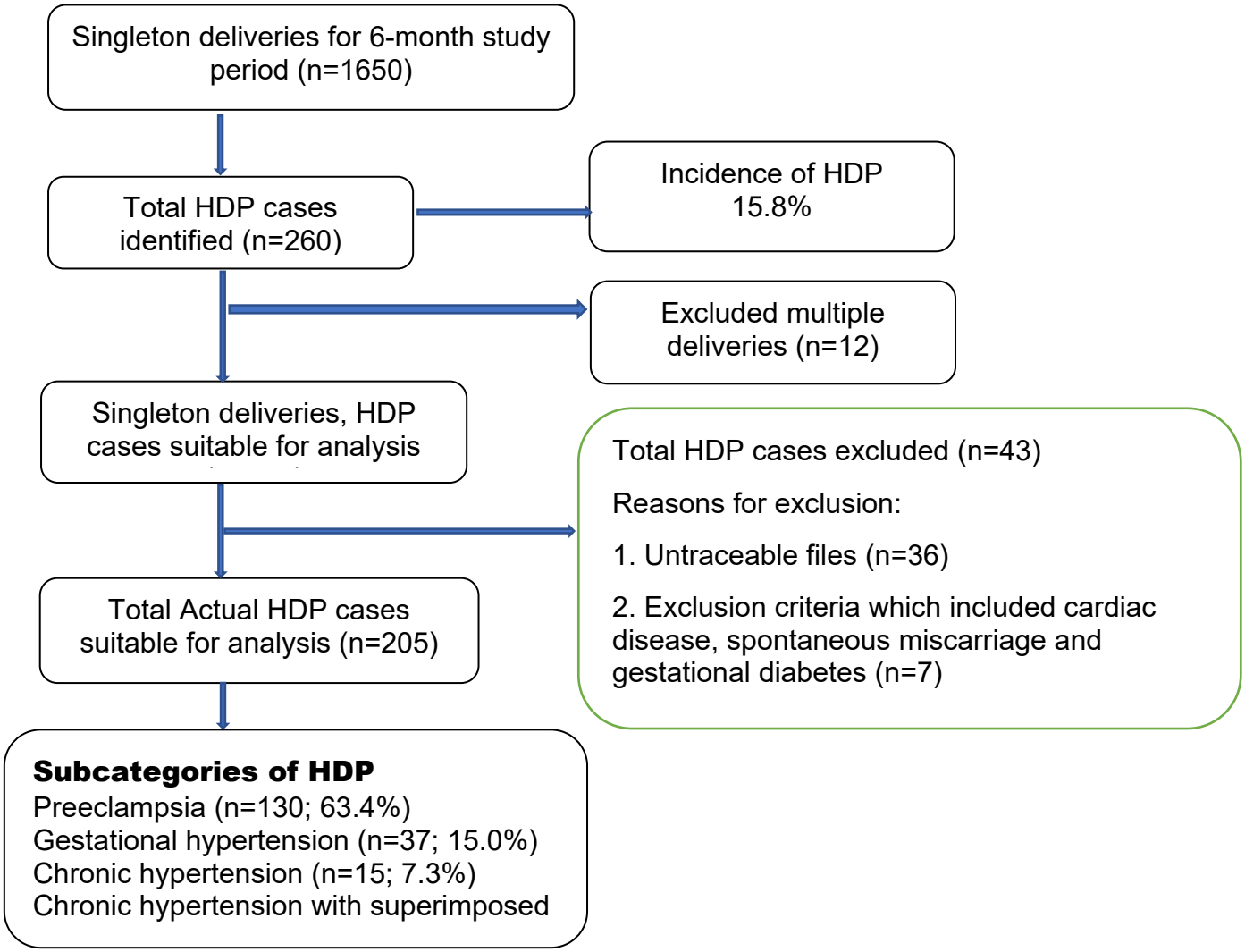

Figure 4.1: Patient selection process for the current study

4.1.1. Socio-demographic and clinical characteristic of the study population

Hypertensive pregnant mothers' age ranged from 13 to 44 years with a median and mean of 29.00 and 28.4±7.4 years, respectively. Some 13.2% of the cases were teenagers and primigravidae accounted for 36.1% of all the cases. Those hypertensive patients aged above 30 years and above 35 years comprised 42.9% and 12.2%, respectively, and 6.34% accounted for those aged 40 years and older. Women older than 30 years were twice [AOR: 2.06, 95 %CI: (1.48–11.74)] as likely to develop hypertensive disorders in pregnancy as those pregnant women younger than 19 years.

One hundred and eighty-six (186; 90.7%) hypertensive pregnant mothers attended antenatal care, and 19 (9.3%) were unbooked. The gravidity was ranging from 1 to 8. Primigravidae numbered 74 (36.1%) while there were 131 (63.9%) multigravidae and with gravidity ranges from 2 to 8. In the study, pregnant women who were multigravidae were 1.7 times more likely to have hypertension disorders in pregnancy compared with pregnant women who were primigravidae. The socio-demographic characteristics and distribution of the various classes of hypertensive disorders of the population is summarised in Tables 4.1–4.8.

Table 4.1: Socio-demographic characteristic of the study population

Variables	Number of observations	Mean (sd)
Mean Age	204	28.4±7.4
Age groups (yrs)		*n(%)*
15-19	26	26 (12.7%)
20-35	134	134 (65.9%)
> 30	88	88 (43.1%)
> 35yrs	44	44 (21.6%)
40 yrs and above	13	13 (6.4%)
		Mean (sd)
Parity	205	1.4±1.4
		n(%)

0	75	75 (36.6%)
1	50	50 (24.4%)
2	41	41 (20.0%)
≥ 3	39	39 (19.0%)
		Mean (sd)
Gravidity	205	2.62±1.6
		n(%)
1	66	66 (32.2%)
2	42	42 (20.5%)
≥ 3	97	97 (47.3%)
		Mean (sd)
Booking for antenatal care	205	4.5±1.9
		n(%)
Booked	186	186 (90.7%)
Unbooked	19	19 (9.3%)
Gestational age at booking		*Mean (sd)*
	205	35±4.6
		n(%)
< 26 weeks 0 days	147	147(71.7%)
26–27 weeks 6 days	13	13 (6.3%)
28–31 weeks 6 days	17	17 (8.3%)
32–33 weeks 6 days	1	1 (0.5%)
34-36 weeks	6	6 (2.9%)
> 37 weeks	4	4 (2.0%)

Table 4.2: Booking status of the study population

Variables	**Number of observations**	**Mean (sd)**	**Cut-off values**
Haemoglobin (g/dl)	203	11.5±1.8	
Mean		*n(%)*	
Non-anaemic	140	140 (68.3%)	
Mild	30	30 (14.6%	
Moderate	30	30 (14.6%)	
Severe	3	3 (1.5%)	
Variables	*Number of observations*	*Mean (sd)*	
RPR	202	202 (100%)	
Negative	201	201 (98.0%)	
Positive	1	1 (0.5%)	
Variables	*Number of observations*	*n (%)*	
Rhesus	202	202 (100%)	
Negative	5	5 (2.4%)	
Positive	197	197 (97.5%)	
Blood pressure @ booking		*Mean (±sd)*	
SBP (mmHg)	189	127.8±19.0	
Variables	*Number of observations*	*n (%)*	
< 140	159	159 (77.6%	
> 140-160	19	19 (9.3%)	
161-180	6	6 (2.9%)	
> 180	5	5 (2.4%)	
Variables	*Number of observations*	*Mean (±sd)*	
DBP (mmHg)	189	76.6±15.3	

Variables	*Number of observations*	*n (%)*
< 90	164	164 (80.0%)
90–109	21	21 (10.2%)
≥ 110	4	4 (2.0%)
HIV status	202	
Negative	178	178 (86.8%)
Positive	25	25 (12.2%)
Variables	*Number of observations*	*n (%)*
Booking for antenatal care	205	
Booked	186	186 (90.7%)
Unbooked	19	19 (9.3%)

4.1.2. Risk profile pattern of the study population

Previous history of maternal hypertensive disorders: of the cases 2.9% (n=6) had maternal hypertensive disorder while 96.1% (n=197) did not have any previous history.

One hundred and thirteen (71.5%) patients had a body mass index (BMI) of 25 kg/m^2 and greater and, 28.5% (n=45) had a BMI of below 25 kg/m^2. After adjusting for maternal age and pre-existing obesity (aOR 4.3; 95% confidence interval: 3.2–5.7; P value < 0.001), women aged ≥ 20-35 years (aOR 1.3; 95% CI: 1.1–1.5; P value < 0.001) remained statistically significant of being diagnosed with HDP (P value < 0.001).

A BMI of 22.9% (n=47) could not be determined because the height, weight or both parameters were missing in the records.

Table 4.3: Risk profile pattern of the study population

Variables	Number of observations	Mean ±sd
BMI (Kg/m^2)	159	31.2±9.2
Underweight (< 18.5)	5	5 (2.4%)
Normal weight (18.5–-24.9)	40	40 (19.5%)
Overweight (25–-29.9)	53	53 (16.1%)
Obese I (30–-34.9)	22	22 (10.7%)
Obese II/III (≥ 35.0)	58	58 (28.3%)
Previous history of HDP	203	N (100%)
Yes	6	6 (2.9%)
No	197	197 (96.1%)

Of these women with HDP, 15 (7.3%) had chronic hypertension, 23 (11.2%) had preeclampsia superimposed on chronic hypertension, 130 (63.4%) had preeclampsia, and 37 (15.0%) had gestational hypertension. The majority of the 130 patients (63.4%) had preeclampsia.

Table 4.4: Types of maternal hypertensive disorders identified in the study population

Types of maternal hypertensive disorders	No of observations	n (%)
Gestational hypertension	37	37 (18)
Chronic hypertension	15	15 (7.3)
Preeclampsia	130	130 (63.4)
Preeclampsia superimposed on chronic hypertension	23	23 (11.2)

Table 4.5: Complication profile of the study population

Variables	Number of observations	Yes n(%)	No n(%)
HELLP	202	41 (20%)	161 (78.5%)
Abruptio	201	17 (8.3%)	184 (89.8%)
Acute kidney injury	205	21 (10.2%)	184 (89.8%)
Pulmonary oedema	204	5 (2.4%)	199 (97.1%)
Eclampsia	205	27 (13.2%)	178 (86.8%)
Anaemia	203	59 (29.1%)	144 (70.2%)
More than one injury	205	29 (14.1%)	176 (85.86%)
CVA	205	2 (1.0%)	203 (99.0%)
Maternal deaths	205	4 (1.95%)	201 (98%)

4.1.3. Comparison of age with clinical and laboratory parameters of the study population

Differentiation between the age and laboratory and clinical parameters was made. Notable associations between age and AST (P value = 0.01); age and platelets (P value = 0.002); age and diastolic blood pressure (P value = 0.000); age at booking of pregnant women and systolic blood pressure (P value = 0.000); and age and birth weight (P value = 0.00) were found. There was no statistical significance when comparing age and HB (P value = 0.470), urea (P value = 0.440) and creatinine (P value = 0.090).

Table 4.6: Clinical data and laboratory parameters of pregnant mothers with maternal hypertensive disorders

Variables	Number of observations	Mean ±sd
Age	204	28.4±7.4
Hemoglobin	203	11.5±1.8
Platelets	115	183.9±98.7
ALT	115	60.7±143.3
AST	115	91.3±277.0
LDH	115	485.9±515.2
Urea	205	3.4±2.6
Creatinine	205	80.5±67.4
Systolic blood pressure	189	127.8±19.0
Diastolic blood pressure	189	76.6±15.3
Gestational age	205	35.0±4.6
BMI	159	31.2±9.2
Birth weights	188	2437.2±890.6

4.1.4. Blood pressure at admission

The SBP was measured from 95 to 236.0 mmHg with a mean of 127.8±19.0mmHg. The DBP was measured from 45 to 172mmHg with a mean of 76.6±15.3mmHg.

4.1.5. Proteinuria on admission

Urinary dipstick was done to measure proteinuria, with protein of ≥ 2+ and considered significant. Some 113 (55.1%) of the patients had significant proteinuria.

4.1.6. Gestational age on admission

On admission, gestational age ranged from 20 to 42 weeks gestation, with a mean of 35.16±3.80 weeks.

4.1.7. Mode of delivery

Sixty-four patients (31.4%) delivered vaginally and those delivered by caesarean section numbered 140 (68.6%).

4.1.8. Birth weight

In this study, there were differential endpoints in terms of normal birth weight, low birth weight and macrosomia – occurring in 42.4%, 49.3% and 2.7%, respectively. The occurrence of low birth weight (P value = 0.032) and low Apgar scores at 5 minutes (P value = 0.04) was statistically significant in preeclampsia when compared to other classes of HDP after adjusting for confounders, maternal age, and parity.

4.1.9. Apgar scores

Regarding Apgar scores, 24.4% of the babies had scores less than seven (7). Comparisons looking at age, clinical and laboratory parameters – there was a significant comparison between age and platelets (P value = 0.004), and age and alanine aminotransferase (AST) (p\P value = 0.36). Age at booking of pregnant women and systolic blood pressure (P value < 0.001), age and diastolic blood pressure (P value = 0.01), age and birthweight (P value < 0.001) had statistical significance. However, there was no statistical significance between age and Hb (P value = 0.19), age and urea (P value = 0.32), and age and creatinine (P value = 0.96).

Table 4.7: Comparison of age with clinical and laboratory parameters of the study population

Variables	Observation[mean(±sd)]	P-value
Systolic blood pressure	189 [127.8±19.0]	<0.001
Diastolic blood pressure	189 [76.6±15.3]	0.01
AST	115 [91.3±277.0]	0.36
Birth weight	188 [2437.2±890.6]	<0.001
Hemoglobin	203 [11.5±1.8]	0.19
Platelets	115 [183.9±98.7]	0.004
Urea	205 [3.4±2.6]	0.32
Creatinine	205 [80.5±67.4]	0.96

Comparisons were made between preeclampsia and other classes of maternal hypertensive disorders identified in the study. Differentiation was done between age and laboratory and

age and clinical parameters. The relationship between low birth weight, SBP, DBP, BMI and gestational age, and preeclampsia (PET) was statistically significant. The mean BMI of PET patients (28.5±7.6 kg/m^2) is lower than that of those without PET (36.3±9.8kg/m^2). Age is a risk factor for having preeclampsia ($p<0.001$), with preeclampsia emerging in younger women. The mean age of hypertensive pregnant mothers who had PET is 26.53±7.4 years.

Table 4.8: Comparison of risk profile of preeclampsia with other maternal hypertensive disorders identified in the study population (clinical and laboratory parameters)

Variable	Preeclampsia	Other HDP classes identified in the study	P value
Mean age of patients	26.53±7.4 (n=129)	31.73±6.6 (n=75)	<0.001
Parity	1.12±1.4 (n=130)	1.73±1.4 (n=75)	<0.001
Mean BMI	28.5±7.6 (n=104)	36.3±9.8 (n=55)	<0.001
SBP	120.8±15.8 (n=118)	139.4±18.5 (n=71)	<0.001
DBP	72.7±14.8 (n=118)	83.0±13.9 (n=71)	<0.001
Baby weight (gram)	2352.0±849.8	2590.9±947.2	0.023
Gestational age	34.8±4.6 (n=130)	35.2±4.5 (n=75)	0.005
Poor neonatal outcome	30 (n=130)	13 (n=75)	<0.001
Gravidity	1.4±1.5 (n=130)	3.1±1.6 (n=75)	<0.001

Summary of key findings

Some15.8% of deliveries were diagnosed with maternal hypertensive disorder in pregnancy. Preeclampsia was the commonest form of maternal HDP followed by gestational hypertension, superimposed preeclampsia on chronic hypertension, and chronic hypertension, and a substantial proportion were multigravidae. In the study, pregnant women who were multigravidae were 1.7 times more likely to develop hypertensive disorders during pregnancy in comparison with primigravidae. HDP occurred in all age groups, with the highest incidence (65.9%) reported among the maternal age range of 20–35 years; and with minimum incidence in mothers aged 40 years and above (6.4%). Lastly, obesity or overweight was an independent risk factor for HDP.

4.2. Discussion

The incidence of HDP varies according to the areas and hospitals within different countries. For instances, an incidence as low as 2.9% was observed in Sweden (Yang, Le Ray, Zhu, Zhang & Hua *et al.,* 2021) while a higher incidence was reported in other countries such as Ethopia with prevalence of 6.07% and 6.8% (Chemeda, Gurmesa, Gedefa & Woldasemayat, 2022), 13.9% in Pakistan (Saleen, Neelum, Sumayya, Amina & Naz *et al*., 2022), 19.4%,17% and 4.9% in Nigeria (Ayogu, Akaba, Offiong, Adwewole & Ekele *et al.,* 2020; Singh, Ahmed, Egondu & Ikechukwu, 2014), 10.64 % in India (Dnanalakshmi, Seema & Narayani, 2022), and 8.2% in Benin (Vodouhe, Obossou, Atade, Kpadonou & Salifou *et al.,* 2021). Incidences greater than 30% have also been reported (Amoah, 2003; Kingue, NgongNgoe, Menanga, Fesuh & Muna, 2015; TabiArrey *et al.,* 2016).

In the current study, the frequency of HDP was 15.8%, which is higher than that (4.6%) reported at Mthatha General Hospital (Buga & Lumu, 1999) and the 6.69% reported at Dora Nginza Hospital (Ojodun, 2012) in similar studies carried out in the Eastern Cape Province. The high figure in the current study may possibly be contributed by the population in Limpopo that Pietersburg Tertiary Hospital is serving given the fact that it is a referral insitution. The variations in this prevalence may result from the difference in types of health facility, geographical locations and settings, study methodology, and the years and periods during which the study was carried out. Although the growing trend in the prevalence of HDP may not be understood, prior studies suggested increasing rates of co-morbidities, such as chronic hypertension, diabetes mellitus, obesity, advanced maternal age, and multiple gestations as being possible explanations.

Several studies have reported that higher and lower maternal ages are an associated risk factor for HDP (Chemeda *et al.,* 2022; Meazaw *et al*., 2020; Temesgen, 2017). In the current study, HDP occurred in all age groups studied but with greater frequency in the 20–35 age group (65.6%), in patients aged 30–35 years (43.1%), those aged 35–40 years (21.6%) and those above 40 years (6.4%). Disturbingly, 13.2% of HDP occurred in teenagers. It is possible that dietary practices of these youth (aged 15 – 19 years) in the current study could be one of the contributing factors towards the development of HDP. For instance, suboptimal nutrient intake (<67%) of average estimated requirements for energy, calcium, iron including fruit and vegetables were reported among pregnant youth at Polokwane local municipality (Bopape, Alberts & Mbhenyane, 2018). Comparison with age groups in the current study showed,

however, no statistically significant difference between pregnant women younger than 20 years and older than 40 years with HDP (χ^2 = 0.096p = 0.757 with Yates correction). However, group comparison between the 20 to 39 year and < 20 year and ≥ 40-year groups reflected a statistically significant difference among these groups (χ^2 = 10.09p = 0.001 and χ^2 = 47.82 p < 0.001). Studies from Ethiopia and Pakistan reported that a greater proportion of their HDP patients occurred in patients greater than 35 years of age (Chemeda *et al.,* 2022; Saleem *et al.,* 2022). The likelihood of having HDP in women above 35 years was 5.3 times greater in comparison with younger pregnant women in a study conducted in Tanzania (Mwanri, Kinabo, Ramaiya & Feskens, 2015). Furthermore, a case-control study done in Ethiopia found that HDP in women above 30 years was seven times higher compared younger pregnant mothers (Ayele & Agedew, 2016). A study done in Kenya found younger women had increased risk of having HDP compared to older pregnant women (Omenya, Nyamongo & Emitaki, 2018). Even though the trends in HDP were observed in all age groups, more focus must be drawn in the management of advanced maternal age women diagnosed with HDP. Also, women with HDP aged < 20 years with poor foetal outcomes have to be a concern to obstetricians. In SA, the higher the maternal age at delivery the higher the risk of the child developing future hypertensive disorders in pregnancy, and this results in potentially poor maternal and perinatal outcomes.

Several studies have reported a statistical significance between increased BMI and HDP (Ayele *et al.,* 2016; Mwanri *et al.,* 2015; Singh *et al.,* 2014). One hundred and thirteen (71.5%) of the patients in the current study had BMI of ≥ 25 kg/m^2 and 28.5% (n=45) of patients had BMI < 25 kg/m^2. A BMI of 22.9% (n=47) could not be reported because of missing information or it not recorded. Higher BMI values are mostly associated with reduced consumption of traditional foods and adherence to a high fat and high sugar diet among the childbearing age group in SA (Madlala, Malaba, Newell & Myer, 2020). Therefore, the similar suggestion is postulated in the current study given the similarity in the settings. A longitudinal study from Nigeria found that the risk of developing HDP in obese women compared with women with a normal BMI was nearly three times higher (Singh *et al.,* 2014). Studies in Ethiopia and Ghana have shown that overweight and obese (BMI of > 25 kg/m^2 and BMI of > 30 kg/m^2, respectively) pregnant women were almost five times more likely to develop HDP compared to those women with a normal BMI, respectively (Kahsay, Gashe & Ayele, 2018; Owirdu, Turpin, Amindu & Laing, 2012). A US multicentre prospective study reported women with 1st-trimester obesity (BMI of 30.0–34.9 kg/m^2) as having approximately double the risk of having

gestational hypertension (aOR 2.5, 95% confidence interval= 2.1-30) and PET (aOR 1.6, 95% confidence interval = 1.1-2.25) compared to women with a BMI of less than 30 kg/m^2, while morbidly obese women (BMI ≥ 35.0 kg/m^2) had three times the risk of developing gestational hypertension (aOR 3.2, 95% confidence interval = 2.6–4.0) and preeclampsia (aOR 3.3, 95% confidence interval = 2.4-4.5) (Weiss, Malone, Emig, Ball & Nyberg *et al.,* 2004). A recent US study of 15.8 million women reported a similar association between obesity (BMI > 30 kg/m^2) and the risk of developing early- and late-onset hypertensive disorders in pregnancy differentiated with a BMI of 18.5–29.2 kg/m^2 (Bicocca, Mendez-Figueroa, Chauhan & Sibai, 2020). The findings of the current study highlight the need to focus on obesity in early pregnancy, as it is significantly associated with developing HDP. In the current study, BMI likely represents those with biological and socioeconomic risk factors of hypertensive disorders in pregnancy. This raises a concern given that the prevalence of maternal obesity has may increase over time.

Pathological mechanisms of the different subtypes of HDP may play different roles in foetal outcomes (Ahmad & Samuelsen, 2012). The current study's findings support the hypothesis that admission/delivery BP levels and foetal outcomes differ between women with preeclampsia and the other HDP types identified.

In the current study we found that management of HDP throughout pregnancy was suboptimal, which caused nearly 9.3% of patients to have a SBP of > 140–160 mmHg, 2.9% at 161–180 mmHg and 2.4% greater than or equal to 180 mmHg, and with DBP of 90–109 mmHg in 10.2% and ≥ 110 mmHg in 2.0% of the patients at delivery/admission. Another study reported that 80% of women at delivery/admission had a BP more than 140/90 mmHg and 24% of them had a BP > 160/110 mmHg (Yang *et al.*, 2021).

Although the number of participants was small in the current study, a positive association (6/205; 2.9%) was found between the previous experience of and current HDP. Furthermore, it has been estimated that a HDP recurrence rate of 35.6% has been reported in women with a history of HDP (Tano, Kotani & Ushida *et al.,* 2021). A study done in Nigerians found that previous HDP meant a four times greater chance of having further HDP in the current pregnancy compared to pregnant women without a history of HDP (Singh *et al.,* 2014). A study done in Cameroon found that pregnant women with a previous history of hypertension in pregnancy had a seven times greater risk of having HDP in their future pregnancies

compared with women without a history of HDP (Tebeu, Foumane, Mbu, Fosso & Biyaga *et al.,* 2011).

Evidence of having HDP with experience of a number of pregnancies is mixed. In the current study, 36.6% of women with HDP were primiparous and 130 (63.4%) were multiparous. In the current study, pregnant women who were multigravidae had a 1.7 times greater chance of having hypertension disorders during pregnancy compared to those pregnant mothers who were primigravidae. Women who were primigravidae are nearly three times more likely to have HDP compared to multiparous mothers in a study from Cameroon (Tebeu *et al.,* 2011). However, an Ethiopian case-control study reported a statistically significant increase in odds of developing HDP for primigravidae patterns compared to multiparous mothers (Hinkosa, Tamene & Gebeyehu, 2020).

In South Africa (SA), HDP is a leading and direct cause of maternal mortality and morbidity and accounts for 18% of all maternal deaths (Moodley, 2018). It was observed that the management of HDP was a challenge at all levels of care. The HDP guidelines were reviewed and developed to ensure a comprehensive and further focus on the problems identified at the different levels of care (Kredo, Wiseman & Gray, 2018). In Ethiopia, HDP attributes for 19% of all maternal deaths (Berhan & Berhan, 2014; Mersha, Abegaz & Seid, 2019). In addition, in Ghana it was found that HDP account for 30% of all maternal mortality (Adu-Bonsaffoh, Obed & Seffah, 2014). No mention was made in the literature that a subcategory of HDP be treated as a separate entity in management. In the current study, a significant proportion of patients with gestational hypertension (18 out of 38) and chronic hypertension (23 out of 27) progressed to preeclampsia and chronic hypertension with superimposed preeclampsia, respectively.

In the current study, 1.95% of women with HDP reported in maternal death compared to 33% (Buga & Lumu, 1999) and 0.79% (790 per 100000 deliveries (Ojodun, 2012). A 4% maternal mortality rate was reported from Ethiopia (Mersha, Abegaz & Seid, 2019). The current findings were lower compared to a study done in Pakistan which found that the maternal death rate among women with hypertension was 6.23% (Hossain, Shah, Khan, Lata & Khan, 2011). The maternal death rate from the current study was more or less comparable to that in other countries, for instance, Saudi Arabia. In the latter country, a 1.3% maternal death rate was reported (Subki, Algethami, Baabdullah, Alnefaie & Alzanbagi, 2018).

The rate of stillbirths in the current study was mostly higher than the rate of early neonatal deaths (20.5 % vs 0.5%). In another study the stillbirth rate was four-fold higher compared to early neonatal deaths (81% vs. 19%) (Endeshaw & Berhan, 2015). Ojodun reported a stillbirth rate of 2.3% (23 per 1000 deliveries) (Ojodun, 2014). Much lower figures were reported by at Mthatha General Hospital which had a stillbirth rate of 112 per 1000 deliveries (Buga, 2014). In addition, Tygerberg Hospital reported that of all perinatal deaths, 9.2% were caused by HDP complications (Talip, Theron, Steyn & Hall, 2010).

In an Ethiopian study, pregnant women with HDP had an associated prevalence of 25% perinatal mortality (Mersha, 2019) compared to 20.9% observed in the current study. The lower prevalence of perinatal mortality in the current study could be related to the improved patient care for disease management during pregnacy, referral and transport system used for patients from one institution to the other. This finding is similar to a study done in Pakistan which found was perinatal mortality of 17.5% for those pregnant women with HDP (Hossain *et al.,* 2017). However, this is different from a Norwegian study done among pregnant women which profiled 9.2% perinatal mortality. These differences can be explained by the quality of follow-up received by a pregnant woman (Ahmad & Samuelsen, 2012). In Ethiopia, the perinatal death rate was reported at 317 per 1000 births (Wolde, Segni & Woldie, 2011), 230/1000 births in Pakistan (Nusrat, Ahson & Munir, 2010), and 144/1000 births in Turkey (Yücesoy, Ozkan, Bodur *et al.,* 2005).

HDPs are strongly associated with several maternal complications. In a study by Odjoun (2012), 43.9% of mothers had complications caused by hypertensive disorders compared to 24.6% noted by Buga and Lumu (1999). More than 80% of the women experienced maternal complications associated with maternal hypertensive disorders in the current study, and this involved pulmonary oedema (2.4%), abruptio placentae (8.3%), HELLP syndrome (20%), maternal death (1.95%), acute kidney injury (10.2%), anaemia (29.1%), and CVA (2.0%). Buga and Lumu reported maternal complications which included, other than eclampsia, abruptio placentae (1.7%), pulmonary oedema (3.9%), HELLP syndrome (1.2%), acute kidney failure (0.9%), DIC (0.5%), coma with cerebral pathology (0.5%), and maternal death (1%) (Buga & Lumu, 1999).

The HELLP syndrome complications affect 13% of pregnant Ethiopian mothers with hypertensive disorders during pregnancy (Mersha *et al.,* 2019). Another study by Karumanchi *et al.* reported a similar finding of a 10–20% rate of HELLP syndrome in pregnant mothers

diagnosed with preeclampsia (Karumanchi, Maynard, Stillman, Epstein & Sukhatme, 2005). In the current study, HELLP complicated the condition of 20% of women with HDP.

Similar to other published estimates (Chesley, 1985), the current research found that women (23%) with chronic hypertension (HT) had superimposed preeclampsia. Previous studies have shown a positive association between chronic hypertension and superimposed preeclampsia (Redman, Sargent & Staff, 2014; Redman & Staff, 2015; Redman, Staff & Roberts, 2020; Spradley, 2017). In the current study, the rate of chronic hypertension progression to chronic hypertension superimposed on preeclampsia was 85.2%, which is significantly higher than the 17–25% reported in an earlier study (Chappell, Enye, Seed, Briley, Postin & Sherman, 2008; Sibai, 2002; Sibai, Koch, Freire, Pinto e Silva & Rudge, 2011). Patients admitted at Pietersburg hospital are mostly referrals from district hospitals and other health centres in which a history related to the frequency of follow ups to detect the progression of chronic hypertension progression to chronic hypertension superimposed on preeclampsia remains unknown or may not be easily explained.

In the current study, 47.4% progressed from gestational HT to PET, which was consistent with the 46% progression reported by Burton, O'brien, Bergauer, Jacques and Sibai *et al*. (2001). This rate of progression from gestational HT to PET was significantly higher than the 17.1% reported by Yemane Teka, Ahmedet *et al.* (2021) and the 15.25% reported by Saudan, Brown, Buddle and Jones (1998). In the latter research, females with PET from GH presented earlier than those who remained with gestational HT until delivery. In the current study, the criteria used to diagnose progression are unknown, but this requires further investigation; earlier studies used a urine dipstick (1^+, 2^+ or 3^+) to diagnose progression. It was observed that as you increase the urine dipstick levels to diagnose progression, the rate of progression decreases.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study aimed to determine the extent of hypertensive disorders in pregnancy at Pietersburg Tertiary Hospital, Limpopo Province. HDP, particularly preeclampsia, was the major high-incident subtype in pregnancy at Pietersburg Hospital. Some demographic variables had a strong association with HDP. HDP can be viewed as a vital process, and, therefore, consideration should be given to the management of hypertension during pregnancy and encouraging the individualised management of hypertension. As a result of varying risk factors included in four HDP subtypes, different strategic management needs to be developed and implemented. The researcher suggests that BP management goals and strict targets should be based on the different HDP subtypes and must be contemplated in future guidelines.

5.2. Recommendations

Quality of care that is given to women diagnosed with HDP at Pietersburg Hospital should be improved to enhance maternal and perinatal outcomes related with these conditions. In addition, further research is needed to scrutinise causes and adverse results (for the 63.4% [n=130]) for pregnant women with preeclampsia. The very high incidence of perinatal deaths indicates the need to overhaul the approach of a multidisciplinary team to these women with these disorders and their babies at this hospital. The results highlight the importance of discussing modifiable risk factors among women during early pregnancy, for example, obesity and anaemia, as it has shown an association with developing HDP.

5.3. Limitations of the study

The study duration and sample size restricted the extent of this study of hypertensive disorders in pregnancy. In addition, the study was retrospective in respect of the drawbacks related to missing information and the dichotomous categorisation of other classes of hypertensive disorders in pregnancy and preeclampsia.

The study involved singleton mothers with pregnancies that are complicated by different types of HDP, which illustrates the confidence of the perinatal outcomes among the groups, so serving as a strength of this study.

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Annexure A: Ethical Approval Letter (TREC)

University of Limpopo
Department of Research Administration and Development
Private Bag X1106, Sovenga, 0727, South Africa
Tel: (015) 268 3766, Fax: (015) 268 2306, Email: trec@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

MEETING: **09 January 2023**

PROJECT NUMBER: **TREC/19/2023: PG**

PROJECT:

Title:	Hypertensive Disorders in Pregnancy at Pietersburg Tertiary Hospital in Limpopo Province, South Africa.
Researcher:	TH Malebana
Supervisor:	Dr LL Makunyane
Co-Supervisor/s:	Dr K Baloyi
School:	Medicine
Degree:	Master of Medicine in Obstetrics and Gynecology

PROF D MAPOSA
CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number: **REC-0310111-031**

Note:

i) **This Ethics Clearance Certificate will be valid for one (1) year, as from the abovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.**

ii) **Should any departure be contemplated from the research procedure as approved, the researcher(s) must re-submit the protocol to the committee, together with the Application for Amendment form.**

iii) **PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.**

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Annexure B 1: Permission Letter: Department of Health (Limpopo Province)

Head of Department
Department of Health (Limpopo Province)
Private Bag X 9302
Polokwane
0700

School of Medicine
University of Limpopo, K - Block
Private Bag X 1106
Sovenga
0727

Dear Sir/Madam

RE: PERMISSION TO CONDUCT ACADEMIC RESEARCH

I, Malebana Thabo Harmonean (210091727), a master's student from the Department of Obstetrics and Gynaecology at the University of Limpopo, hereby request permission to conduct a research study at Pietersburg Hospital (Capricorn District), Gynaecology Ward. The title of the research is "**Hypertensive disorders in pregnancy at Pietersburg Tertiary Hospital in Limpopo Province, South Africa".** The purpose of the study is to determine the prevalence of hypertensive disorders in pregnancy at Pietersburg Tertiary Hospital in Limpopo Province, South Africa which the researcher believes will benefit in contributing to the body of knowledge in the existing literature and possibly prompt interventions related to hypertensive disorders. This research obtained ethical clearance from the Turfloop Research and Ethics Committee (approval attached). An approved copy of the research document explaining the details of the research is also included as part of the attachments. For further clarifications, the researcher may be contacted on the details appearing at the bottom of this letter.

Hoping the contents will be found to be in good order and that we will hear from your office soon.

Kindest regards,

Malebana TH
210091727@keyaka.ul.ac.za
Cell: 0726207256

Annexure B 2: Permission Letter: Pietersburg Hospital (Capricorn District)

The Chief Executive Officer
Pietersburg Hospital (Capricorn District)
Private Bag X 9315
Polokwane
0700

School of Medicine
University of Limpopo, K - Block
Private Bag X 1106
Sovenga
0727

Dear Sir/Madam

RE: PERMISSION TO CONDUCT ACADEMIC RESEARCH

I, Malebana Thabo Harmonean (210091727), a master's student from the Department of Obstetrics and Gynaecology at the University of Limpopo, hereby request permission to conduct a research study at Pietersburg Hospital, Gynaecology Ward (Capricorn District). The title of the research is "**Hypertensive disorders in pregnancy at Pietersburg Tertiary Hospital in Limpopo Province, South Africa".** The researcher requests access to six months of records (January–June 2022) at the Registry Department of pregnant women, which are generated from the Gynaecology Ward, to help achieve the aim of the research. The aim is to determine the prevalence of hypertensive disorders in pregnancy at Pietersburg Tertiary Hospital in Limpopo Province, which the researcher believes will contribute to the body of knowledge in the literature and possibly prompt interventions associated with hypertensive disorders. This research obtained ethical clearance and approval from the Turfloop Research and Ethics Committee and the Limpopo Department of Health, respectively (approvals attached). An approved copy of the research document explaining the details of the research is also included as part of the attachments. For further clarification, the researcher may be contacted using the details appearing at the bottom of this letter.

Hoping that the contents are in good order and that we will hear from your office soon.

Kindest regards,

Malebana TH
210091727@keyaka.ul.ac.za
Cell: 0726207256

Annexure B 3: Approval letter from Limpopo Department of Health

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
HEALTH

Ref : LP_2023-02-005
Enquires : Ms PF Mahlokwane
Tel : 015-293 6028
Email : Phoebe.Mahlokwane@dhsd.limpopo.gov.za

Malebana Thabo Harmonean

PERMISSION TO CONDUCT RESEARCH IN DEPARTMENTAL FACILITIES

Your Study Topic as indicated below;

HYPERTENSIVE DISORDERS IN PREGNANCY AT PIETERSBURG TERTIARY HOSPITAL IN LIMPOPO PROVINCE, SOUTH AFRICA

1. Permission to conduct research study as per your research proposal is hereby Granted.
2. Kindly note the following:
   a. Present this letter of permission to the Office Clinical Executive Director a week before the study is conducted.
   b. This permission is **ONLY for Pietersburg Hospital.**
   c. In the course of your study, there should be no action that disrupts the routine services, or incur any cost on the Department.
   d. After completion of study, it is mandatory that the findings should be submitted to the Department to serve as a resource.
   e. The researcher should be prepared to assist in the interpretation and implementation of the study recommendation where possible.
   f. The approval is only valid for a 1-year period.
   g. If the proposal has been amended, a new approval should be sought from the Department of Health
   h. Kindly note that, the Department can withdraw the approval at any time.

Your cooperation will be highly appreciated

pp **Head of Department** 13/01/2023 **Date**

Private Bag X9302, Polokwane
Fidel Castro Ruz House, 18 College Street, Polokwane 0700. Tel: 015-293 6000/12. Fax: 015 293 6211.
Website: http/www.limpopo.gov.za

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Annexure C: Data collection Tool

1. Demographic	1.1 Age:		1.2 Parity:		1.3 Gravity:		1.4 Gestational Age					
2. Booking Status	2.1 Haemoglobin		2.2 RPR		2.3 Rhesus		2.4 Booking BP		2.5 HIV Status			
2.6 Maternal weight					Body Mass Index (BMI)							
3. Type of hypertension disorders	3.1 Gestational hypertension		3.2 Chronic hypertension		3.3 Preeclampsia		3.4 Preeclampsia superimposed on chronic hypertension					
4. Features	4.1 Proteinuria		4.2 Cerebro-vascular accident		4.3 HELLP syndrome		4.4 Placenta abruptio		4.5 Grade			
5. Kidney involvement	5.1 Creatinine		5.3 Eclampsia		5.4 Pulmonary oedema		5.5 PRES		5.6 CVA			
	5.2 Urea											
6. Lab Investigations	6.1 Haemoglobin		6.2 Platelets		6.3 ALT		6.4 AST		6.5 LDH			
7 Outcome of mother 7.1 Maternal Death					7.2 Cause							
8. Mode of Delivery			8.1 Caesarean Section				8.2 Normal Vaginal Delivery					
9. Fetal	9.1 Apgar				9.2 Weight							
	9.3 IUGR				9.4 Medical termination of pregnancy							
10. IUFD		10.1 Macerated still birth				10.2 Fresh still birth						

HDP in previous pregnancy? Yes=1; No=2

If yes, state neonatal outcome…….

Total deliveries during the study period…….

Total HDP cases……

Data Sheet

		Yes		No		
11. Age	1. 15–19 years					
	2. 20–35 years					
	3. > 35 years					
Antenatal care No of visits						
12. Parity						
13. Gestational age at booking	1. < 26 weeks 0 days					
	2. 26–27 weeks 6 days					
	3. 28–31 weeks 6 days					
	4. 32–33 weeks 6 days					
	5. 34–36 weeks 6 days					
	6. > 37 weeks					
Hypertensive disorders of pregnancy (type)						
14. Gestational hypertension						
15. Chronic hypertension						
16. Preeclampsia superimposed						
17. Preeclampsia						
18. Eclampsia						

19. Hemolysis, elevated liver enzymes and low platelets (HELLP syndrome)						
Complications						
Placenta Abruptio						
20. Cerebrovascular accident						
21. Pulmonary oedema						
22. Acute kidney Injury						
23. Posterior reversible encephalopathy syndrome						
Mode of delivery						
24. Caesarean section						
25. Vaginal delivery						
Maternal outcome						
26. Maternal death Alive						
Fetal outcome						
27. Fetal outcome	27.1 Alive					
	27.2 Dead MSB FSB ENND					
	27.3 Apgar >7					
	27.4 Apgar <7					
28. Birth weight	28.1 < 500 gram					
	28.2 500–999 gram					
	28.3 1000–1499 gram					
	28.4 1500–1999 gram					
	28.5 2000–2499 gram					
	28.6 > 2500 gram					

"Apgar below 7 is poor and more than 7 is good in 5 minutes"